Encyclopedia of AGING

EDITORIAL BOARD

Encyclopedia of AGING

David J. Ekerdt, Editor in Chief

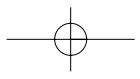
VOLUME 3

Language about Aging – Psychotherapy

MACMILLAN
REFERENCE
USA™

THOMSON
GALE

New York • Detroit • San Diego • San Francisco • Cleveland • New Haven, Conn. • Waterville, Maine • London • Munich



Encyclopedia of Aging
David J. Ekerdt, Editor in Chief

For more information, contact
Macmillan Reference USA
An imprint of the Gale Group
300 Park Avenue South, 9th Floor
New York, NY 10010

Macmillan Reference USA
The Gale Group, Inc.
27500 Drake Rd.
Farmington Hills, MI 48331-3535

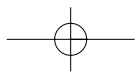
LIBRARY OF CONGRESS CATALOG-IN-PUBLICATION DATA

Encyclopedia of aging / David J. Ekerdt, editor.— 1st ed.
p. cm.
Includes bibliographical references and index.
ISBN 0-02-865472-2 (set : hardcover : alk. paper)
1. Gerontology—Encyclopedias. 2. Aged—Encyclopedias. 3. Aging—Encyclopedias. I. Ekerdt, David J. (David Joseph), 1949-

HQ1061 .E534 2002
305.26'03—dc21
2002002596

ISBNs
Volume 1: 0-02-865468-4
Volume 2: 0-02-865469-2
Volume 3: 0-02-865470-6
Volume 4: 0-02-865471-4

Printed in the United States of America
10 9 8 7 6 5 4 3 2 1



L

LANGUAGE ABOUT AGING

Social phenomena and social practices often exist long before they receive an identifying label. The subsequent act of naming an activity is significant because it allows people to refer to it. The word *ageism* is a case in point. Until Robert N. Butler introduced the term in 1969, there was no uniform way to refer to the behaviors associated with the practice of ageism, even though the activity had existed long before it acquired a label. This word now appears in virtually every dictionary of the English language published since the 1970s. The first definitions of ageism focused almost exclusively on its negative characteristics, since much of the treatment of older adults in society constituted mistreatment. The term may allude to prejudice (stereotypes and attitudes) or to discrimination (personal or institutional). Prejudice exists in the mind and represents stereotypical notions about individual members of a group based on misinformation or erroneous observations. Discrimination is a deliberate act, based on prejudice, perpetrated against members of a group. Once ageism received a name, scholars began to describe its various societal manifestations, concentrating their research on its harmful instances. Nevertheless, ageism also has a positive dimension, one which views older adults and aging in a strictly favorable light. Both views, of course, may result in misrepresentations and stereotypes about older adults.

Even though most definitions of ageism focus on its negative properties, one definition captures the duality of this term. Erdman B. Palmore defines this concept simply and accurately as "any prejudice or discrimination against or in favor of an age group" (Palmore, p. 4). Because most discussions of ageism focus solely on the negative aspects of this practice, Palmore's definition is preferable because of its balance. Palmore rightly points out that ageist prejudice and discrimination may be either negative or positive.

Language, or words, constitute an intermediate point between an attitude and an act. In this sense, the words chosen by an individual provide a strong indication about that person's beliefs, and possibly actions, towards members of an identifiable group. Just as words have the power to harm or to heal people, ageist vocabulary may also have the same effect. As we shall see, the vocabulary alluding to older people is largely negative, hence its potential to harm is far more significant.

Addressed here are the following aspects of language about aging: (1) an appropriate name for older adults; (2) the vocabulary about older adults and aging; (3) metaphoric language; (4) proverbial language; (5) slogans; and (6) names and forms of address.

Designations for older adults

The appropriate designation for people who are older has been a debatable issue. A 1979 Harris Poll conducted for the National Council on the Aging provided a list of ten terms (*aged person, elderly person, golden ager, mature American, middle-aged person, old man/old woman, old timer, older American, retired person, senior citizen*) to determine their acceptability among older adults—defined as people over the age of sixty-five. The results of this survey indicated that the most liked

terms were *senior citizen, retired person,* and *mature American*.

In an empirical study of the naming preferences of three separate age groups (17–44, 45–64, and 65 and older), Carole A. Barbato and Jerry D. Feezel examined the reactions of members of each group to the following lexical terms for older adults: *mature American, retired person, senior citizen, golden ager, old timer, elderly, aged person, old folks, biddy,* and *fogie*. The results of this experiment showed that respondents from all three age groups favored *mature American, senior citizen,* and *retired person*. The two oldest groups had a favorable reaction to *senior citizen* and *mature American*. The youngest group of respondents liked *elder,* but only one positive response for this term occurred in the other two age groups. The other three preferred terms, in order of preference, were *retired person, golden ager,* and *elderly*.

In their discussion of the results of this study, published in the *Gerontologist,* Barbato and Feezel note that Frank Nuessel (1982) viewed the term *elderly* as neutral and nonstereotypic. They point out that this term ranked among the lowest in their study. Nevertheless, in their own examination of the 1984 and 1985 issues of the *Gerontologist, elderly* was found to be the most frequently used expression. Barbato and Feezel (p. 531) further note that, two years later, Nuessel (1984) believed that *elder* was a more neutral term. In a response to the Barbato and Feezel article, Nuessel (1987) argues that the imposition of a term on older adults may not be the best approach to this terminological issue. Since naming is a question of self-definition, a group-determined appellation may ultimately be the best solution.

Times, like language, change, and the editors of this volume have avoided the terms *the aged* and *the elderly*. In place of the latter, the expressions *older adults* or *elderly persons* have been used. This change in preference for terms to refer to older adults is reflected elsewhere, such as in the *Thesaurus of Aging Terminology* (Diliberti and Eccles, p. 43), where, under the entry "elderly," the reader is advised to use the expression *older adults*. Under the entry "older adult," the editors state that this phrase has been "assigned routinely to all documents focusing on persons aged 60 and older." Clearly *older adult* has become the preferred professional term.

Vocabulary about older adults and aging

The vocabulary about aging consists of two basic types. On the one hand, there is the vast array of technical terminology, usually of Greco-Latin origin and generally considered to be neutral or nonageist, that appears in professional publications such as those published by The Gerontological Society of America (i.e., the *Gerontologist* and the *Journals of Gerontology*). Specific examples of professional terminology of Greek origin include: *geriatrician, geriatrics, gerontologist, gerontology, geropsychology, gerontophilia,* and *gerontophobia*. Expressions of Latin derivation include the following: *sexagenarian, septuagenarian, octogenarian, nonagenarian,* and *centenarian*.

Another group of English words about older adults and aging also exists. These expressions occur in ordinary conversation, and virtually all of them disparage older adults in various ways. Of an extensive vocabulary of perhaps 450,000 words, a relatively small, though frequently used, number of these lexical items refer to aging and older adults. Two studies on the vocabulary of ageist language have documented some of the most common ageist expressions. Both of these studies (Nuessel 1982, 1984) found that the popular vocabulary for older adults is largely negative. Despite the abundance of disparaging expressions for older adults, however, there are a few favorable terms used to allude to older adults, such as *mature, mellow, sage, venerable, veteran,* and *wise*. Although the adjective *old* generally bears a negative connotation when applied to people, it has a positive sense when applied to objects such as brandy, wine, cheese, lace, and wood. It is perhaps reflective of our society that old things possess more value than old people. The deprecating verbiage for older adults and their attributes, however, far surpasses the relatively few positive words.

Language may be spontaneous (e.g., the words employed in everyday speech), or it may be deliberate and calculated (e.g., word used in the print media, including greeting cards, newspapers, magazines, books, and cartoons—or in the nonprint media, such as television shows, movies, music videos, video games, and song lyrics). The source of most nonprint media language derives from an original script, so there is ultimately a written source for visual and auditory media. Negative linguistic ageism may manifest itself in different ways. In discourse or in writing, ageist language may be explicit and

blunt. Some individuals automatically refer to older adults in terms of preconceived notions about them. Such notions include *distortion,* which is the attribution of negative physical, behavioral, and mental traits to older adults (i.e., *toothless, grumpy, senile*); and *degradation,* which alludes to the practice of portraying older adults as physically obnoxious or intellectually inferior (i.e., *decrepit, foolish*).

Scripted material is a major source of calculated caricatures of older adults and old age. The birthday card provides the most ubiquitous example. A visit to any card shop provides numerous examples of this verbal depiction of older adults and old age. Humorous cards about old age frequently allude to its negative characteristics, which are reflected in the language, such as allusions to such caricatures as the *dirty old man*—often also reflected in unflattering line drawings. Many of the verbal allusions in these cards relate to behavior (*cranky, silly*) or physical appearance and demeanor (*rumpled, shriveled*).

In plays, stage directions provide actors with the author's visual and mental conceptualization of various characters. This interlinear commentary frequently alludes to the nonverbal behavior of the character to be portrayed, especially older adults. Words alluding to the kinesic behavior, or the significant bodily movements, of an older character may include expressions such as *teetering, unstable,* and so forth. Other vocabulary items that refer to paralanguage, or how something is said, are often associated with older characters, including verbs like *mumble* and *mutter.* Other stage directions for older characters that reflect their stereotypic conceptualization by the author involve words that refer to manifestations of physical problems, such as *drool* and *totter.* Additional verbal descriptions may appear as verb phrases referring to certain problems associated with old age, including *to cup one's ear* to indicate a hearing deficit or *to squint* to signal a visual problem. Samuel Beckett's one dramatic piece *Krapp's Last Tape,* for example, describes the protagonist in the following terms as "very near-sighted" and "hard-of-hearing" (p. 9). The author uses specific kinesic verbs such as "fumble" (p. 10) to signify the character's lack of agility, and the phrase "cup the ear" (p. 13) to allude to the character's hearing impairment. The paralinguistic expression "fit of coughing" (p. 17) stands for his poor health.

Certain negative descriptive adjectives frequently refer to older adults. These descriptors fall into specific categories: (1) physical appearance (*decrepit, frumpy, wrinkled*); (2) behavioral patterns (*crotchety, fussy, garrulous, grouchy, grumpy, miserly*); (3) physical ability (*debilitated, feeble, infirm, rickety*); and (4) mental ability (*doddering, eccentric, feebleminded, foolish, rambling, senile*). A selected listing of terminology used to refer to older adults and aging appears in Table 1.

Metaphoric language

In traditional literary analysis, a metaphor is a figure of speech or a linguistic adornment intended to enhance the expressive qualities of a text. George Lakoff and Mark Johnson (1980), however, have shown that metaphoric language constitutes a way of viewing the world that directly influences people's perception of it. A metaphor is an implied comparison, and it has the form A = B (e.g., "John is a snake." Here, the hearer has to fill in certain information generally known about the appearance and behavior of a snake). In this sense, a metaphor describes the unknown in terms of the known. Metaphors are thus powerful cognitive devices, since they allow one dimension of the world to shape another. Thus, metaphors function as a linguistic mechanism that selects and filters certain aspects of the real world and projects these dimensions onto other parts of it. In this constructivist view of metaphor, one in which language shapes our perceptions of reality, a decidedly negative view of older adults and old age emerges. One common geriatric metaphor is OLD AGE IS TERMINAL DECLINE. This conceptual metaphor may produce a negative ageist view of older adults because it considers old age to be a period of deterioration and decadence. This perspective may thus facilitate medical undertreatment of older adults because of its erroneous view of old age as one of irreversible degeneration.

A subcategory of metaphor is metonymy (the use of the part for the whole). Within health care settings, metonymy is a common way to allude to older adults; the use of such expressions as *the sick heart, the broken hip,* or *the cancerous liver* are examples. In some respects, these references underlie Western medicine's belief that the human body is a mechanism with replaceable or repairable parts.

Table 1
A Selected List of Ageist Terms and Expressions

A Selected List of Ageist Terms and Expressions

Act one's age	Graybeard
Aged	Grimalkin
Anachronism	Grouch
Anectodage	Grouchy
Anile	Grump
Anility	Grumpy
Antediluvian	Hag
Antiquated	Harridan
Back number	Infirm
Bag	Infirmity
Baldy	Lawrence Welk Generation
Bat	Little old lady
Battle ax(e)	Maid
Biddy	Miser
Bottle-nose	Miserly
Caducity	Mumble
Cantankerous	Mummy
Codger	Murmur
Constipated	Obsolete
Convalescent center	Old
Coot	Old buzzard
Crank	Old cornstalk
Cranky	Old crock
Crone	Old duffer
Crotchety	Old guard
Cup one's ear	Old hat
Debiliated	Old Nick
Debility	Old wives' tale
Declining years	Old-fangled
Decrepit	Old-fashioned
Decrepitude	Old-timer
Dirty old man	Oldster
Doddering	Out to pasture
Dotage	Outmoded
Dotard	Over the hill
Dote	Overage
Drool	Past one's prime
Eccentric	Peevish
Fart	Pop
Feeble	Rambling
Feebleminded	Reprobate
Flabby	Rickety
Fogy (fogie)	Second childhood
Fogyish	Senile
Fogyism	Senile dementia
Fool	Senility
Foolish	Senior Citizen
Fossil	Show one's age
Frail	Silly
Fuddy-duddy	Squint
Fussbudget	Spinster
Fussy	Superannuated
Gaffer	Teetering
Galoot	Totter
Garrulous	Toothless
Geezer	Trot
Generation gap	Twilight years
Geriatric ghetto	Unstable
Geritol generation	Useless
Goat	Wizen
Goose	Wizened
Granny (grannie)	Wrinkled
Gray panthers	

SOURCE: Author

Proverbial language

Many dictionaries define proverbs as brief, fixed popular sayings that state a commonly held belief. A study of seventy-two Italian proverbs about aging and older people (Nuessel 2000a, p. 312) found that thirty-nine were positive, thirty were negative, and three were ambiguous in their interpretation. In their thematically arranged dictionary of American proverbs, Mieder, Kingsbury and Harder (1992, pp. 12–13, 437–438) include ninety-eight proverbs and variants under the rubrics *age, aged,* and *old*. Of these, seventy-five depict old age in a negative fashion, while twenty-three offer a positive view. Proverbs such as "nature abhors the old" and "there is no fool like an old fool" reflect the negative perspective in proverbial language, while "with age comes wisdom" and "old foxes are not easily caught" express the positive viewpoint.

Slogans

Related to proverbial language is the slogan—a memorable, fixed catchphrase intended to advance some cause. The ubiquitous bumper sticker is one of the most common manifestations of this linguistic form. Some of the better known examples of slogans have a positive reference, including "age is just a number" and "older is bolder." These slogans often affirm old age and older adults.

Names and forms of address

In interpersonal communication, forms of address and names define social relationships. The use of a person's first name indicates a close, long-standing relationship, hence the expression "to be on a first name basis." Nevertheless, there are circumstances in which the use of an appropriate title (Mr., Mrs., Miss, Doctor, etc.) and surname is necessary because of the formal nature of the discourse; these include job interviews, initial contact with a person, and so forth. This use of forms of address and personal names, though not formalized, derives from implicit rules of discourse that set the stage for ongoing social relationships. Their use thus reveals much about personal associations (e.g., the use of a formal form of address by one conversational participant and an informal one by the other signals the dominant and subordinate speaker). The inappropriate use of forms of address and names may have the effect of infantilizing older adults. Such

patronizing and demeaning usage often occurs in health care and geriatric facilities.

Negative linguistic ageism frequently manifests itself in the names and in the forms of address used with older adults. This sort of language behavior is a verbal indication of the infantilizing process. There are five common examples of this subtle form of linguistic abuse. The first one involves the use of an older adult's first name, especially by a younger person, without first asking permission to do so. This tactic immediately establishes power relationships in a conversation. It should be noted, however, that there is a tendency in contemporary U.S. society to use a person's name without seeking permission though many older adults are not accustomed to this practice. Second, the use of diminutive forms of first names, such as *Johnny* or *Annie,* with older individuals is a more degrading usage than using the first name—these are forms that are generally reserved for speaking with small children. A third example involves the inappropriate use of terms of affection and endearment (*dear, honey, poor dear, good girl, good boy*) by people who have no claim to their use. Diminutive forms (*dearie, sweetie*) of these words only add to this infantilizing humiliation. A fourth example of names used with older people includes such generic names as *gramps* or *granny,* which are frequently employed by small children with their older relatives. The fifth form of this kind of linguistic ageism is anonymity. Not using the name of an older person at all marks them as nonentities whose worth is negligible. Two additional examples of linguistic ageism that often take place in health care environments involve pronominal forms. In the first instance, a third person pronominal reference (he, she) is used in the presence of the person being spoken about as if they were unworthy of conversational inclusion (e.g., "he's having a bad day"). A second instance involves the use of the first-person plural pronoun (we) as a subordinating communicative act, such as in the expression "How are we doing today?" It is clear in this usage that there is no sense of solidarity with the older person.

FRANK NUESSEL

See also AGE DISCRIMINATION; IMAGES OF AGING; LITERATURE AND AGING; SOCIAL COGNITION.

BIBLIOGRAPHY

ARLUKE, A., and LEVIN, J. "Old Age as a Second Childhood." *Aging* 346 (1984): 7–11.

BARBATO, C. A., and FEEZEL, J. D. "The Language of Aging in Different Groups." *The Gerontologist* 27 (1987): 527–531.

BECKETT, S. *Krapp's Last Tape and Other Dramatic Pieces.* New York: Grove Press, Inc., 1960, Pages 7–28.

BUTLER, R. N. "Age-ism: Another Form of Bigotry." *The Gerontologist* (1969): 243–246.

BYTHEWAY, B. *Ageism.* Buckingham, U.K.: Open University Press, 1995.

COUPLAND, N.; COUPLAND, J.; and GILES, H. *Language, Society, and the Elderly.* Oxford, U.K.: Blackwell, 1991.

DILIBERTI, W., and ECCLES, M., eds. *Thesaurus of Aging Terminology,* 5th ed. Washington, D.C.: Research Information Center, American Association of Retired Persons, 1994.

KENYON, G. M.; BIRREN, J. E.; and SCHROOTS, J. J. F., eds. *Metaphors of Aging in Science and the Humanities.* New York: Springer, 1991.

LAKOFF, G., and JOHNSON, M. *Metaphors We Live By.* Chicago: University of Chicago Press, 1980.

MIEDER, W.; KINGSBURY, S. A.; and HARDER, K. B., eds. *A Dictionary of American Proverbs.* New York: Oxford University Press, 1992.

NUESSEL, F. "The Language of Ageism." *The Gerontologist* 22 (1982): 273–276.

NUESSEL, F. "Ageist Language." *Maledicta* 8 (1984–1985): 17–28.

NUESSEL, F. "Letter to the Editor." *The Gerontologist* 27 (1987): 809.

NUESSEL, F. *The Image of Older Adults in the Media: An Annotated Bibliography.* Westport, Conn.: Greenwood Press, 1992a.

NUESSEL, F. *The Semiotics of Ageism.* Monograph Series of the Toronto Semiotic Circle, No. 10. Toronto: Toronto Semiotic Circle, 1992b.

NUESSEL, F. "Metaphors of Aging." *Semiotica* 97 (1993): 177–188.

NUESSEL, F. "Metaphorical Constructs, Aging, and Health Care Delivery." *Signifying Behavior: A Journal of Research in Semiotics, Communications and Cognitive Science* 1 (1994): 201–213.

NUESSEL, F. "Future Directions for Research on the Media Depiction of Older Adults: A U.S. Perspective." In *Images of Aging in Western Societies.* Edited by Cornelia Hummel and Christian J. Lalive D'Epinay. Geneva, Switzerland: Centre for Interdisciplinary Gerontology, University of Geneva, 1995. Pages 287–319.

NUESSEL, F. "The Depiction of Older Adults and Aging in Italian Proverbs." *Proverbium* 17 (2000a): 299–314.

NUESSEL, F. "The Use of Metaphor to Comprehend and Explicate Scientific Theory." In *Semiotics as a Bridge between the Humanities and the Sciences*. Edited by Paul Perron, Leonard G. Sbrocchi, Paul Colilli, and Marcel Danesi. Ottawa, Ontario: Legas Press, 2000b. Pages 479–500.

NUESSEL, F., and STEWART, A. V. "Research Summary: Patronizing Names and Forms of Address Used with Older Adults." *Names* 47 (1999): 401–409.

PALMORE, E. B. *Ageism: Negative and Positive*, 2d ed. New York: Springer Publishing Co., 1999.

WARD, R. A. *The Aging Experience: An Introduction to Social Gerontology*. New York: J. P. Lippincott Co., 1979.

LANGUAGE COMPREHENSION

Language comprehension is an important aspect of day to day functioning in adulthood. Comprehension of written and spoken language relies on the ability to correctly process word and phrase meanings, sentence grammar, and discourse or text structure. Difficulties in any of these domains can produce comprehension problems. Age-related memory declines have been reported in many studies comparing younger and older adults on language comprehension tasks. Therefore, it is believed memory capacity limitations in older adults may cause language comprehension problems (Wingfield and Stine-Morrow). In particular, age-related declines in the capacity of working memory to temporarily store linguistic information may be responsible for older adults' language comprehension problems. Older adults have typically been found to have smaller working memory spans than young adults and such span measures have been found to correlate with language comprehension measures. Van der Linden, and colleagues (1999) tested young and older adults on their ability to understand texts and recall sentences and words. They were also given a large battery of tests designed to measure processing speed, working memory capacity, and the ability to inhibit distracting thoughts. The analysis indicated that these three general factors (speed, working memory, inhibition) did account for age-differences in performance on the language processing tasks. Further, Van der Linden, and others concluded that "age-related differences in language, memory and comprehension were explained by a reduction of the capacity of working memory, which was itself influenced by reduction of speed, [and] increasing sensitivity to interference. . ." (p. 48).

Interference arising from a breakdown of inhibitory mechanisms appears to contribute to language comprehension problems (Hasher, Zacks, and May) by permitting the intrusion of irrelevant thoughts, personal preoccupations, and idiosyncratic associations. These irrelevant thoughts compete for processing resources, such as *working memory* capacity, and impair older adults' comprehension and recall. Hence, older adults' comprehension may be affected by distractions or intrusive thoughts. This hypothesis received support from a study by Kwong See and Ryan. Kwong See and Ryan examined individual differences in text processing attributable to working memory capacity, processing speed, and efficiency of inhibitory processes. Their analysis suggested that older adults' text processing difficulties can be attributed to slower processing and less efficient inhibition, rather than to working memory limitations.

Research by Connelly, Hasher, and Zacks compared passage reading times and answers to probe comprehension questions for young and older adults for texts that did or did not have distracting material interspersed amid target texts. The distractors, presented in a different type face, consisted of words or phrases conceptually related to the content of the target text and recurred over and over again throughout the target text. Connelly et al. reported that young adults not only read the texts containing the distracting material more rapidly than older adults but that they also showed greater comprehension of the target material. Connelly and colleagues' conclusion has been challenged by Dywan and Murphy who modified the procedure to include a surprise word recognition test for the interposed material. They found that the young adults had superior recognition memory for the distractor words, a result that is difficult to explain if the young adults are assumed to have been successful at inhibiting processing of the distractors. Burke also argues that research on the activation of word meanings and the detection of ambiguity provides "no support" for claims that "older adults are deficient in suppressing contextually irrelevant meaning or that they activate more irrelevant semantic information than young adults or that they retrieve more high frequency, dominant, or typical information than young adults" (p. P257).

Strategy differences may also underlie other age differences in language comprehension by affecting how readers process individual words. In general, young and older adults have been found to use similar reading strategies; however, age differences in reading strategies have been reported for specific aspects of syntactic and semantic processing. Stine found that young and older adults allocate reading time in similar ways to word-level and phrase-level processing. However, she also found young adults spent extra time reading words that occurred at sentence boundaries, minor clause boundaries, and major clause boundaries. While older adults also allocated extra time to major and minor clause boundaries, they did not spend extra time at sentence boundaries, suggesting older adults spend less time on sentence-level integration than young adults. Stine-Morrow, Loveless, and Soederberg (1996) let young and older adults read syntactically coherent text at their own pace. Both young and older adults who achieved good recall allocated extra reading time to syntactically complex sentences. However, some age differences were found with regard to other time allocation strategies used to achieve good recall. For young adults, good recall was related to the allocation of additional reading time to infrequent words and to new concepts first mentioned in the text. In contrast, for older adults, good recall was related to the allocation of additional reading time as they progressed serially through the text. These findings indicate that older adults use a different strategy than young adults to achieve good recall. Whereas young adults rely on recalling key words and concepts, older adults may rely on recalling a global text structure that is built up serially.

Despite working memory limitations, inhibitory deficits, and strategy differences, many older adults comprehend spoken and written language proficiently in everyday life. The age-related deficits observed in language comprehension studies may be offset by the ability to fill in missing elements of the discourse with meaningful reconstructions based on background knowledge and everyday reasoning abilities. Speakers and writers may also be able to minimize comprehension problems by using a special speech register, sometimes termed *elderspeak*. Elderspeak uses exaggerated pitch and intonation, simplified grammar, limited vocabulary, and slow rate of delivery. However, the use of elderspeak is controversial. On one hand, elderspeak may benefit older adults by reducing memory and processing demands. On the other hand, it may reinforce negative stereotypes of older adults and contribute to the social isolation and cognitive decline of older adults because it resembles "baby talk." Addressing older adults in "baby talk" by using short, simple sentences delivered very slowly and loudly with contrastive pitch seems to convey the impression to older adults that they are cognitively impaired and have communication problems (Kemper and Harden). Hence, practical techniques for modifying speech and writing targeted at older adults must reduce processing demands without triggering negative stereotypes.

SUSAN KEMPER
RUTH E. HERMAN

See also MEMORY: PERCEIVED HEALTH; HUMAN FACTORS.

BIBLIOGRAPHY

BURKE, D. "Language, Aging, and Inhibitory Deficits: Evaluation of a Theory." *Journal of Gerontology: Psychological Sciences* 52B (1997): 254–264.

CONNELLY, S. L.; HASHER, L.; and ZACKS, R. T. "Age and Reading: The Impact of Distraction." *Psychology and Aging* 6 (1991): 533–541.

DYWAN, J., and MURPHY, W. E. "Aging and Inhibitory Control in Text Comprehension." *Psychology and Aging* 11 (1996): 199–206.

HASHER, L.; ZACKS, R. T.; and MAY, C. P. "Inhibitory Control, Circadian Arousal, and Age." In *Attention and Performance XVII: Cognitive Regulation of Performance: Interaction of Theory and Application*. Edited by D. Gopher and A. Koriat. Cambridge, Mass.: MIT Press, 1999. Pages 653–675.

KEMPER, S., and HARDEN, T. "Disentangling What is Beneficial about Elderspeak from What is Not." *Psychology and Aging* 14 (1999): 656–670.

KWONG SEE, S. T., and RYAN, E. B. "Cognitive Mediation of Adult Age Differences in Language Performance." *Psychology and Aging* 10 (1995): 458–468.

STINE, E. A. L. "On-Line Processing of Written Text by Younger and Older Adults." *Psychology and Aging* 5 (1990): 68–78.

STINE-MORROW, E. A. L.; LOVELESS, M. K.; and SOEDERBERG, L. M. "Resource Allocation in On-Line Reading by Younger and Older Adults." *Psychology and Aging* 11 (1996): 475–486.

VAN DER LINDEN, M.; HUPET, M.; FEYEREISEN, P.; SCHELSTRAETE, M.-A.; BESTGEN, Y.; BRUYER,

R.; LORIES, G.; EL AHMADI, A.; and SERON, X. "Cognitive Mediators of Age-Related Differences in Language Comprehension and Verbal Memory Performance." *Aging, Neuropsychology, and Cognition* 6 (1999): 32–55.

WINGFIELD, A., and STINE-MORROW, E. A. L. "Language and Speech." In *Handbook of Aging and Cognition,* 2d ed. Edited by F. I. M. Craik and T. A. Salthouse. Mahwah, N.J.: Erlbaum Associates, 2000. Pages 359–416.

LANGUAGE DISORDERS

Human communication and socialization to a large degree occur through *language*, which is a symbol system used to represent, convey, and interpret ideas, thoughts, and feelings. Typically one language user (a sender) arranges words or other vocabulary symbols (e.g., gestures, as used in sign language) to express particular intentions or ideas to at least one other language user (a receiver). While many equate language with speech, they are not identical. Speech, along with writing and pantomime, is just one of the channels used to express language. Language is understood through reciprocal channels, like listening, reading, or interpreting manual signs.

Language involves a number of interactive systems related to its content, form, and use. *Semantics* refers to a system of concepts or meanings. The "mental dictionary" that contains vocabulary symbols for expressing and interpreting these concepts is called the lexicon. *Morphology* is concerned with word formation. Morphemes, the smallest units of language that signal meaning, can be single words or they can be add-ons, like possessive or past tense markers, that change the meaning of their root words. *Phonology* refers to the sound system of language (vowels and consonants), and to stress and melody patterns. Although phonology is most obviously connected with the speech channel, there is ample evidence that adults also access phonology when they read silently. *Syntax* involves the ways that words representing different parts of speech can be sequenced to construct acceptable and interpretable phrases, clauses, and sentences. To illustrate, English syntax allows only certain combinations of nouns and verbs (e.g., "The girl ate" is acceptable, but "Ate the girl" is not); and different word orders signal different meanings (compare "The girl told the boy" with "The boy told the girl"). Finally, *pragmatics* is concerned with the ways in which language is used to communicate particular purposes and intents. For example, pragmatics involves the difference between what someone actually says and what they mean by it, as when teasing or being sarcastic. The particular communicators, their shared assumptions and knowledge, and their current social context all are important pragmatic considerations.

Language disorders can take the form of difficulty expressing and/or understanding ideas and intentions through any or all language channels, and can be reflected in disturbances of any or all language systems. Because language is not identical to speech, language disorders are different from speech disorders. The latter may reflect, among other things, abnormalities in vocal tract structures such as the lungs, larynx (commonly known as the voice box), and oral articulators (e.g., tongue, lips, jaw), or difficulties in managing the breathstream, which provides the energy source for speech.

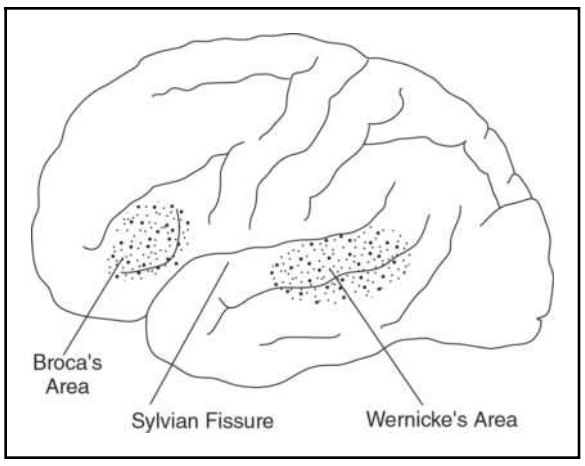
Language disorders in older adults

As people age, they tend to experience changes in language functioning. Some aspects, like the use or understanding of complex syntax, typically show signs of decline. Others, like vocabulary knowledge, improve with age, though the older one gets the more difficult it becomes to retrieve from the lexicon the precise words one wants. While full-blown language disorders are not the norm for elderly people, some particular language disorders are more likely to co-occur with advancing age, because the medical conditions that cause them primarily affect older individuals. These conditions include stroke and dementing illnesses. Their common language after effects include aphasia, right hemisphere communication disorders, and the language of generalized intellectual impairment.

Aphasia is an acquired language disorder. Typically, it is the result of damage to the left side of the brain, which for most individuals is "dominant" for language functions. The damage that induces aphasia is usually cortical and peri-Sylvian, which means that it affects the outermost layers of brain cells that surround the Sylvian fissure (see Figure 1). Most often caused by stroke, aphasia also can result from other conditions, like head trauma, when the brain damage predominantly affects left peri-Sylvian regions.

Aphasia affects both the expression and interpretation of language, through all of its chan-

Figure 1
Left hemisphere of the brain showing the Sylvian Fissure and the approximate location of Broca's and Wernicke's areas of the angular gyrus.



SOURCE: Adapted from Hart, S. and Semple, J. S. *Neuropsychology and the Dementias.* London: Taylor and Francis (1990): 166.

nels, but to different degrees in different individuals depending on the nature and extent of brain damage. Language changes that reflect sensory deficits, such as hearing loss, do not constitute aphasia. Also, language impairment in aphasia is disproportionate to, and cannot be explained by, other types of cognitive changes, such as memory problems.

A word retrieval deficit, or difficulty in selecting the precise words one wants to use from an unaltered lexical store, is a universal symptom of aphasia. These word retrieval difficulties, often called *anomia,* are more frequent and less likely to be resolved than the word retrieval challenges of normal aging. It is important to note, though, that word retrieval deficits are common after any kind of brain damage; thus, they are not diagnostic. The other language systems are variably affected in adults with aphasia.

Classical views of aphasia divide it into syndromes or types, such as Broca's and Wernicke's aphasia. Each type has some expressive and receptive characteristics that grossly differentiate it from other types of aphasia, and that are presumed to stem from damage to particular peri-Sylvian regions in the left cerebral hemisphere. However, it has become clear that damage confined to a particular brain area (e.g., Broca's or Wernicke's area; see Figure 1) does not generate a lasting aphasia of the same type. More generally, the accuracy and value of aphasia syndrome classifications, as well as the correspondence between language disorder profiles and brain lesion locations, are the subject of much debate (see, e.g., commentaries following an article by Yosef Grodzinsky). Research is ongoing to specify the complex relationships among normal brain anatomy and its contribution to the functioning of various language systems, as well as the precise ways in which particular kinds of brain damage produce particular types of language symptoms.

Right hemisphere language disorders also can result from stroke. This time the stroke affects the side of the brain that is not dominant for language; typically, as the name implies, the right hemisphere. These disorders have been systematically studied since the mid-1980s. Because so little is known about the nature of right hemisphere language deficits, there is not yet an appropriate diagnostic label. However, some descriptive generalizations are possible. Strokes that are restricted to the right hemisphere in older adults appear to have little effect on phonology, morphology, or syntax, and their consequences for lexical-semantic processing are unclear. But adults with right hemisphere damage can be particularly impaired in pragmatic aspects of language. As senders, for example, they may have special difficulty supplying content that is appropriate to the communicative circumstances, by assuming that a receiver knows something that he or she does not know, or by being too wordy, too terse, too detailed, too tangential, and/or too vague. As receivers, they may be particularly impaired at understanding implications that are not directly stated, such as those conveyed by nonliteral language (e.g., jokes or irony) or other ambiguous information. These difficulties, while not always immediately obvious to others, can render adults with right hemisphere damage quite socially disadvantaged.

Finally, the *language of generalized intellectual impairment* (Wertz) is a diagnostic label that refers to language disorders resulting from neurologically degenerative processes such as Alzheimer's disease. In people with the language of generalized intellectual impairment, both sides of the brain typically are affected by the degenerative process. Thus, these individuals may have a constellation of language deficits that includes any or all that typify aphasia and right hemisphere lan-

guage disorders. In addition, however, they generally have other cognitive deficits, such as difficulties with memory and attention, that cause, contribute to, or confound their language symptoms.

Many clinicians, including most medical professionals, use the term *aphasia* to refer to language disorders that accompany neurologically degenerative conditions. However, many clinical aphasiologists, like Robert T. Wertz, find value in distinguishing the two labels, in part because prognoses and treatment options differ substantially. People who have strokes improve, sometimes dramatically. This occurs naturally as the brain heals, as well as through language therapy. In addition, as alluded to earlier, the nature of the language impairments typically is different in adults who have simple strokes versus dementias. The language deficits in adults with dementing conditions may be rooted in, or are at least significantly complicated by, profound cognitive impairments, such as difficulties in learning and remembering new material. To illustrate, immediately after they hear a brief prose passage, adults with incipient dementia can retell it normally; but after only fifteen minutes, they may recall nothing about it. This is not the case for adults with the other language disorders reviewed above. For them, the difference between immediate story retelling and short-term recall is much less extreme, and may be on par with that for normally aging adults (e.g., Bayles and Kaszniak).

Language deficits in early Alzheimer's disease and other progressive conditions

As noted above, memory deficits are among the earliest hallmarks of the onset of probable Alzheimer's disease (AD). In the language domain, individuals with suspected early AD have predominantly lexical-semantic impairments. For example, they may have particular difficulty naming pictures, naming items that are described to them (e.g., "what do you use to tell time?"), and generating more than a few common examples of words that start with a given letter of the alphabet. They may also wander from the topic of a conversation and be vague in what they say. Syntax, morphology, and phonology are relatively preserved until the later stages of the disease. Thus, early in the course of AD, language production may be perfectly structured, but "empty" or lacking in content (e.g., "The thing is over there, you know").

Progressive aphasia is a poorly understood condition in which language deteriorates over time, but which only infrequently is identified at autopsy as AD (Mesulam). Like AD, symptom onset and decline are gradual, but in contrast to most cases of AD, language difficulties are the earliest and the primary signs of trouble. While non-language aspects of cognition reportedly are retained for several years after the onset of language symptoms, deficits may be evident with careful testing. Once clearly identified, non-language cognitive abilities may decline less rapidly than language skills.

Again, progressive aphasia may manifest in various ways. Language expression may be effortless and well-formed but low in content, as in early AD, or it may be effortful and "telegraphic" in quality, consisting primarily of nouns and verbs (e.g., "Boy - girl - cookie - falling"). Likewise, language comprehension may be relatively good or poor. According to Mesulam, progressive aphasia often is associated with a loss of nerve cells in relatively focal cortical areas of the brain, but precise causal factors are unclear.

Complications in diagnosing language disorders in older adults

During the aging process, changes in bodily systems such as vision, hearing, or motor control for speech may cause changes in everyday language activities, such as reading the newspaper, following a conversation, or speaking clearly on the telephone. But as implied in the discussion of aphasia, one must be careful to account for or rule out difficulties of this sort before diagnosing a language (or other cognitive) disorder. Depression, while not a normative condition in older adults, is worth noting here as well, because it can reduce performance in testing situations and thus, without careful assessment, masquerade as a language or other cognitive disorder.

Education, and potentially related factors like literacy and language practice or use over the lifespan, also may complicate assessment and diagnosis of language disorders. Performance on aphasia tests, for example, shows a clear relationship to education. As such, unless an examiner is appropriately cautious, traditional assessments may overdiagnose difficulties in people with little formal education or language proficiency. On the other side of the coin, many measures may not be sufficiently sensitive to detect definite

changes in highly educated or literate individuals.

CONNIE A. TOMPKINS
MARGARET T. LEHMAN-BLAKE

See also BRAIN; DEMENTIA; SPEECH; STROKE.

BIBLIOGRAPHY

BAYLES, K. A. "Management of Neurogenic Communication Disorders Associated with Dementia." In *Language Intervention Strategies in Adult Aphasia,* 3d ed. Edited by R. Chapey. Baltimore: Williams & Wilkins, 1994. Pages 535–545.

BAYLES, K. A., and KASZNIAK, A. W. *Communication and Cognition in Normal Aging and Dementia*. Boston: College-Hill, 1987.

FROMKIN, V., and RODMAN, R. *An Introduction to Language,* 4th ed. New York: Holt, Rinehart and Winston, 1988.

GRODZINSKY, Y. "The Neurology of Syntax: Language Use Without Broca's Area." *Behavioral and Brain Sciences* 23 (2000): 1–71.

MELVOLD, J. L.; AU, R.; OBLER, L. K.; and ALBERT, M. L. "Language During Aging and Dementia." In *Clinical Neurology of Aging,* 2d ed. Edited by M. L. Albert and J. E. Knoefel. New York: Oxford University Press, 1994. Pages 329–346.

MESULAM, M.-M. *Principles of Behavioral and Cognitive Neurology,* 2d ed. Oxford: Oxford University Press, 2000.

TOMPKINS, C. A. *Right Hemisphere Communication Disorders: Theory and Management*. San Diego: Singular, 1995.

WERTZ, R. T. "Neuropathologies of Speech and Language: An Introduction to Patient Management." In *Clinical Management of Neurogenic Communicative Disorders,* 2d ed. Edited by D. F. Johns. Boston: Little, Brown and Company, 1985. Pages 1–96.

WINGFIELD, A., and STINE-MORROW, E. A. L. "Language and Speech." In *The Handbook of Aging and Cognition*. Edited by F. I. M. Craik and T. A. Salthouse. Mahwah, NJ: Erlbaum, 2000. Pages 359–416.

LATIN AMERICA

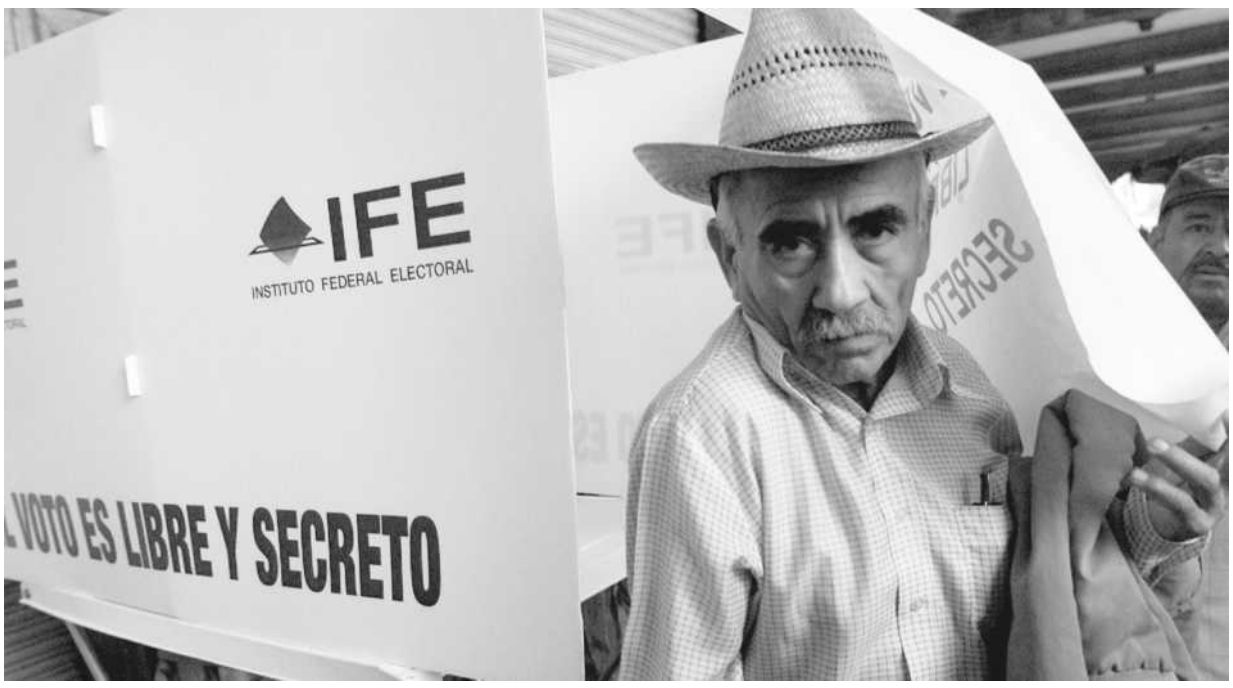
Although Latin American populations are still fairly young (8 percent were over age sixty in 2000), the countries are aging in a quietly rapid way that could soon overwhelm existing infrastructures. Even as they struggle to develop economically, Latin American populations are aging far faster than those in western Europe, Canada, or the United States, a consequence of past successes in fertility and mortality reductions. By 2030 an estimated 1 in 6.3 people in Latin America will be age sixty or above. In addition, future elderly populations there will include a larger proportion of "old old" (age eighty or above), females, and disabled people. The new reality will include an increased demand for adequate pensions and health services. In the short term, at least, the new reality will include large proportions of elders who are poorly educated, who are in the informal economic sector, and who lack adequate health service or pension coverage. The new reality should give cause for concern.

Demographic background

The Latin American population's median age is expected to rise from 23.2 years in 2000 to 33.4 years in 2030, according to recent United Nations medium-variant projections. This is a result of dramatic declines in both mortality and fertility, and, in the short term, of the high fertility and decline of childhood mortality of 1950–1965. In 1950 life expectancy at birth was only fifty-one years, and the infant mortality rate was about 125 per 1000. By 2000 comparable figures were seventy years' life expectancy and 40 per 1000 infant mortality. By 2030 life expectancy is predicted to rise to seventy-six years, and the infant mortality rate to fall to 20 per 1000. In 1950 the total fertility rate was almost six children per woman. In 2000 it was less than three, and by 2030 it is expected to be only 2.2.

The dramatic aging of Latin America's population is occurring much faster than in the United States or western Europe. Whereas it took approximately eighty-four years for Sweden's sixty-five-plus age group to grow from 7 percent to 14 percent of the population, it will probably take only twenty years for the same change to occur in Latin America.

At present Latin America's sixty-plus age group is growing at 3 percent per year, whereas the under-fifteen age group is growing at only 0.08 percent per year. The eighty years and over age group is growing fastest of all, at over 4 percent a year. This latter group is predominantly female. Whereas slightly more males than females are born, projections suggest that by 2025 two-thirds of the population older than age seventy-five will be female.



In Mexico City, Mexico, an elderly man leaves the voting booth after casting his ballot in the Mexican national election on July 2, 2000. (Corbis/Reuters NewMedia photo by Jorge Silva.)

While life expectancy as a whole is rising, many people suffer from poor health in old age. The health of a population group is difficult to quantify. The best information at present is in terms of self-rated health, information supplied by survey respondents regarding their own general health. Many elderly Latin Americans rate their health as poor or fair, levels similar to African-American elders in the United States and much worse than white elders in the United States. Disability among elderly women, compared with elderly men in particular, is high in parts of Latin America. People who survived childhood diseases, and thus became part of the reduction in childhood mortality, carry their weakened condition into old age. Such people live, but do they live well? People everywhere are asking whether longer life means living longer in a healthy state or living longer in a disabled state. For Latin America in particular, the Pan American Health Organization is in the process of gathering information on health-related factors of the elderly population in a number of urban areas.

Generalizations are not meant to neglect the fact that the region's countries are highly diverse. Demographically one can see rather mature countries such as Argentina, in which 13.5 percent of the population was age sixty and over in 2000, and rather young countries such as nearby Bolivia, in which only 6.2 percent of the population was age sixty and over in 2000 (see Table 1).

The proportion of elderly is related not only to factors such as life expectancy at birth, infant mortality, and fertility but also to such social and economic factors as level of urbanization, per capita GNP, number of inhabitants per physician, school enrollment rates, literacy, economic activity, and pensions. When there are higher proportions of elders in the country, there tend to be higher levels of these social and economic factors as well. Let us take literacy, the ability to read and write, as an example.

Literacy

Although people of younger ages tend to be better educated—and thus the future elderly population will be better educated—present elders grew up at a time when many were unable to attain even basic levels of literacy. This low education level among elders is more prevalent in some countries than in others, and more common for females than for males. Consider the

Table 1
Percent of Population 60 and Over

Country	Year 2000	Year 2010
Argentina	13.5	14.4
Belize	5.9	5.7
Bolivia	6.2	6.8
Brazil	8.4	10.2
Chile	10.2	12.1
Colombia	7.0	8.8
Costa Rica	7.5	9.1
Cuba	13.5	16.9
Dominican Rep.	6.8	8.5
Ecuador	6.9	8.2
El Salvador	6.5	7.2
Guatemala	5.5	5.8
Guyana	6.3	7.6
Haiti	5.9	5.9
Honduras	5.2	5.8
Mexico	6.7	8.4
Nicaragua	4.8	5.3
Panama	8.1	10.1
Paraguay	5.7	6.7
Peru	7.0	8.5
Puerto Rico	14.2	16.5
Suriname	7.9	8.0
Uruguay	17.0	16.8
Venezuela	6.6	8.5
Total	8.1	9.6

SOURCE: Annex II of *World Population Prospects: The 1994 Revision.* United Nations, 1995 (ST/ESA/SER.A/145)

Table 2
Percent of Population 65 and Over that Was Literate Circa 1990

	Total	Male	Female
Argentina	91	92	90
Bolivia	40	54	28
Chile	81	81	80
Ecuador	64	70	59
Honduras	36	38	33
Mexico	62	69	50
Panama	68	69	68
Uruguay	86	85	87

SOURCE: U.S. Census Bureau, International Data Base

proportions of persons sixty-five years and older in 1990 in several Latin American countries who were reported to be literate (see Table 2).

Figures such as these help to demonstrate the regional diversity of Latin America, the glaring inequality within many Latin American countries, and the lack of resources available to present-day elders, especially female elders, when they were young. Consider for example, the contrast between Argentina and Bolivia again, or the contrast between males and females within Bolivia.

Living arrangements

Since most elders in Latin America do not participate in an official pension program, old age does not have a clearly defined onset, as it does for many people in developed countries, where retirement age is often used to delineate age groups. But living arrangements, and changes in those arrangements, can be used to observe patterns in the lives of elders in Latin America. For instance, one's marital status (single, married, widowed, etc.) may be a critical determinant of both family status and household arrangements in Latin America. Whereas married elders may live in an extended household, in a nuclear household with unmarried children (if there are unmarried children), or in an "empty nest," unmarried elders typically live with extended kin, with unmarried children (if there are unmarried children), or alone. The older a person becomes, the less likely it is that there is still an unmarried child at home.

Many elders in Latin America do in fact reside with extended kin, and such residence can be viewed as just one way the family cares for its elders. For instance, in 1994 an estimated 53 percent of people age sixty and older in Mexico resided with extended family members. Such coresidence may benefit younger people as well older ones, since the arrangement is often part of an exchange of both monetary and nonmonetary resources. Elders who do not themselves work outside the house for pay may relieve younger people of many of the household chores, such as child care, that would prevent them from working for pay. Aging parents are often part of a family whose members care for each other no matter what.

Many elders do not reside with extended kin, however, but with their nuclear family. In Latin America most elderly men are still married but many elderly women are not, mainly due to widowhood. In Chile in 1992, for example, 24 percent of married people sixty years and older lived only with their spouse, and 15 percent of unmarried people in the same age group lived alone. Thus, although unmarried elderly men were more likely to live alone than unmarried el-

derly women (21 percent vs. 13 percent), a lower proportion of elderly men overall lived alone because most were still married. The proportion of all elders living alone, 7 percent, is relatively low in international perspective. Most people in Latin America cannot rely on pensions. Living alone in Latin America may mean being totally destitute (although living with extended family as a last resort may have its costs as well).

Economic activity and retirement

Activity rates (the proportion of the population that is economically active) for Latin American countries are hard to come by, and even when they are found (e.g., as estimated by the Census Bureau's International Programs Center), the figures tend not to be comparable between countries or even between years in the same country. Still, a picture emerges of fairly high activity rates among males age sixty and over compared with countries such as the United States and Canada, where there are widespread pension programs. (Reported economic activity among older women is quite low.) There appears to be no widespread definition of when "old" means "too old to work," especially for people who draw no pension. For instance, in 1995 roughly a fourth of males age sixty-five and older in Argentina were reported as economically active. Over 40 percent of Colombia's males sixty and over were reported as economically active in 1996. When people retire, it is not usually because they have become eligible for a pension, although activity rates tend to be lower for people in urban areas and/or with more education.

Pension policy

When people retire, they maintain themselves economically in one or more of three ways: savings, dependence on an extended family, a pension. Few Latin American elders appear to have sufficient savings to sustain themselves in old age, and while many elders, especially unmarried ones, reside in extended family households, others reside alone. So what is the pension situation?

Most Latin American countries have had public pension schemes on the books since the 1940s (some as early as the 1920s or as late as the 1960s), but the schemes have often been specific to particular occupations in the formal economy and much of the population consequently has gone uncovered. Sometimes only public servants (including the military) seem to have adequate coverage. Benefit amounts have varied considerably, so that many people receiving a pension have received inadequate amounts. Finally, retirement age has tended to vary; some people have retired as early as age forty-eight (women) or fifty-three (men), while others have had to wait until age sixty-five.

Although pension policies differed, until recently most shared the characteristic of being pay-as-you-go systems, mainly for people in the formal economy. Such systems depend on the current labor force to finance the pensions of retired people. These systems can break down when demographic shifts in the population cause too many elders to be eligible for pensions for the current labor force to support. This problem is compounded when poor economic conditions further erode the pool of pension money available. During the 1980s analysts seemed to heed alarms about demographic aging amid harsh economic conditions in Latin America. The leader in this respect was Chile, with Peru, Argentina, Colombia, Mexico, Uruguay, Costa Rica, and, to some extent, Brazil following. In Chile's system, salaried workers make earnings-related contributions to an investment fund; self-employed workers and workers in the informal economy are not automatically included. In Peru and Colombia the proportion of the labor force contributing to pensions is about one-fourth. The proportion in Chile is higher, but the scheme's effect is not yet known because years of participation are required.

Major pension system reform schemes can be referred to as unitary, dual, or mixed systems. Under a unitary scheme, such as that in Chile and Mexico, people enrolled in the former social insurance scheme are placed into a new capitalization scheme. Dual systems, such as in Colombia and Peru, have both the older social insurance scheme and a newer capitalization scheme. People choose one of the schemes. The mixed schemes of Argentina, Uruguay, and Costa Rica have elements of both types of schemes. Such schemes may reflect older populations, higher income per capita, and a stronger commitment to the redistributive principles behind social insurance.

SUSAN DE VOS
ALBERTO PALLONI

See also CANADA; POPULATION AGING.

BIBLIOGRAPHY

BARRIENTOS, A. "The Changing Face of Pensions in Latin America: Design and Prospects of Individual Capitalization Pension Plans." *Social Policy & Administration* 31 (1997): 336–353.

DE VOS, S., and HOLDEN, K. "Measures Comparing the Living Arrangements of the Elderly." *Population and Development Review* 14 (1988): 688–704.

MARTIN, L. G., and KINSELLA, K. "Research on the Demography of Aging in Developing Countries." In *Demography of Aging*. Edited by Linda G. Martin and Samuel H. Preston. Washington, D.C.: National Academy Press, 1994. Pages 356–403.

MESA-LAGO, C. *Health Care for the Poor in Latin America and the Caribbean*. Washington, D.C.: Pan American Health Organization, 1992.

MESA-LAGO, C. *Changing Social Security in Latin America: Toward Alleviating the Social Costs of Economic Reform*. Boulder, Colo.: Lynne Rienner, 1994.

LEARNING

Learning is the process of forming associations that result in a relatively long-lasting change in the organism. Learning that involves relations between events is called associative learning, and the primary forms of associative learning are called classical and instrumental conditioning. Learning and memory are closely associated phenomena because memory occurs as a consequence of learning.

Older adults typically complain that their memory is not as good as it used to be, even though it may be their ability to learn that is actually most affected. Whereas their memories from the young adult period of their lives may be quite intact, older adults have greater difficulty remembering people's names or the items to pick up at the grocery store. This type of memory involves the formation of new associations and thus involves learning as well as memory. When a memory can be elicited, it indicates that learning has occurred. However, learning can occur and still not be demonstrated as a memory at a later time. The learning may have been poor in the first place (a common problem in normal aging), the memory may have decayed with time (over the older adults' life spans there is a much longer time period available for memory decay to occur), there may be injury or impairment in the brain (more likely in older than in younger adults), or the memory may be temporarily unavailable for retrieval because of the particular state of the person. For instance, older adults have sensory and perceptual deficits that affect memory test performance, and some also get more anxious and fatigued during testing than do younger adults.

Associative learning is most commonly investigated with classical (Pavlovian) and instrumental (Thorndikian) conditioning. Both paradigms involve exposing the organism to relations between events. The history of the study of classical conditioning is relatively long, beginning late in the nineteenth century. Although he received the Nobel prize in 1904 for his research on the physiology of digestion in dogs, Ivan Petrovitch Pavlov had already turned his attention to investigating formally the phenomenon of classical conditioning. Pavlov found that when he presented a neutral stimulus such as a bell shortly before he placed meat powder on the tongue of a dog, the bell would elicit a similar response to the response elicited by the meat powder. Namely, the dog would salivate when it heard the bell.

Instrumental conditioning was first systematically studied by Edward Lee Thorndike early in the twentieth century. In the case of instrumental conditioning, reinforcement (the consequence) is contingent upon the occurrence of a given behavioral response. For most of the twentieth century, techniques for the investigation of simple associative learning have been available, and these techniques have been applied to the study of normal aging and neuropathology in aging. Despite paradigmatic differences between classical and instrumental conditioning, the existing data in animal studies indicate that age-related differences in instrumental performance usually parallel those found in classical conditioning. In humans, there is far more evidence of deficits in classical than in instrumental conditioning.

Classical conditioning

Pavlov was the first to observe that old dogs classically condition more slowly than young dogs. This initiated the very fruitful investigation of classical conditioning and normal aging. First in Germany and later in the United States, investigators moved from studying the slower autonomic nervous system responses such as salivation to assessment of conditioning in the somatic nervous system using the eyeblink

response. The standard format for the presentation of stimuli in classical conditioning was named the "delay" procedure because there is a delay between the onset of the conditioned stimulus (CS) and the onset of the unconditioned stimulus (US). A neutral stimulus such as a tone or light is the CS, and it is presented for a duration of around half a second. While it is still on, the reflex-eliciting US air puff is presented, and the CS and US end together 50 to 100 msec later. Learning occurs when the organism responds to the CS before the onset of the US. This learned response is called the conditioned response (CR). Many additional classical conditioning procedures are used, but most studies of aging have used the delay procedure discussed here.

Differences between classical eyeblink conditioning in young and elderly nursing home residents in a single seventy-to-ninety-trial conditioning session were first observed in the early 1950s by the Russian scientists and reported in the United States by Edward Jerome in the first *Handbook of the Psychology of Aging* in 1959. These results were replicated and extended to normal, community-residing older adults. The main and striking result was the relative inability of the older subjects to acquire CRs. Several studies in Diana Woodruff-Pak's laboratory demonstrated that age differences in eyeblink conditioning do not begin in old age, rather the deficits begin to appear in mid-life by the age of fifty years.

The neural circuitry underlying eyeblink classical conditioning in all mammals including humans has been almost completely identified. The essential site of the changes that occur during learning reside in the cerebellum, and the hippocampus, while not essential, can affect the rate of conditioning. Significant changes occur in the cerebellum around the age of fifty years. Anatomical (volumetric) brain magnetic resonance imaging (MRI), delay eyeblink conditioning, and extensive neuropsychological testing were carried out in Woodruff-Pak's laboratory in healthy older subjects. The correlation between the volume of the cerebellum and eyeblink conditioning performance was exceedingly high. Hippocampal volume and total cerebral volume were also measured, but neither hippocampal nor total cerebral volume correlated with eyeblink classical conditioning. A similar high correlation between cerebellar volume and eyeblink conditioning was found in young adults. These volumetric MRI results add to the increasing evidence in humans demonstrating a relationship between the integrity of the cerebellum and eyeblink classical conditioning.

Whereas age-related changes in eyeblink classical conditioning do not impact the daily life of older adults, these changes focused researchers on aging in a brain structure that has been relatively overlooked in gerontological investigations of cognition. Recent findings have demonstrated a role for the cerebellum in such cognitive domains as attention, working memory, visuospatial processing, and language. Age-related changes in the cerebellum may play a role in the aging of these cognitive abilities.

Instrumental conditioning

Instrumental conditioning refers to the type of learning in which the probability of a response is altered by a change in the consequences for that response. When a grandmother smiles and says, "Good boy," right after her grandson feeds the dog, the probability that the boy will feed the dog again is increased. Relatively few attempts have been made to create animal models of learning, memory, and aging using instrumental conditioning, and less research has been carried out on aging and instrumental conditioning than has been carried out on aging and classical conditioning.

To summarize the results on instrumental conditioning in aging animals, it appears that there is a consistent deficit that is restricted to the early association of the response with its consequence, but there is less of a difference once a response is established to a criterion level. This may be analogous to small or nonexistent differences in memory between young and older humans once initial learning is equated.

These observations indicate that only under certain circumstances are age-related effects on learning significant. These effects may be overcome by additional training, and they appear to reflect quantitative rather than qualitative differences. In many instances there is intact memory and relearning of previously learned behaviors by older organisms. This result suggests that recent experience involving activation of the neurological elements contributing to learning and memory may ameliorate age-related differences in learning.

DIANA S. WOODRUFF-PAK

See also MEMORY.

BIBLIOGRAPHY

GREEN, J. T., and WOODRUFF-PAK, D. S. "Eyeblink Classical Conditioning: Hippocampus is for Multiple Associations as Cerebellum is for Association-Response." *Psychological Bulletin* 126 (2000): 138–158.

HOUSTON, F. P.; STEVENSON, G. D.; MCNAUGHTON, B. L.; and BARNES, C. A. "Effects of Age on the Generalization and Incubation of Memory in the F344 Rat." *Learning and Memory* 6 (1999): 111–119.

PORT, R. L.; MURPHY, H. A.; and MAGEE, R. A. "Age-related Impairment in Instrumental Conditioning is Restricted to Initial Acquisition." *Experimental Aging Research* 22 (1996): 73–81.

WOODRUFF-PAK, D. S. *Neuropsychology of Aging*. Oxford, U.K.: Blackwell, 1997.

WOODRUFF-PAK, D. S.; GOLDENBERG, G.; DOWNEY-LAMB, M. M.; BOYKO, O. B.; and LEMIEUX, S. K. "Cerebellar Volume in Humans Related to Magnitude of Classical Conditioning." *NeuroReport* 14 (2000): 609–615.

WOODRUFF-PAK, D. S., and JAEGER, M. E. "Predictors of Eyeblink Classical Conditioning over the Adult Age Span." *Psychology and Aging* 13 (1998): 193–205.

WOODRUFF-PAK, D. S., and STEINMETZ, J. E., eds. *Eyeblink Classical Conditioning*. Vol. 1, *Applications in Humans*. Vol. 2, *Animal Models*. Boston: Kluwer Academic Publishers, 2000.

LEISURE

Leisure is one facet of the quest for meaning that continues throughout life. From earliest cognition to dying breath, meaningful engagement and self-validation appear to be enduring attractors. Two trends speak to the probable importance of leisure. During the course of the twentieth century, there was a vast expansion in access to leisure. At the same time, social demographic changes already apparent—extensions of life expectancy, improving health status, and economic currents altering the nature of work and retirement—also speak to leisure's prospect. It is not too much to assert that leisure lifestyles have become a way of life for many segments of the population.

No doubt a great deal of significance and satisfaction is derived from work-related or familial activities, but leisure also provides highly nuanced opportunities to express, explore, and confirm personal agency, identity, membership affirmation, and life stage. Over the course of life the primacy of most roles shifts and shifts again, transforming as perspectives change as new agendas emerge. What is considered significant at one point may be of lesser importance at another, replaced by priorities previously either nonexistent or relegated to the periphery. With the progression through the adult years, several such changes are possible and in each instance the meaning of leisure may be redefined.

In characterizing leisure as a cradle of meaning and as a significant realm of social engagement and participation, it is important to view it as more than simply activity or time left over from other obligations. Early analysts often spoke of leisure as a residual category: the converse of work, a period of recuperation, or time to be filled after work was done. No doubt such a perspective is valid, in part, but leisure is also an independent domain subject to many of the same forces that shape the rest of the life course. If changes in the way work is performed come to pass and patterns of lifelong employment built on explicit career ladders become less prevalent, then the delineation of socially defined passages previously provided by work will also diminish. If so, alternative sources of meaning may emerge, based on what they can contribute to normative definitions of age, structuring of the life course, and personal identity (Han and Moen).

Among the ramifications of the globalization of production and accompanying economic transformation is that the relative salience consigned to productive roles and other realms of activity may be adjusted under certain emerging scenarios. Specifically, as people find themselves less reliant on their work roles for satisfaction as the structure of the workplace changes, the relative importance of alternative sources of meaning will shift. For example, if internal labor hierarchies are flattened, work is not highly age-structured, retirement occurs earlier or intermittently, or contingent employment akin to spot labor markets becomes the norm, the intrinsic meanings derived from work will be abridged and alternative opportunities for self-agency will be sought (Henretta). Even absent such changes, the subjective value of intrinsic work rewards declines with age (Crimmins and Easterlin), depending on financial wherewithal. In addition, many people never did find significant gratification in what they did to earn a living, or were not active in the world of work in the first place.

Types of leisure activities

How do older persons spend their free time? In what types of activities do they participate? What forms of leisure pursuits are most popular? Data from a variety of sources give us a good glimpse into the daily lives of older persons and the types of leisure activities in which they are currently involved.

Contrary to images of older people spending the bulk of their later years in a rocking chair kind of existence, evidence points to a far more active lifestyle. The 1995 National Health Interview Survey, for example, queried persons about their participation in leisure-time physical activity (exercises, sports, physically active hobbies). By this measure, only 34 percent of Americans sixty-five years of age and older reported not being engaged in any of these types of activities during the previous two weeks, as having what might be termed a "sedentary" lifestyle, and this figure represented a decline from 40 percent in 1985 (Federal Interagency Forum on Aging Related Statistics, Table 20). Similarly, viewing older persons as "engaged" in social activities would be an apt characterization. Findings from the Second Supplement on Aging to the 1994 National Health Interview Survey showed that in the previous two weeks 88 percent of persons seventy years of age and older had contact with friends or neighbors; 92 percent had contact with relatives not living in the household; 50 percent had attended a religious service, 27 percent had attended a movie, sports event, club, or group event; 64 percent had gone to a restaurant. And over the previous twelve months, 16 percent reported performing volunteer work. The majority of older Americans also appear to be quite satisfied with their level of social activity; only 21 percent reported they would like to be more active than they are presently (Federal Interagency Forum on Aging Related Statistics, Tables 19A and 19B).

A different and more in-depth glimpse into the daily activities of older persons is provided by examination of "time budgets." These studies ask persons to keep detailed records of how they spend their time during a given interval, for example, during the previous twenty-four hours. Employing this approach, Robinson, Werner, and Godbey have estimated the average number of hours men and women ages sixty-five and older spend weekly in a variety of activities. TV viewing leads the list for both men and women (26.7 hours/week for men; 26.6 for women). Substantial amounts of time are spent traveling (8.8 hours/week for men; 6.6 for women), communicating (7.8 hours for men; 8.0 for women), reading (7.2 and 6.8 hours, respectively), visiting (6.5 hours for both), and in pursuing various hobbies (3.7 and 4.4 hours). Men are more involved in sports than women (3.7 vs. 1.2 hours), women spend more time in religious activities (1.4 hours for men; 1.9 for women), and both spend about the same amount of time participating in organizations (1.6 and 1.5 hours per week, respectively). Other activities, such as education, attending events, and listening to the radio or stereo took up an additional 2.5 hours per week for men and 1.5 hours for women.

Comparable data from a German study (Horgas, Wilms, and Baltes) using a "yesterday interview" approach confirm the contention that older persons spend a greater portion of their day engaged in leisure pursuits than in resting or doing nothing. Among these respondents seventy years of age and older, more than seven hours a day were devoted to a range of discretionary activities such as watching TV, reading, socializing, and "other" leisure activities (e.g., cultural, educational, creative, church, and political activities; sports; gardening; walking; excursions; writing; playing; listening to radio/tape/record). Time spent resting averaged less than three hours a day, although this varied considerably by age—less than two hours a day among persons in their seventies compared to four and a half hours a day for those in their nineties.

The portent of leisure

Leisure and consumption are closely intertwined (Kammen). The fiscal parameters of the leisure market provides valuable testimony to the emerging importance of leisure pursuits. From the Wild West shows fashionable at the dawn of the twentieth century, to the popularity of traveling circuses and mechanized amusement parks between the two world wars, to the opening of the first of the family theme parks in the mid-1950s, the scale of the leisure market has expanded exponentially, reflecting the legitimation of leisure and diversionary entertainment. By the beginning of the twenty-first century, personal expenditures for leisure, entertainment and other discretionary diversions were estimated by some to be as much as $1 trillion dollars annually (Kammen). Add to that the $21 billion

spent in 1996 by local, state, and federal governments on parks and recreation (U.S. Bureau of the Census, Table 504) and the scope of the leisure market begins to become apparent. One thing is clear, leisure consumption is big business. To put the figures in perspective, they totaled more than either housing or health care expenditures on a per capita basis at the same point in time. It is also the case that expansion of the contingent labor pool in the service sector, especially in entertainment and recreation hiring, has grown far more quickly than the overall U.S. economy (U.S. Bureau of the Census, Table 678). Any way it is analyzed, the commercialization of the leisure market is substantial, yet leisure-related expenditures represent only part of the picture.

The symbolic value of leisure may be more portentous than its commercial promise, especially if it is understood as a subjectively defined expressive domain that is discretionary, providing intrinsic rewards calculated in terms of personal meaning systems (Dittman-Kohli and Westerhof). At its heart, leisure can be an opportunity for self-discovery, exploration, and affirmation (Cutler and Hendricks, 1990). The connection between leisure participation and physical and mental well-being has been widely documented. Enhanced self-esteem, morale, sense of control, and cognitive and physical functioning, along with lower risk of fracture and mortality, are all linked to leisure participation (Andersen, Schnohr, Schroll, and Hein; Herzog, Franks, Markus, and Holmberg; Kelly; Reitzes, Mutran, and Verrill; Stebbins).

Leisure in later life is often discussed in terms of where it takes place and whether it involves active or passive pursuits. Previous research has pointed to a negative slope between rigorous physical activity and age; however, there is no real rationale for assuming that pattern will hold for future cohorts of older persons. In recent years, continuing education and voluntary activity have been seen as components of leisure, and both have been demonstrated to continue into the ninth decade and perhaps beyond. Another change concerns how social class, hierarchical access, and gender roles play out in the realm of leisure (Cutler and Hendricks, 2000). Despite an evolving conceptual framework, leisure studies are not immune from what some have described as the "busy ethic," in which visible activity is more highly valued than seeming nonactivity (Ekerdt; Katz).

Defining age-appropriate leisure is fraught with risk, not only because much of the research has been cross-sectional, but also because better-educated and healthier cohorts will manifest new norms in years to come. It is also relevant to point out that in many instances, what is work for some may be leisure for others; gardening may be no more than a chore for one person but a source of meaning and pleasure for another. Rather than identifying specific activities as leisure pursuits, researchers should permit participants to define for themselves what constitutes leisure. One dimension of leisure that results in great satisfaction revolves around the perception of "challenge." Activities and pursuits that permit participants to explore one or another of their limitations may provide maximally meaningful opportunities for validation of their sense of self (Guinn; Stebbins). A related dimension of meaningful leisure engagement promotes solidarity through a leisure-based interaction.

Because of its symbolic relevance and its links to a sense of well-being, leisure will be promoted as a consumer good and the size of the leisure market will grow as more and more people seek gratification in alternative, expressive roles. Gerontology must also attend to the same potential and to how individuals of any age derive significance in their lives.

JON HENDRICKS
STEPHEN J. CUTLER

See also DISENGAGEMENT; EDUCATION; VOLUNTEER ACTIVITIES AND PROGRAMS.

BIBLIOGRAPHY

ANDERSEN, L. B.; SCHNOHR, P.; SCHROLL, M.; and HEIN, H. O. "All-Cause Mortality Associated with Physical Activity During Leisure Time, Work, Sports, and Cycling to Work." *Archives of Internal Medicine* 160 (2000): 1621–1628.

CRIMMINS, E. M., and EASTERLIN, R. A. "What Goals Motivate Individual Behavior." In *Evolution of the Aging Self*. Edited by K. W. Schaie and J. Hendricks. New York: Springer, 2000. Pages 159–168.

CUTLER, S. J., and HENDRICKS, J. "Age Differences in Voluntary Association Memberships: Fact or Artifact." *Journal of Gerontology: Social Sciences* 55B (2000): S98–S107.

CUTLER, S. J., and HENDRICKS, J. "Leisure and Time Use across the Life Course." In *Handbook of Aging and the Social Sciences*, 3d ed. Edited by Robert H. Binstock and Linda K.

George. San Diego: Academic Press, 1990. Pages 169–186.

DITTMAN-KOHLI, F., and WESTERHOF, G. "The Personal Meaning System in a Life Span Perspective." In *Exploring Existential Meaning*. Edited by Gary Reker and Kerry Chamberlain. Newbury Park, Calif.: Sage, 1999. Pages 107–122.

EKERDT, D. "The Busy Ethic: Moral Continuity between Work and Retirement." *The Gerontologist* 26 (1986): 239–244.

Federal Interagency Forum on Aging Related Statistics. *Older Americans 2000: Key Indicators of Well-Being*. Washington, D.C.: Federal Interagency Forum on Aging Related Statistics, 2000.

GUINN, B. "Leisure Behavior Motivation and the Life Satisfaction of Retired Persons." *Activities, Adaptation & Aging* 23 (1999): 13–20.

HAN, S.-K., and MOEN, P. "Clocking Out: Temporal Patterning of Retirement." *American Journal of Sociology* 105 (1999): 191–236.

HENRETTA, J. "Social Structure and Age-Based Careers." In *Age and Structural Lag*. Edited by Matilda W. Riley, Robert L. Kahn, and Anne Foner. New York: Wiley-Interscience, 1994. Pages 57–79.

HERZOG, A. R.; FRANKS, M. M.; MARKUS, H. R.; and HOLMBERG, D. "Activities and Well-Being in Older Age: Effects of Self-Concept and Educational Attainment." *Psychology and Aging* 13 (1998): 179–185.

HORGAS, A. L.; WILMS, H.-U.; and BALTES, M. M. "Daily Life in Very Old Age: Everyday Activities as Expression of Successful Living." *The Gerontologist* 38 (1998): 556–568.

KATZ, S. "Busy Bodies: Activity, Aging, and the Management of Everyday Life." *Journal of Aging Studies* 14 (2000): 135–152.

KAMMEN, M. G. *American Culture, American Tastes: Social Change and the 20th Century*. New York: Knopf, 1998.

KELLY, J. R. "Leisure." In *Encyclopedia of Sociology*. Edited by Edgar Borgatta and Rhonda Montgomery. New York: Macmillan, 2001. Pages 1581–1591.

REITZES, D. C.; MUTRAN, E. J.; and VERRILL, L. A. "Activities and Self-Esteem: Continuing the Development of Activity Theory." *Research on Aging* 17 (1995): 260–277.

ROBINSON, J. P.; WERNER, P.; and GODBEY, G. "Freeing Up the Golden Years." *American Demographics* 19 (1997): 20, 22–24.

STEBBINS, R. A. *Amateurs, Professionals, and Serious Leisure*. Montreal: McGill-Queen's University Press, 1992.

U.S. Bureau of the Census. *Statistical Abstract of the United States: 1999*. 119th ed. Washington, D.C.: U.S. Government Printing Office, 1999.

LIFE COURSE

C. Wright Mills described the task and promise of the sociological imagination as the ability to "grasp history and biography and the relations between the two." The life course perspective takes this task seriously, providing a theoretical framework, concepts, and analytical tools for examining how lives unfold in historical contexts. This perspective views aging as a life-long process. Examples of research employing a life course perspective include studies of the influence of early or midlife events on later life outcomes, patterns and pathways in midlife that enhance healthy aging, and the timing and sequence of key events such as retirement (Elder and Pavalko; Elder, Shanahan, and Clipp; Han and Moen; Moen, Dempster-McClain, and Williams). The life course perspective also views these processes as imbedded in historical contexts, and thus expects that they will vary across birth cohorts and be influenced by historical events. Much of life course research also examines how aging differs for persons born in different historical times or who encounter different historical events.

A life course perspective on aging began to be developed in the 1960s as social scientists became increasingly interested in time, process, and variability in how individuals age. Key research programs, such as Glen Elder's work on the Great Depression and the Second World War, Matilda Riley's research on aging and social change and Bernice Neugarten's emphasis on norms for life events have provided the organizing themes that have guided life course research. Contributions from human development, demography, family sociology, social psychology and history have provided additional theoretical and conceptual development. These have been further aided by investments in long-term longitudinal data collections such as the National Longitudinal Surveys, the Panel Study of Income Dynamics, and the Retirement History Survey. These are just a few of the many public data sets that allow empirical investigation of life course processes for a large number of individuals and groups.

Key concepts and distinctions

The life course is both a theoretical perspective and a concept (Elder and O'Rand). The theoretical perspective provides an organizing theme for research on aging, emphasizing aging as a process occurring within historical time. Because theoretical perspectives guide research questions and analysis designs, emerging perspectives such as the life course perspective are particularly exciting because they provide new ways of looking at issues and problems.

Within this perspective, the *concept* of the life course refers to the successive role statuses held by individuals as they age. By focusing on social roles, this concept targets the sociological dimensions of aging, viewing these life-long processes as a succession of interactions between the individual and work, family, education, and other institutions. It posits that much of what defines various life stages, such as when one becomes an adult, enters midlife, or is defined as "elderly" is shaped by these institutions and their associated roles. It is the patterns and sequences of these various roles, such as student, parent, or worker that we refer to as the life course.

The concept of the life course can be distinguished from several related terms. The term *life cycle* is often used interchangeably with life course, but a more strict definition of life cycle refers to distinct stages, maturation, and generational replacement. It is more applicable to populations, organizations, or groups such as the family, which undergo a series of stages (O'Rand and Krecker). The concept of *life span* is applicable to individuals and refers to the duration of time from birth to death. While all three concepts reference temporal processes, only the life course concept taps the changing social roles that individuals hold as they age.

Understanding the dynamics of social roles making up the life course has required new concepts. The two most important are *transitions* and *trajectories* (Elder and O'Rand). Transitions are the short-term changes in roles such as getting married, becoming widowed, or changing jobs. Trajectories are the longer-term patterns such as the work career or family history. Trajectories are made up of various transitions, but also provide the larger context that gives individual transitions their meaning. For example, an exit from a full-time job for someone in their early sixties may or may not be a major transition in the life course. Whether or not it is defined as one's "retirement" will depend on its location in the larger trajectory of the work career.

Separating variation that is due to *age, historical period,* and *birth cohort* is central to understanding individual aging in changing societies. Age variation refers to the biological or social maturation that occurs as people age, such as age-related physical changes. Variation by historical period refers to large-scale social change and events such as wars, economic downturns, and changing divorce rates. Although the influences of these macro changes are widespread, their impact on individuals may vary depending on where they fall in the person's life course. For example, Elder's research shows that the influence of the Great Depression depended on the individual's life stage in the early 1930s. These varying effects in turn produce variation across birth cohorts as each cohort develops within a unique set of historical conditions (Ryder).

While age, period, and cohort are conceptually distinct, all are marked by the passage of time. Differences across age groups may reflect maturational changes or birth cohort variation. Because both types of variation are measured by an individual's age, research designs often cannot distinguish these two types of variation. Even studies following multiple cohorts over time cannot completely separate all three sources of variation. More precise measures of at least one of these effects, such as how individuals experience a key historical event, are needed to fully separate age, period, and cohort influences (Hardy).

Contributions to aging

Life course contributions to aging have increased dramatically since the mid-1980s as questions about aging and later life have incorporated life course concepts. One example of this influence can be seen through research on retirement. Rather than viewing retirement as a single transition from full-time work to a full exit from the labor force, research from the life course perspective has directed attention to retirement as a process and questioned whether this process changes over time. While some workers do retire in a single transition, this is by no means the case for all, or even a majority of workers (Elder and Pavalko; Mutchler et al.). Comparisons across birth cohorts also indicate a trend toward workers starting the process earlier but drawing it out over a longer period of time (Elder and Pavalko; Han and Moen). Other research on retirement

has shown the influence of prior earlier work and family careers on the retirement process (Han and Moen; O'Rand and Henretta).

The life course perspective has also illuminated the midlife pathways that promote successful aging in later life. For example, Phyllis Moen examines women's involvement in family and nonfamily roles in midlife and then examines the influence of those roles on later health, well-being, and survival into later life (Moen et al.). Research on men's midlife career patterns has similarly demonstrated the influence of career patterns on longevity (Pavalko, Elder, and Clipp).

Finally, emerging research on the intersection between the state and the life course raises new questions about how definitions of various life stages, including later life, change over time (Mayer and Schoepflin). One important message from this line of research is that our current definitions of different life stages are defined by larger institutional structures. We should thus expect these definitions to change as institutional structures and policies such as education, work, and pensions are transformed. Attention to these changes is important for adding context to our current understanding of various life stages but also offers a framework for thinking about how larger institutions shape the life course.

Challenges and developments in conducting life course research

Researchers adopting a life course perspective face a number of challenges in studying life course processes in specific historical contexts. Some of the greatest challenges are presented by data limitations. Answers to many life course questions require data collected over time. Researchers interested in long-term pathways must thus choose between following respondents for long periods of time before they can answer their research questions, collecting retrospective information, or using longitudinal survey data collected by others. There are strengths and weaknesses of each of these options, but the growing availability of many large longitudinal data collections has made it increasingly feasible to examine life course processes for large numbers of people.

An additional challenge for those studying the influence of historical events on the life course is that they have to depend on data collected during that time period. Thankfully, a number of long-term longitudinal studies were conducted throughout the twentieth century, but contemporary researchers using older archives must be cautious when using the data to answer very different questions than those for which the data were originally designed (Elder, Pavalko, and Clipp). Data repositories such as the Henry Murray Center at Radcliffe College that collect and store old survey archives are particularly valuable for those wishing to do historical life course research.

Growth in the number of longitudinal data collections is matched by a parallel expansion in the tools available for longitudinal analyses. Researchers are thus presented with a wide range of techniques such as event history analysis, hierarchical linear modeling, and sequence analysis for analyzing single or multiple events, patterns and sequences of roles, or more gradual patterns of stability and change. The complexity and range of available analytical tools presents both challenges and opportunities. As new approaches are developed to capture different kinds of processes, they provide greater flexibility for measuring and analyzing life course processes in multiple ways. At the same time, our ability to measure process in multiple ways, whether it be sequences, events, pathways, or more simple change, pushes us to more clearly specify the nature of the processes we are trying to study.

While challenges in answering life course questions are increasingly being met with new data and analytical tools, a persistent challenge inherent to the life course perspective is balancing attention to the complexity and variability of individual lives with a goal of generalizing patterns across individuals (Settersten). Is attention to variation in the historical and structural contexts in which lives unfold at odds with efforts to develop a more generalizable understanding of life course processes? At what point does attention to the complex dynamics of lives, such as the interlocking trajectories of family, work, and health, become so unwieldy that it threatens the usefulness of the perspective? There are inherent tensions in any perspective that seeks to understand lives in context, but they are particularly salient for life course research (Settersten).

New directions

Much of the growth of the life course perspective is likely to continue to be through its ap-

plication to a variety of research areas such as caregiving, stress processes, health, and successful aging. In addition, there are several new directions that are likely to further our understanding of life course processes. For example, despite attention to the development of lives in context, we still know relatively little about how lives unfold in specific neighborhoods, work organizations, or schools. Emerging methods for multilevel analysis offer significant promise for increasing our ability to examine lives in different structural contexts. Another important new direction is likely to be the use of cross-cultural studies for addressing variability in how individuals age. Much of the theoretical development and empirical research on the life course has taken place in the United States and Western Europe and we know relatively little about how life course patterns differ in non-Western and industrializing counties. Cross-cultural comparisons of life course transitions, trajectories, and the entire organization of the life course will be critical for improving our understanding of the various paths and processes through which people age.

ELIZA PAVALKO

See also AGE-PERIOD-COHORT MODEL; COHORT CHANGE; LONGEVITY: SOCIAL ASPECTS.

BIBLIOGRAPHY

ELDER, G. H. *Children of the Great Depression: Social Change and Life Experience*. Chicago, Ill.: University of Chicago Press, 1974.

ELDER, G. H., and O'RAND, A. "Adult Lives in a Changing Society." In *Sociological Perspectives on Social Psychology*. Edited by K. S. Cook, G. A. Fine, and J. S. House. Needham Heights, Mass.: Allyn and Bacon, 1995. Pages 452–475.

ELDER, G. H., JR., and PAVALKO, E. K. "Work Careers in Men's Later Years: Transitions, Trajectories and Historical Change." *Journal of Gerontology: Social Sciences* 48 (1993): S180–S191.

ELDER, G. H., JR.; SHANAHAN, M. J.; and CLIPP, E. C. "When War Comes to Men's Lives: Life Course Patterns in Family, Work and Health." *Psychology and Aging*, Special Issue 9, no. 1 (1994): 5–16.

HAN, S.-K., and MOEN, P. "Clocking Out: Temporal Patterning of Retirement." *American Journal of Sociology* 105 (1999): 191–236.

HARDY, M. A. *Studying Aging and Social Change: Conceptual and Methodological Issues*. Thousand Oaks, Calif.: Sage Publications, 1997.

MAYER, K. U., and SCHOEPFLIN, U. "The State and the Life Course." *Annual Review of Sociology* 15 (1989): 187–209.

MILLS, C. W. *The Sociological Imagination*. New York. Oxford, 1959.

MOEN, P.; DEMPSTER-MCCLAIN, D.; and WILLIAMS, R. M. "Successful Aging: A Life-Course Perspective on Women's Multiple Roles and Health." *American Journal of Sociology* 97 (1992): 1612–1638.

MUTCHLER, J. E.; BURR, J. A.; PIENTA, A. M.; and MASSAGLI, M. P. "Pathways to Labor Force Exit: Work Transitions and Work Instability." *Journal of Gerontology: Social Sciences* 52B (1997): S4–S12.

NEUGARTEN, D. A. *The Meanings of Age: Selected Papers of Bernice L. Neugarten*. Chicago, Ill.: University of Chicago Press, 1996.

O'RAND, A. M., and KRECKER, M. L. "Concepts of the Life Cycle: Their History, Meanings and Uses in the Social Sciences." *Annual Review of Sociology* 16 (1990): 241–262.

O'RAND, A. M.; and HENRETTA, J. C. "Delayed Career Entry, Industrial Pension Structure, and Retirement in a Cohort of Unmarried Women." *American Sociological Review* 47 (1982): 365–373.

PAVALKO, E. K.; ELDER, G. H., JR.; and CLIPP, E. "Worklives and Longevity: Insights from a Life Course Perspective." *Journal of Health and Social Behavior* 34 (1993): 363–380.

RILEY, M. W.; FONER, A.; and WARING, J. "Sociology of Age." In *Handbook of Sociology*. Edited by N. Smelser, Newbury Park, Calif.: Sage Publications, 1988. Pages 243–290.

RYDER, N. "The Cohort as a Concept in the Study of Social Change." *American Sociological Review* 30 (1965): 843–861.

SETTERSTEN, R. A. *Lives in Time and Place. The Problems and Promises of a Developmental Science*. Amityville, N.Y.: Baywood, 1999.

LIFE CYCLE THEORIES OF SAVINGS AND CONSUMPTION

Economists have developed three major theories of consumption and saving behavior: (1) The life-cycle hypothesis (Modigliani and Brumberg, 1954; Modigliani and Ando, 1957; Ando and Modigliani, 1963); (2) the permanent income hypothesis (Friedman, 1957); and (3) the

relative income hypothesis (Dusenberry, 1949). All three theories have their conceptual roots in the microeconomic theory of consumer choice. However, the life-cycle and permanent income hypotheses are the most similar; both theories assume that individuals attempt to maximize their utility or personal well-being by balancing a lifetime stream of earnings with a lifetime pattern of consumption. The relative income hypothesis is quite different. Dusenberry theorized that individuals are less concerned with their absolute level of consumption than with their relative level—the idea of "keeping up with the Joneses."

The life-cycle hypothesis has been utilized extensively to examine savings and retirement behavior of older persons. This hypothesis begins with the observation that consumption needs and income are often unequal at various points in the life cycle. Younger people tend to have consumption needs that exceed their income. Their needs tend to be mainly for housing and education, and therefore they have little savings. In middle age, earnings generally rise, enabling debts accumulated earlier in life to be paid off and savings to be accumulated. Finally, in retirement, incomes decline and individuals consume out of previously accumulated savings.

Empirical studies of the life-cycle hypothesis have generated a large literature. Studies that have focused on the savings behavior of older persons, however, have been inconclusive regarding the correspondence between observed savings behavior and the pattern of saving and dissaving predicted by the life-cycle hypothesis. Many studies seemingly in conflict with the life-cycle hypothesis, have found that older persons continue to save in retirement. Several explanations have been offered for this. King (1985), for example, notes that saving in retirement is not necessarily inconsistent with the life-cycle hypothesis, if one accounts for the aversion of individuals to uncertainty about the future (e.g., how long they will live and future inflation). Another explanation is that the generosity of pensions reduces the need to save in preparation for retirement and to dissave while in retirement. Life-cycle savings patterns in some European countries that have generous pension systems such as France, Germany, and Italy appear to be consistent with this explanation. Another related explanation for lack of dissaving in retirement is that deteriorating health may limit the ability of individuals to consume at levels that are higher than their pension income. Moreover, the pension wealth that retired persons hold is not liquid and they are not able to draw down their pension wealth any faster than the annuity payments that they receive. This health aspect of life cycle savings and consumption patterns raises an interesting question: Should payments for health insurance also be viewed as a form of savings, and receipt of health care services as drawing down one's "health insurance wealth"?

A number of other studies, however, *have* found evidence of a hump-shaped pattern of savings that is consistent with the life-cycle hypothesis. It is important to note that most studies have tended to underestimate the degree of dissaving among older persons, because these studies have not generally accounted for the decumulation of pension wealth associated with Social Security and private pension payments.

Pension payments are probably the best example of decumulation of savings in the latter stages of the life cycle. Under Social Security and defined benefit pension plans, older persons have established a claim on a future stream of income payments that is generally some function of each person's earnings history and life expectancy. The expected total value of this stream of income payments in current dollars over their remaining lifetime is known as their pension wealth. Thus, as retirees receive pension payments, they draw down their *pension wealth*. This factor has generally not been taken into account in studies that have examined whether older persons dissave in retirement, as would be predicted by the life-cycle hypothesis. After accounting for personal contributions and withdrawal of benefits from pensions, Jappelli and Modigliani (1998) find evidence for the expected hump-shaped savings profile.

In an analysis of the savings behavior of the baby boom generation, Gist et al. (1999) estimate that Social Security and pension wealth accounted for more than half of all wealth for 90 percent of the pre-retired population. As a consequence, it seems clear that failing to account for the reduction in pension wealth implied by the receipt of Social Security or other defined benefit pension payments leads to a substantial underestimation of dissaving in retirement. Moreover, in countries such as the United States, where out-of-pocket health care costs are rising more rapidly than the value of pension payments, one might expect to observe dissaving in the retirement years. In particular, among the old-old popula-

tion, rising medical and long-term care expenditures are likely to occur at a point in the life cycle where, for many, the real value of their pension income has eroded over time and may be inadequate to cover out-of-pocket health care costs.

Implications for retirement behavior

The life-cycle hypothesis is closely related to the theory of work-leisure choice, which has been widely applied in the retirement literature. In the theory of work-leisure choice, individuals are assumed to maximize their utility derived from the consumption of goods and services, as well as from leisure. However, the consumption of goods and services requires income that, in turn, must be generated by earnings or savings. In this context, the retirement decision is based on the tradeoff between the utility gained from leisure time spent in retirement and the consumption of goods and services. Since retirement usually implies a substantial reduction of, or total absence of, wage income, the retirement decision is based on the point where an individual's savings accumulation has reached the level where it is sufficient to support the levels of consumption and leisure that maximizes his or her utility.

Implications for income adequacy

In considering the economic status of current and future older persons, few would argue that money income alone is the best measure. Another approach is to use *household net worth* as a measure of economic status. *Net worth* is defined as the total market value of all assets, such as home equity, stocks and bonds, and savings accounts, minus all debts, such as mortgages, school loans, and automobile loans. Net worth is a conceptually important measure because it reflects the ability to have met consumption needs in the past (net worth will be positive if income has been higher than expenditures up to that point in one's life), as well as the capacity to finance future consumption by drawing upon accumulated assets.

Michael Hurd (1990) provides an overview of the different ways in which researchers have used current income and net worth to measure economic status. A widely used approach is to convert net worth into an income stream (based on life expectancy and interest rate assumptions) and add this income stream to current income, excluding the income already being received from assets. Such studies consistently show that the income stream generated from assets is modest for most elderly persons, especially those who have low incomes to begin with. Consequently, annuitizing assets has limited promise as a mechanism for increasing the incomes of elderly persons with inadequate incomes.

If the life-cycle hypothesis is correct, one would expect older adults (at least at the beginning of retirement) to have higher wealth holdings than younger households. Consistent with this expectation, Edward Wolff (1998) found that mean household net worth was $173,700 for households of those under age sixty-five and $314,500 for households headed by those age sixty-five and older. Growing recognition of the greater wealth of older households relative to younger households has led to increased interest in the potential role of asset holdings for meeting public policy objectives. An important example of this interest is the concern that elderly households with low money incomes but large amounts of home equity may be receiving income transfers through government programs from younger households that have higher money incomes but who would not be as well-off as older households if one took account of wealth.

Studies have repeatedly found that, except for the most affluent of older households, the majority of net worth is held in the form of home equity. Eller (1994) found that, in 1991, the median net worth of older households was $88,192, but was only $26,442 with home equity excluded. Recent evidence indicates that the effects of annuitizing household wealth are fairly similar across age groups, and that such a policy would have almost no effect on reducing household income inequality.

Although converting assets into an income stream is appealing—because it enables current income and wealth to be combined into a single measure—there are some problems with using it to compare households in different age cohorts. First, there is the problem of choosing an appropriate interest or discount rate for valuing the income stream produced by an asset. The discount rate can greatly influence the size of the income stream generated by an asset. In addition to the choice of an appropriate discount rate, there is the problem of changes in the size of income streams produced by assets at different stages in the life cycle. For a given amount of wealth, income streams will be larger for those with shorter

life expectancies, making older households appear to be more affluent than younger households with the same amount of income and wealth. In addition, comparisons between older and younger households based on the income value of their assets will be influenced by the generally higher stock of durable goods held by older households.

Implications for aggregate savings and consumption patterns

The life-cycle hypothesis suggests that population aging will initially lead to an increase in national savings as the proportion of the population in the maximum savings years increases. Cantor and Yuengart (1994) estimate that saving by the baby boom generation may add as much as 1.4 percent to the national savings rate between 1990 and 2010. As the population continues to age and the relative proportion of the population of those reaching retirement age grows relative to the middle-aged population, however, the life-cycle hypothesis predicts a reduction in aggregate savings.

The existence of public and private pension systems complicates the private savings patterns that would be predicted by the life-cycle hypothesis in the absence of these systems. In 1974, Martin Feldstein argued that the effect of Social Security on aggregate private savings is theoretically indeterminate. On the one hand, savings may decline because Social Security benefits reduce the need to save for retirement (the benefit, or asset substitution, effect). Conversely, the availability of Social Security benefits may encourage early retirement from the labor force. If so, a shorter working life and longer time spent in retirement would require increased savings rates (the induced retirement effect). As noted earlier, a substantial literature has attempted to identify which effect dominates, but this literature remains inconclusive.

The vast majority of the research on the life-cycle theory has focused on patterns of savings behavior. Savings, however, are only half of the story. To adequately interpret whether observed savings patterns are consistent with the life-cycle theory, it is also necessary to examine consumption patterns. And, as with savings, it is necessary to account not only for out-of-pocket consumption but also expenditures made on behalf of older persons in retirement (e.g., health care expenditures). As the population ages, the life-cycle consumption patterns of older persons—in particular, the greater allocation of expenditures to health care—will shift the composition of aggregate private household demand. In addition, public expenditures will shift in response to population aging (e.g., away from education expenditures for the young toward expenditures for pension payments and health care insurance). The economy has experienced the interaction of life-cycle consumption patterns and demographic change before, the baby boom generation swelled the demand for housing and education services in the 1950s and 1960s. Shifts in aggregate demand due to the aging of the baby boomers will be far less disruptive because, in contrast to the arrival of the baby boom generation, the economy and public policy will have many years to anticipate and adapt to population aging.

Collectively, these shifts in patterns of household and government spending will change the composition of aggregate demand in the economy. Population aging will also shift patterns of aggregate private savings, private pension wealth, and Social Security wealth. Given the prominence of the life-cycle hypothesis among economists, it is interesting that so little work has been conducted on life cycle consumption behavior of older persons. Debates about the out-of-pocket health care costs of older persons are a reflection of the intersection between economic resources, consumption needs, and public policy. The formulation of public policy for the elderly population needs to recognize this intersection and to be informed by careful research that explicitly accounts for the effects of life-cycle events on economic status in old age. The life-cycle hypothesis provides an integrated conceptual framework for the development of income maintenance and health care policy for older persons, and indicates clearly that income and health care policies should not be considered in isolation.

WILLIAM H. CROWN

See also ASSETS AND WEALTH; CONSUMPTION AND AGE; ECONOMIC WELL-BEING; RETIREMENT, DECISION MAKING; SAVINGS.

BIBLIOGRAPHY

ANDO, A., and MODLIGLIANI, F. "The Life-Cycle Hypothesis of Saving: Aggregate Implications

and Tests." *American Economic Review* 53 (1963): 55–84.

BERTAUT, C., and HALIASSOS, M. "Precautionary Portfolio Behavior from a Life-Cycle Perspective." *Journal of Economic Dynamics and Control* 21 (1997): 1511–1542.

BORSCH-SUPAN, A. "Saving and Consumption Patterns of the Elderly: the German Case." *Journal of Population Economics* 5 (1992): 289–303.

BORSCH-SUPAN, A., and STAHL, K. "Life-Cycle Savings and Consumption Constraints." *Journal of Population Economics* 4 (1991): 233–255.

CROWN, W. "Economic Status of the Elderly." In *Handbook of Aging and the Social Sciences*. Edited by R. H. Binstock and L. K George. New York: Academic Press, 2001. Pages 352–368.

CARROLL, C., and SUMMERS, L. "Consumption Growth Parallels Income Growth: Some New Evidence." In *National Saving and Economic Performance*. Edited by B. D. Bernheim and J. Shoven. Chicago: University of Chicago Press, 1991.

CANTOR, R., and YUENGART, A. "The Baby Boom Generation and Aggregate Savings." *Federal Reserve Bank of New York Quarterly Review* (Summer/Fall 1994): 76–91.

DANZIGER, S.; VAN DER GAAG, J.; SMOLENSKY, E.; and TAUSSIG, M. "The Life-Cycle Hypothesis and the Consumption Behavior of the Elderly." *Journal of Post-Keynesian Economics* 5 (1982): 208–227.

DUSENBERRY, J.S. *Income, Saving, and the Theory of Consumer Behavior*. Cambridge, Mass.: Harvard University Press, 1949.

ELLER, T. J. "Household Wealth and Asset Ownership, 1991." In *Current Population Reports*. 70–34. Washington, D.C.: U.S. Government Printing Office, 1994.

FELDSTEIN, M. "Social Security, Induced Retirement, and Aggregate Capital Accumulation." *Journal of Political Economy* 82 (1974): 905–926.

FRIEDMAN, M. *A Theory of the Consumption Function*. Princeton, N.J.: Princeton University Press, 1957.

FUCHS, V. *Provide, Provide: The Economics of Aging*. NBER Working Paper 6642. Cambridge, Mass.: National Bureau of Economic Research, 1998.

GIST, J.; WU, K.; and FORD, C. *Do Baby Boomers Save and, If So, What For?* Washington, D.C.: AARP, 1999.

GOKHALE, J.; KOTLIKOFF, L.; and SABELHAUS, J. "Understanding the Postwar Decline in United States Saving: A Cohort Analysis." *The Brookings Papers on Economic Activity*.

HURD, M. "Research on the Aged: Economic Status, Retirement and Consumption and Saving." *Journal of Economic Literature* 28 (1990): 565–637.

JUSTER, F. T. "Current and Prospective Financial Status of the Elderly Population." In *Saving for Retirement*. Edited by P. Cagan. Washington, D.C.: American Council of Life Insurance, 1981. Pages 24–66.

KING, M. "The Economics of Saving: A Survey of Recent Contributions." In *Frontiers of Economics*. Edited by K. Arrow and S. Houkapohja. New York: Basil Blackwell, 1985. Pages 227–294.

LEONESIO, M. "Economic Model of Work-Leisure Choice." In *Handbook on Employment and the Elderly*. Edited by W. Crown. Westport, Conn.: Greenwood Press, 1996. Pages 213–248.

MCNEIL, J., and LAMAS, E. "Year-Apart Estimates of Household Net-Worth from the Survey of Income and Program Participation." In *The Measurement of Saving, Investment, and Wealth*. Edited by R. Lipsey and H. S. Tice. Chicago: University of Chicago Press, 1989. Pages 431–471.

MENCHIK, P., and DAVID, M. "Income Distribution, Lifetime Savings, and Bequests." *American Economic Review* 73 (1983): 672–690.

MERRILL, S. "Home Equity and the Elderly." In *Retirement and Economic Behavior*. Edited by H. Aaron and G. Burtless. Washington, D.C.: The Brookings Institution, 1994. Pages 197–227.

MIRER, T. "The Dissaving Behavior of the Retired Aged." *Southern Economic Journal* 46 (1980): 1197–1205.

MODIGLIANI, F., and ANDO, A. "Tests of the Life-Cycle Hypothesis of Savings." *Bulletin of the Oxford University Institute of Economics and Statistics* 19 (1957): 99–124.

MODIGLIANI, F., and BRUMBERG, R. "Utility Analysis and the Consumption Function." In *Post-Keynesian Economics*. Edited by K. Kurihara. New Brunswick, N.J.: Rutgers University Press, 1954. Pages 338–436.

RADNER, D. "The Wealth of the Aged and Nonaged, 1984." In *The Measurement of Saving, Investment, and Wealth*. Edited by R. Lipsey and H. Tice. Chicago, Ill.: The University of Chicago Press, 1989. Pages 645–689.

TORREY, B., and TAUBER, C. "The Importance of Asset Income among the Elderly." *Review of Income and Wealth* 32 (1986): 443–449.

VENTI, S., and WISE, D. *Aging and the Income Value of Housing Wealth*. NBER Working Paper no. 3547. Cambridge, Mass.: National Bureau of Economic Research, 1990.

WOLFF, E. "Recent Trends in the Size Distribution of Household Wealth." *Journal of Economic Perspectives* 12, no. 3 (1998): 131–150.

LIFE EVENTS AND STRESS

Life events are defined as discrete experiences that disrupt an individual's usual activities, causing a substantial change and readjustment. Examples of life events include marriage, divorce, illness or injury, and changing or losing a job. In the literature on stress, life events have been traditionally considered as one type of stressor, along with chronic strains (ongoing stressful circumstances such as living with disability or poverty). Since the pioneering work of Tom Holmes and Richard Rahe in 1967, an enormous body of literature has developed on the topic of life events and illness.

Life events research

Life events research has evolved from early models viewing life changes as inherently stressful and having similar effects on all who experience them to more complex models emphasizing individual differences in both reactions and vulnerability to life events. In addition, there have been a number of conceptual and methodological critiques that have led to more sophisticated models and methods of assessing life events. Recent studies demonstrate that, even with careful attention to methodological issues, life events can have important effects on health and psychological well-being.

Historical issues. Early studies conceptualized life events in terms of the amount of readjustment or change that the events were likely to entail (see Dohrenwend and Dohrenwend; Holmes and Rahe). These studies were based on the assumption that any change in life would be stressful. Particularly influential was the work of Holmes and Rahe, who developed the Social Readjustment Rating Scale (SRRS). The SRRS asked subjects to report the occurrence of life events that had occurred over the previous year, and these events were given life-change unit scores (e.g., 100 for death of a spouse, 28 for an outstanding personal achievement). Total scores were viewed as a measure of life change and as an index of stress. While research with the SRRS did suggest that life events were associated with mental and physical health, limitations to this approach were noted in subsequent work, and conceptual and methodological improvements have been made.

Individual differences in response to life events. Contrary to the assumption that life events have uniform effects that can be measured by life-change units, later studies have shown that the consequences of life events depend on the nature of the events (e.g., whether they are undesirable, unpredictable, or uncontrollable). Growing attention has been paid to subjective meaning of the events to the particular individuals who experience them, rather than the objective occurrence of the events. Since the occurrence of the same event can yield different meanings in each individual, subjective appraisal has been identified as a critical part of the effect life events have on well-being (see Lazarus and Folkman). For example, people generally think that divorce is a stressful experience; however, for some individuals, such as those who have gone through a long-term problematic marriage, divorce can be a resolution of stress and even a relief.

The consequences of life events on physical and psychological well-being are influenced by individual differences in coping resources. When life events occur, individuals' coping resources can buffer the negative consequences of life events and facilitate adjustment. Coping resources may include physical resources (e.g., health and function), psychological resources (e.g., personality traits, values, goals, religious beliefs, self-concept, and self-control), and social resources (social network and social support). One of the most frequently researched psychological resources is *mastery*, which refers to the extent to when a person feels that he or she has control over his or her life and environment. Individuals with high mastery tend to have a positive perspective on the social environment and believe that they can control or alter their environment. Therefore, those with high mastery are more likely to protect themselves from negative consequences when they face stressful life events.

The impact of social networks and social support has also been widely studied, and there exists a general consensus on their beneficial roles in dealing with stressful life events. It has been found that individuals with persistent deficits in social support experience more stressful life events, higher levels of perceived stress, and greater risk of recurrent depression (see Redinbaugh, MacCallum, and Kiecolt-Glaser). An ex-

amination of individuals' personal and social resources is important in understanding individual valances in responding and adapting to stressful life events, and also serves as an important basis for developing effective intervention programs.

Types of life events. Criticisms have been raised concerning the tactic of aggregating total life events to generate an overall score. Many studies on life events have turned the total number of events into a single score by aggregating all life events experienced within a given time frame. This approach treats all events the same, without taking into account the subjectively perceived importance of each event. Since life event inventories cover a variety of events of different importance, equating those events may be insensitive in capturing the significance of different life events, and it may fail to detect the effects of specific events that generate a great deal of stress. Some researchers have suggested the use of a more dimension-specific approach, focusing on specific kinds of events by dividing scales into categories, such as health-related events and loss events.

Retrospective bias in reporting life events. Conventional life event inventories usually ask respondents to read a list of events and report those that occurred to them over a specific time period. The time frames vary from six to eighteen months. Some researchers have raised questions on the accuracy of individuals' memories for life events. In general, people tend to report fewer events for a more distant time period. In addition, a retrospective approach is vulnerable to biasing effects such as selective memory, denial, and over-reporting. For example, depressed people are likely to report more negative events because they tend to focus on the adverse sides of life and to search for events to justify their current moods.

Given this dissatisfaction with the checklist method, researchers have attempted innovative ways to assess life events. Some studies have used combined methods of self-reporting on checklists and interviews. Karen Raphael and colleagues (1991) assessed the occurrence of life events every month for ten months using a checklist, and at the end of the study they did detailed interviews on experience with life events for the studied period. They found that more events were reported on a concurrent monthly basis than were reported on a retrospective interview for the same period. As an alternative to retrospective report over long periods, some researchers have conducted multiple follow-ups for the occurrence of life events, with a very short interval between interviews, in order to detect the onset of events. This approach solves some problems associated with the retrospective report using a checklist method; however, it requires a large sample and longitudinal follow-up.

Life events are not uniform across populations. Some researchers have called into question whether scale items contain relevant and representative life events for target populations. Since scales are rarely generated on the basis of large and well-developed sampling frames, it is hard to judge if the items cover a sufficiently wide range of possible events. More importantly, exposure to life events varies in terms of age, gender, and social roles. For example, retired individuals cannot be promoted, men cannot be pregnant, and unmarried individuals cannot experience marital conflict or divorce. Inclusion of irrelevant items for the target population may result in misclassifying individuals as having fewer numbers of life events.

In response to this concern, a number of life event inventories have been developed for various populations, including the Psychiatric Epidemiological Research Interview (PERI) for general populations; the Life Experiences Survey (LES) for adult age groups; the College Student Life Events Schedule (CSLES) for college students, and the Louisville Older Persons Events Scale (LOPES) for the elderly population.

Confounding of life events and outcomes. *Confounding* is a particularly important issue in the examination of life events. Many items in life event inventories are closely related to health (e.g., illness, injury, hospitalization), so they can be easily confounded with physical and mental health outcomes. Due to concerns about the confounding of health and life events, some researchers recommend separating health-related life events from non-health-related items. Some studies have selected only healthy elderly individuals in examining the impacts of life events in order to exclude confounding of health variables (see Willis, Thomas, Garry, and Goodwin).

Recent findings on life events and well-being. Numerous studies have examined the consequences of life events on a variety of physical and psychological outcomes. In general pop-

ulations, life events have been shown to be associated with a variety of physical problems and indicators of psychological distress. However, the magnitude of these associations is often found to be only modest. Researchers have suggested several ways to explain the low associations found in such studies, including methodological issues and individual differences in coping resources.

One fruitful strategy in the study of the effects of life events is longitudinal study of individuals with psychological or physical disorders that tend to have periods of remission and recurrence. For example, it is extremely difficult to demonstrate conclusively that life events provoke the initial onset of depressive disorders, but longitudinal research on individuals with a history of depression provides convincing evidence that life events can lead to recurrence of depressive episodes. Sophisticated longitudinal studies even support the contention that major life events play important roles in onset and recovery from episodes of bipolar disorder and multiple sclerosis—disorders that are commonly viewed as entirely biomedical. Research on life events in these clinical populations has also led to increasing recognition that some life events are caused by the disorders studied; for example, loss of a job may be precipitated by early symptoms of a mental disorder.

Finally, life events have been demonstrated to be potent factors affecting physiological processes, in particular the immune and endocrine systems, with implications for health and recovery from illness. For example, studies of individuals undergoing stressful life events ranging from taking final examinations to experiencing bereavement demonstrate a slowing of wound healing—a finding with clear implications for practical problems such as recovery from surgery.

Life events in old age

Individuals from various age groups are exposed to different sets of life events. Yet, despite potentially important age differences, relatively little research has focused on life events in later life. Research on life events in old age is of great importance, since identifying prevalent events and managing stress in later life can not only improve our understanding of human development and adaptation, but can also serve as a basis for interventions and social policies.

Age differences in the occurrence of life events. Contrary to the general belief that old age is a stressful period of time, studies have consistently shown that older adults experience fewer life events than do younger adults. However, though the overall number of events that individuals experience may decline with advancing aging, some specific types of life events are more likely to be encountered in later life. Illness and injury, hospitalization, and the death of a spouse or a friend are examples of undesirable life events that are more prevalent in old age. Using a large sample of community-dwelling older adults, Stanley Murrell and colleagues (1984) showed that over half of their sample had experienced hospitalization, either their own or that of significant others, in the past year. Of course, some other types of life events, such as family conflict and problems with jobs, are less prevalent in older adults.

Another reason for the reduction in life events in later life may be found in the composition of measurement scales. Since most life event inventories used in previous studies were originally developed and standardized on relatively young populations, items less relevant to older adults, such as getting married, having children, and changing jobs, are often included. Given the different experiences in the life cycle, some researchers have developed life event inventories for older individuals. Studies employing relevant measures for older individuals have been shown to be more successful in relating life events and measures of well-being. The LOPES is one notable measure specifically designed for older populations. This scale includes fifty-four life events, selected on the basis of a large, stratified sample of older Kentuckians, and a recall period of six months in order to ensure greater accuracy of older adults' recall. It also contains additional useful ratings of subjects such as desirability, the degree of change required, preoccupation, date of occurrence, and novelty of each event.

Age differences when responding to life events. Some events experienced by older individuals are age-normative events that are expected by most people to occur later in the life cycle. When events are anticipated, their adverse impact may be limited because individuals are prepared for them. In the case of planned retirement, older individuals fare much better than do younger persons who involuntarily lose a job. In addition, retirement may even lead to enhanced physical and psychological well-being.

On the other hand, the death of an adult child is a non-normative experience for older individuals. Even though only a small portion of the older population experiences the loss of a child, it can have a devastating influence on physical and emotional well-being of older individuals. The unexpected and untimely nature of such an event interferes with adjustment and adaptation, and can also make older adults feel guilty.

Studies show that older individuals are more likely than younger persons to be affected by the events that occur to people they are close to. Such events have been referred to as *network events* or *nonegocentric events*. Examples include adult children's marital or financial problems and illness of family members or friends. With advancing age, individuals pay more attention to the problems of others and become vulnerable to these events.

Researchers have suggested that individuals' prior experiences should be considered to better understand their experiences with life events. This is particularly true for older adults who have had various and rich experiences through the life course. A life-long experience of dealing with stress may provide a context to understand an individual's response to certain events. In many cases, older individuals tend to perceive life events as less troublesome because they are more likely to have relevant experiences to help them cope. Research that focused on older victims of a flood showed that older individuals with prior experience of floods showed less anxiety and distress than younger persons or persons without such experience (see Murrell et al., 1988). Accumulated life experiences may make older individuals more resilient and facilitate their adaptation to change. The experience of seeing others undergo life events may also aid older people in adaptation to life events. For example, the experience of spousal bereavement may be less devastating for older widows compared to younger ones, in part because widowhood of older females is more prevalent and there are many role models in society.

Along with prior experience, current life situations also provide an important context for interpreting individual differences in the impacts of life events. Life events that happen concurrently with other events or under situations of chronic strains may have different meanings than a single event. Older caregivers of dementia patients report more negative events and appraise them as more stressful than controls who are not caregivers (see Reed, Stone, and Neale). In contrast, some researchers have suggested that chronic strains may actually mute the impact of stressful events because minor stressful events pale in comparison to more chronic stressors.

Chronic strains can even change the context and outcomes of major life events. Research suggests that highly strained caregivers show some recovery of functioning after the death of a spouse, while noncaregivers react with increased depression. Since chronic strains and life events interact in a variety of ways, examination of both life events and chronic strains is helpful in understanding individuals' responses to life events.

Positive life events. Most life events research has focused on negative and undesirable life events, and the beneficial effects of positive life events need to receive more attention. Birth of grandchildren, going on a trip out of town, receiving an award or special praise, and starting a new hobby or recreational activity are some of examples of positive events that happen in later life. These positive life events not only have a desirable meaning to older individuals but also moderate the impacts of stressful events. Positive events make individuals focus on good feelings, change views of other events, and provide motivation and resources to overcome stress resulting from negative events. Research on depression in late life has shown that depressed older adults have relatively few pleasant events, and that treatments aimed at increasing pleasant events can reduce depression.

Future directions

With its long history, life events research has progressed a great deal and provided important information from both theoretical and practical perspectives. The study of life events in late life has produced promising results and findings that challenge conventional stereotypes about the vulnerability of older persons. Conceptual sophistication about aging and the life course is evident in the attention that has been paid to the different occurrence of, and reactions to, life events in later life.

However, research on life events and aging has lagged behind that of the broader field in terms of methodology. For example, few studies of life events in older adults have utilized longitu-

dinal assessments and frequent individualized interviews to avoid problems of retrospective recall. While sophisticated methods have been developed and applied to the study of life events in psychiatric and medical disorders in younger people, little is known about how life events may trigger relapse or recurrence of these disorders In the elderly. Studies of older adults should borrow heavily from methods that have been refined in studies of younger persons.

A particular need is for more clinically relevant research on life events and aging, with the goal of promoting an empirically based practice of clinical geropsychology. Evidence to date suggests that older adults respond well to cognitive-behavioral or psychoeducational intervention programs that teach specific skills in coping with life events and chronic strains, and that research on life events provides valuable information for clinicians designing and implementing such intervention programs. However, interventions for bereavement in older adults have shown disappointing results to date, serving an example of an area in which clinicians need better research information to improve clinical practice for older adults.

YURI JANG
WILLIAM E. HALEY

See also BEREAVEMENT; CONTROL, PERCEIVED; GERIATRIC PSYCHIATRY; SOCIAL SUPPORT; STRESS AND COPING.

BIBLIOGRAPHY

ALDWIN, C. M. "The Elders Life Stress Inventory: Egocentric and Nonegocentric Stress." In *Stress and Coping in Later-Life Families*. Edited by M. A. P. Stephens, J. H. Crowther, S. E. Hobfoll, and D. L. Tennenbaum. New York: Hemisphere Publishing, 1990. Pages 49–69.

AVISON, W. R., and GOTLIB, IAN H. *Stress and Mental Health: Contemporary Issues and Prospects for the Future*. New York: Plenum, 1994.

CHIRIBOGA, D. A. "The Measurement of Stress Exposure in Later Life." In *Aging, Stress, and Health*. Edited by K. S. Markides and C. L. Cooper. Chichester, U.K.: John Wiley & Sons, 1989. Pages 13–41.

DOHRENWEND, B. S.; ASKENASY, A. R.; KRASNOFF, L.; and DOHRENWEND, B. P. "Exemplification of a Method for Scaling Life Events: The PERI Life Events Scale." *Journal of Health and Social Behavior* 19 (1978): 205–229.

DOHRENWEND, B. P., and DOHRENWEND, BARBARA S. *Social Status and Psychological Disorder*. New York: John Wiley, 1969.

FOLKMAN, S.; LAZARUS, R. S.; PIMLEY, S.; and NOVACEK, J. "Age Differences in Stress and Coping Processes." *Psychology and Aging* 2 (1987): 171–184.

HLASTALA, S. A.; FRANK, E.; KOWALSKI, J.; SHERRILL, J. T.; TU, X. M.; ANDERSON, B.; and KUPFER, D. J. "Stressful Life Events, Bipolar Disorder, and the Kindling Model." *Journal of Abnormal Psychology* 109 (2000): 777–786.

HOLMES, T. H., and RAHE, R. H. "The Social Readjustment Rating Scale." *Journal of Psychosomatic Research* 11 (1967): 315–328.

KESSLER, R. C. "The Effects of Stressful Life Events on Depression." *Annual Review of Psychology* 48 (1997): 191–214.

KIECOLT-GLASER, J. K.; PAGE, G. G.; MARUCHA, P. T.; MACCALLUM, R. C.; and GLASER, R. "Psychological Influences on Surgical Recovery Perspectives from Psychoneuroimmunology." *American Psychologist* 53 (1998): 1209–1218.

LAZARUS, R. S., and FOLKMAN, S. *Stress, Appraisal, and Coping*. New York: Springer, 1984.

MURRELL, S. A.; NORRIS, F. H.; and GROTE, C. "Life Events in Older Adults." In *Life Events in Psychological Functioning*. Edited by L. H. Cohen. Newbury Park, Calif.: Sage, 1988. Pages 96–122.

MURRELL, S. A.; NORRIS, F. H.; and HUTCHINS, G. L. "Distribution and Desirability of Life Events in Older Adults: Population and Policy Implications." *Journal of Community Psychology* 12 (1984): 304–311.

NEIMEYER, R. A. "Searching for the Meaning of Meaning: Grief Therapy and the Process of Reconstruction." *Death Studies* 24 (2000): 541–558.

PEARLIN, LEONARD I., and SKAFF, M. M. "Stressors and Adaptation in Later Life." In *Emerging Issues in Mental Health*. Edited by M. Gatz. Washington, D.C.: American Psychological Association, 1995. Pages 97–123.

RAPHAEL, K. G.; CLOITRE, M.; and DOHRENWEND, BRUCE P. "Problems of Recall and Misclassification with Checklist Methods of Measuring Stressful Life Events." *Health Psychology* 10 (1991): 62–74.

REDINBAUGH, E. M.; MACCALLUM, R. C.; and KIECOLT-GLASER, J. K. "Recurrent Syndromal Depression in Caregivers." *Psychology and Aging* 10 (1995): 358–368.

REED, BRUCE R.; STONE, ARTHUR A.; and NEALE, J. M. "Effects of Caring for a Demented Relative on Elders' Life Events and Appraisals." *The Gerontologist* 30 (1990): 200–205.

SANDLER, I. N., and LAKEY, B. "Locus of Control as a Stress Moderator: The Role of Control Perceptions and Social Support." *American*

Journal of Community Psychology 10 (1982): 65–80.

SARASON, I. G.; JOHNSON, J. H.; and SIEGEL, J. M. "Assessing the Impacts of Life Changes: Development of the Life Experiences Survey." *Journal of Consulting and Clinical Psychology* 46 (1978): 932–946.

SCHULZ, R.; BEACH, S. R.; LIND, B.; MARTIRE, L. M.; ZDANIUK, B.; HIRSCH, C.; JACKSON, S.; and B., LYNDA. "Involvement in Caregiving and Adjustment to Death of a Spouse: Findings from the Caregiver Health Effects Study." *Journal of the American Medical Association* 285 (2001): 3123–3129.

SCHWARTZ, C. F.; FOLEY, F. W.; RAO, S. M.; BERNARDIN, L. J.; LEE, H.; and GENDERSON, M. W. "Stress and Course of Disease in Multiple Sclerosis." *Behavioral Medicine* 25 (1999): 111–116.

WILLIS, L.; THOMAS, P.; GARRY, P. J.; and GOODWIN, J. S. "A Prospect Study of Response to Stressful Life Events in Initially Healthy Elders." *Journal of Gerontology* 42 (1987): 627–630.

ZARIT, S. H., and ZARIT, J. M. *Mental Disorders in Older Adults: Fundamentals to Assessment and Treatment*. New York: Guilford Press, 1998.

LIFE EXPECTANCY

Life expectancy is a summary measure of the average number of additional years a group of people can expect to live at a given exact age. Life expectancy figures are derived from a life table. Life table methodology has been developed for human populations to determine average lengths of life, of healthy life, of married life, and of working life. Indeed, life tables have recently been used to determine the average career length of professional athletes. And life tables have been used to determine the average length of life of nonhumans, including automobiles and animals.

Life expectancy at birth is derived by applying a set of age-specific mortality rates to a hypothetical group of newborns. For example, with data for the year 2000, we could impose the current age-specific mortality patterns of individuals from birth through the oldest ages onto a group of newborns. These calculations are based on mortality rates prevailing today, not in the future; individuals born today may actually experience lower (or possibly higher) mortality one hundred years hence, when they reach age one hundred. Thus, life expectancies represent a current, and not future, measure of survival.

Table 1
Life table for the U.S. population, selected ages, 1998

Age	Life expectancy
0	76.7
5	72.4
15	62.5
25	53.0
35	43.5
45	34.3
55	25.5
65	17.8
75	11.3
85	6.3
95	3.5

SOURCE: Adapted from: Murphy, Sherry L. "Deaths: Final Data for 1998." *National Vital Statistics Reports* 48 (2000): 1–106.

Further, period-specific events influence life expectancies. For instance, mortality due to human immunodeficiency virus (HIV), a cause of death that was not evident before the 1980s, affects current life expectancy estimates.

Life expectancy is most commonly used for cohorts of newborns, but can also be reported for other ages, as Table 1 depicts. The first row reveals that individuals born in the United States in 1998 can expect to live an average of 76.7 years, the highest figure ever achieved by individuals in this country. Indeed, in 1900, the average life expectancy at birth was just 47.3 years (Anderson).

The table shows the remaining life expectancy for selected ages. The remaining life expectancy is an additional 72.4 years at age 5 and 3.5 years at age 95. With increasing age, remaining years of expected life generally decreases because individuals have already lived through previous years; but the total life expectancy (age plus remaining years) increases because individuals have already survived earlier ages. Thus, at age 75, the remaining life expectancy is 11.3 years, while the total life expectancy is 86.3 years.

Life expectancy is often confused with *life span,* a demographic term that refers to the maximum number of years a person can be expected to live under the most ideal circumstances

(Nam). Life span for humans is about 120 years. In contrast, life expectancy at birth for individuals in the most long-lived nations around the world is approximately eighty years.

A number of factors influence life expectancies, including socioeconomic status, health behaviors, chronic conditions, sex, race, and ethnicity. Indeed, life expectancy figures are often calculated separately by sex and by race/ethnicity. Life expectancy estimates contribute to aging research by providing an excellent summary measure of the length of life of current and future populations.

RICHARD G. ROGERS
ROBERT A. HUMMER
PATRICK M. KRUEGER

See also LIFE SPAN EXTENSION; LONGEVITY: SOCIAL ASPECTS; POPULATION AGING.

BIBLIOGRAPHY

ANDERSON, R. N. "United States Life Tables, 1997." *National Vital Statistics Reports* 47 (1999): 1–40.

MURPHY, S. L. "Deaths: Final Data for 1998." *National Vital Statistics Reports* 48 (2000): 1–106.

NAM, C. B. *Understanding Population Change*. Itasca, Ill.: FE Peacock Publishers, 1994.

LIFE REVIEW

Life review is a progressive return to consciousness of memories and unresolved past conflicts for reevaluation and resolution. It is a normal, developmental task of the later years, a private process that differs with each individual. This evaluative process is believed to occur universally in all persons in the final years of their lives, although they may not be totally aware of it and may in part defend themselves against realizing its presence.

In late life, people have a particularly vivid imagination and memory for the past. Early life events are remembered with sudden and remarkable clarity, and people often experience a renewed ability to free-associate. A life review can provide new insights that result in the resolution of old issues, reconciliation with estranged loved ones, atonement for past mistakes, and integration of the past with the present. Life review can culminate in serenity and acceptance of the life one has lived. Elemental aspects of life, such as children, friendship, nature, humor, and human contact, often gain great significance as people identify the things they hold dear and minimize less important parts of their lives. The resolution of life conflicts may result in creative works, such as memoirs, art and music, or in a new interest in sharing their family histories.

However, the life review can be very painful for individuals who believe they have committed unforgivable acts, have led meaningless lives, or are unable to forgive others for perceived wrongs that may have been committed many years ago. In extreme cases, if a person is unable to resolve problems or accept them, terror, panic, and suicide can result. In cases where guilt, depression, and despair cannot be resolved, professional treatment is necessary.

A life review occurs spontaneously, or it can be structured. Structured life review is sometimes referred to as guided autobiography, and is conducted by an individual trained in psychotherapy. Life review can take many forms, among them autobiographical memory, which refers to memories of specific events that occurred in an individual's daily experience. Reminiscence, which is defined as the process of recollecting past experiences and events, is often used as a therapeutic tool. However, reminiscence is not considered to be a true life review because it does not require that the person evaluate the experience.

A brief history

In the 1950s, psychology, psychiatry, and gerontology textbooks often devalued reminiscence and memories. Reminiscing was thought to be an early diagnostic sign of senile psychosis—what is known today as Alzheimer's disease—and people who engaged in reminiscence were thought to be living in the past, even considered "boring" and garrulous."

In 1955–1956 the National Institute of Mental Health conducted studies for the first time on healthy older persons. The importance of reminiscence was demonstrated. In 1961, Robert N. Butler postulated the universal occurrence in older persons of an inner experience or mental process he called the life review. He proposed that life review helps account for the increased reminiscence in the aged. Today, life review is acknowledged to be a way of maintaining cognitive vitality.

Life review as psychotherapy. The life review and similar autobiographical concepts have

been suggested as psychotherapeutic techniques. These methods include the Martin Method, originated by Lillian Martin, in which the client is asked to relate life history in detail; life review therapy, promulgated by Myrna I. Lewis and Butler; guided autobiography, described by James E. Birren; and reminiscence and structured life review therapy, described by Irene Burnside, Barbara Haight, and others.

In the 1970s, psychiatrists began to move away from psychodynamics and the inner life, and toward the use of psychoactive medications to ease the emotional burden many people feel as they near the end of life.

These therapies are not necessarily mutually exclusive. Medications that ease anxiety and make pain tolerable can be used in conjunction with therapeutic life review to help patients achieve reconciliation and gentle closure.

End-of-life review

To a dying patient, life review can offer validation of the life that has been lived and a way of saying goodbye to family members. Perhaps paradoxically, the review of a life at its end can be a life-affirming experience. Fears about time running out may be reduced and replaced by an acceptance of the past and an appreciation of the here and now.

However, for some individuals, reviewing a life at its end can cause what Eduardo Krapf called "panic at the closing of the gate." In the extreme, life review may involve the excessive preoccupation of the older person with the past. It may proceed to a state approximating terror and result in suicide. The more severe consequences tend to occur when the process proceeds in isolation in those who have been deeply affected by the loss of friends and family, and notable psychosocial discontinuities such as forced retirement and death of a spouse.

Memoir as life review

Memoirs are one form of life review. They represent the writer's search for meaning and the desire to leave a record for posterity. Although religious confessional memoirs, such as the *Confessions* of St. Augustine and *The Book of Margery Kempe* survive from the medieval period, it was not until the seventeenth century that people began to view personal experience as having intrinsic value. For the first time in history, men and women who were neither members of the clergy nor of royal lineage revealed themselves through their memoirs. The interest in writing personal memoirs has not diminished, and in the latter part of the twentieth century memoirs became the signature genre of the era.

Memoirs range from angry to tell-all, to personal journeys to confessional and painful soul searching. For example, the memoirs of Robert S. McNamara, (*In Retrospect: The Tragedy and Lessons of Vietnam,* 1995) illustrate courage and humiliation in acknowledging grave mistakes. Larry McMurtry's memoir, *Roads: Driving America's Great Highways* (2000) is an example of introspective soul searching.

Neither memoirs, nor autobiographies nor oral life reviews necessarily represent the unvarnished truth. They are attempts to understand, integrate, and evaluate in hindsight the life decisions that were made.

Life review as oral history

Recollections of historic events and the era in which they occurred are valuable eyewitness accounts and part of a nation's heritage. For example, in Britain, the group Age Exchange organized the Reminiscence Theatre company, to which Londoners have shared their memories of living through the blitz in World War II. In America, only a few hundred are still alive of the 200,000 orphaned and poor children who were sent west between 1854 and 1929. They meet annually to share remembrances of that era, and their stories are important historical accounts of a little known social experiment.

During the U.S. bicentennial celebration in the summer of 1976, under the auspices of the Smithsonian Institution, Robert Butler, along with anthropologists Margaret Mead and Wilton Dillon obtained the stories of visitors to the Mall in Washington, D.C. In 1993, Sarah L. Delany and A. Elizabeth Delany published *Having Our Say: The Delany Sisters' First 100 Years,* a firsthand account of what it was like to live as African Americans in the United States in the twentieth century.

Universality of the life review

Life review has been called a Western phenomenon because of its focus on the individual.

However, a number of research studies have been conducted around the world. Major programs of reminiscence and life reviews are carried out under the auspices of both national organizations and individuals in Japan and Singapore as well as in the United States and the United Kingdom. An International Society for Reminiscence and Life Review was established in 1995.

Conclusion

The life review concept has contributed to a better understanding of late-life and end-of-life development as well as development across the life span. It has helped demonstrate the therapeutic value of reminiscence for older people and helped eliminate prejudice against those who reminisce.

ROBERT N. BUTLER

See also LIFE SPAN DEVELOPMENT; NARRATIVE; PSYCHOTHERAPY.

BIBLIOGRAPHY

BIRREN, J. E., and SCHROOTS, J. F. *A History of Geropsychology in Autobiography*. Washington, D.C.: APA Books, 2000.

BIRREN, J. E., et al., eds. *Aging and Biography: Explorations in Adult Development*. New York: Springer Publishing, 1996.

BIRREN, J. E., and DEUTCHMAN, D. E. *Guiding Autobiography Groups for Older Adults*. Baltimore, Md.: Johns Hopkins University Press, 1991.

BUTLER, R. N. "The Life Review: An Interpretation of Reminiscence in the Aged." *Psychiatry* 26 (1963): 65–76.

DISCH, R. "Twenty-Five Years of the Life Review: Theoretical and Practical Considerations." *Journal of Gerontological Social Work* 12, nos. 3/4 (1988).

HAIGHT, B. K., and WEBSTER, J. D., eds. *The Art and Science of Reminiscing: Theory, Research, Methods, and Applications*. Washington, D.C.: Taylor & Francis, 1995.

LEWIS, M. I., and BUTLER, R. N. "Life Review Therapy: Putting Memories to Work in Individuals and Group Psychotherapy." *Geriatrics* 29 (1974): 165–169, 172–173.

RUBIN, D. C.; WETZLER, S. E.; and NEBES, R. B. "Autobiographical Memory Across the Life Span." In *Autobiographical Memory*. Edited by D. C. Rubin. Cambridge, U.K.: Cambridge University Press, 1989.

STAUDINGER, U. M. *The Study of the Life Review: An Approach to the Investigation of Intellectual Development Across the Life Span*. Berlin: Max Planck Institut fur Bildungsforschung, 1989.

LIFE-SPAN DEVELOPMENT

Life-span developmental theory provides a framework for understanding human aging. The main purpose of theory in the study of aging is to provide a context for describing and explaining the regular transformations that occur with time to representative organisms living under representative conditions. Theories in general aid the process of articulating meaningful patterns from observations that would otherwise be disconnected pieces of a puzzle and less meaningful. In the study of aging, theories serve as frameworks for organizing research findings as well as general observations or intuitions about aging and the elderly. For example, the study of aging can be seen either as largely the inevitable accumulation of deficits and losses, or as a mixture of gains and losses that depends to some extent on the individual's actions.

Aging is universal in that similar changes in human behavior occur at about the same age for all persons. Some of these age-related changes are controlled by a "biological clock," and the term, *primary aging*, refers to the biologically based mechanisms that are responsible for breakdowns in particular organ systems. In contrast to the consequences of many disease processes that are relatively abrupt and that affect primarily one system or organ, primary aging eventually affects all systems within the organism, and aging occurs gradually and in a cumulative fashion. For example, it is known that all sensory systems become less acute and that the speed of processing information becomes gradually slower with advancing age. Further, there are predictable changes in physiological systems and in physical appearance with aging.

Despite the ubiquity and universality of aging processes, one of the most remarkable characteristics of human aging is the wide range of heterogeneity in the expression of the consequences of aging. Secondary aging factors such as stress, trauma, exposure to toxins, and disease exacerbate the rate of primary aging. However, it is also the case that some individuals successfully avoid disease, maintain high levels of physical and cognitive function, and continue to be active-

Table 1
Themes associated with a life-span approach to the study of aging.

1. Aging is part of a life-long process, and the individual's past and future provide a context for understanding the individual's behavior at any point in time.
2. Aging is multi-dimensional and multi-directional in that there is variability in the amount and direction of change for different characteristics within individuals and across individuals.
3. There is plasticity and resiliency in function throughout the life-span.
4. Aging is a product of the intractive effects of bio-genetic processes and the socio-cultural contexts in which change takes place. The contributions of environmental and biological influnces vary for different dimensions at different points in the life-span. Some combinations of biogenetic and environmental influences may be uniquely synergistic, and others may be uniquely damaging.

SOURCE: Author

ly engaged in life. Individual characteristics as well as the circumstances and the sociocultural contexts associated with particular periods of historical time (e.g., the Vietnam War era) are influential in producing distinctive patterns of aging.

No one is born old, and individuals become more unique as they grow older in part because of particular histories of life experience. During the life course, the repertoire of individuals is shaped by how the person invested time and energy. The life-span approach to the study of aging is one way of conceptualizing many of the factors that affect how individuals change as they grow older, and how different individuals show different patterns of change with aging.

Life-span theory

Life-span developmental theory is usually considered to be a "meta-theory" in that it is a set of themes for approaching the study of development and aging. The life-span approach is not a set of empirically testable hypotheses; rather, it provides a broadened orientation to the study of aging. It should also be pointed out that life-span theory is not new, but has its origins in the work of several eighteenth- and nineteenth-century writers, especially Johann Nikolaus Tetens (1736–1807) and Adolphe Quetelet (1796–1874).

The main themes associated with the life-span approach are summarized Table 1. The idea that aging is multidimensional and multidirectional is one of the basic themes of a life-span orientation to the study of aging. Consistent with evidence suggesting increased inter-individual differences with aging in healthy adults, the experience of aging seems to produce cumulative differentiation within individuals along multiple dimensions. Although it might seem obvious, the idea that gain or growth as well as loss or decline can be observed throughout the life span has not usually been appreciated in research that is narrowly focused on the study of age-related deficits or decline. For example, the study of the characteristics of wisdom and mature thinking, the maintenance or continued evolution of cognitive expertise in the later years, and the emergence of emotional maturity are areas receiving increased research attention. Although there are relatively few research investigations aimed at describing the positive aspects and potentials of late-life functioning compared with the number of investigations in the literature aimed at description and explication of age-related deficit, research inspired by a life-span approach helps to provide a more balanced and accurate account of aging. Life-span theorists seem to enjoy the challenge of chipping away at the prevailing views of aging in science and in society as monotonic deterioration, decrement, and loss. In their efforts to dispel overly negative views of aging, life-span researchers are skeptical about overly narrow conceptions of aging. The results of research describing ordinary lives in real settings often provides a contrasting picture of aging compared with the results of research describing performance on tests and measures that are indigenous to youth and insensitive to the unique qualities of older adults. Another line of research evidence in support of a balanced view is derived from studies that distinguish between the characteristics of normal aging, illness-free aging, and successful aging. Research on successful aging has as one of its aims to identify the personal attributes and contextual characteristics of individuals who minimize or escape the negative consequences of aging and disease. From a gains/losses perspective, there is a complex array of human capabilities; some show decline, some improve, and some remain the same across selected time periods.

Research methods and themes

The description or analysis of simultaneous gains and losses along multiple dimensions across time or age requires sophisticated re-

search methods. Perhaps one of the most important methodological issues derivative from life-span theory has been the distinction between age, cohort, and time of measurement as sources of influence in developmental research. In the study of aging, it is known that observations of age differences in behavior are attributable to both cohort factors (influences associated with time of birth) and to age factors. Further, observations of longitudinal changes across multiple times of measurement are attributable to chronological age change and to the influences of changing socio-historical circumstances. The significance of age, cohort, and socio-historical factors as distinct sources of influence was not really appreciated until development was conceptualized in a broad life-span framework.

Another important methodological theme in life-span developmental theory has to do with the specification and meaning of the age variable. Although age-related change is usually described in terms of chronological age, years since birth provides a crude and unsatisfactory index of many aging phenomena. One theme of the life-span approach is to replace chronological age with index measures that more accurately capture the sources of time-related or age-related change. For example, the effects of aging on behavior are sometimes irreversible. The effects of aging on behavior can also be quantitative and continuous rather than qualitative, and reversible rather than irreversible. Further, markers of elapsed time are insensitive to the meaning of time as a relative and subjective dimension. Indeed, the experience of the passing of 365 days is not likely to be the same for different aged individuals. There are "social clocks" based on culture-related age prescriptions as well as "biological clocks" based on physiological time. Because age and time are not causes of change per se, an aim of aging research is to identify the mechanisms that are primarily responsible for age-related change. Careful description of the social and biological processes that produce aging would enable researchers to replace the index variable, time since birth, with the variables for which it is proxy. For example, there is some evidence to suggest that measures of brain reserve capacity can serve as more accurate measures of the effects of aging than chronological age.

Plasticity, reserve capacity, and resiliency

Most developmental research describes what is normal, not what is possible. Referring to Table 1, another main theme in life-span developmental theory is associated with *plasticity, reserve capacity,* and *resiliency*. Plasticity refers to the potential for intra-individual change. Intra-individual plasticity is evident when there is variability in levels of performance across different kinds of tasks or when there is variability in performing the same task measured at different times or under different conditions. Even the mature adult brain retains considerable functional plasticity, and there is continued cortical reorganization based on adult experience (e.g., Greenough and Black; Ramachandran). Life-span researchers are interested in understanding developmental differences in the gap between observable behavior and actual or potential competence. The potential for optimization is present throughout the life course, although it is likely that it becomes increasingly constrained near the end of the life span. In other words, there appears to be diminished reserve capacity near the end of the life span, such that the individual is vulnerable to a variety of circumstances associated with mortality.

Individuals also exhibit varying capacities to protect themselves from impairment and insult associated with aging and disease, and to adapt effectively to the demands of stressful situations. The term *reserve capacity* refers to the individual's resources for responding effectively to challenging conditions. The term *resiliency* is similar in its meaning, and refers to a capacity for successful adaptation and recovery in response to stressful life events. Although the concept of resilience has been used mainly in reference to protective resources in children, recently some life-span researchers have argued that resilience is a useful concept for describing individual adaptation throughout the life span.

The concepts of plasticity and reserve hold promise for providing a full understanding of the relationship between aging and behavior. Analogous to cardiovascular function, or muscular efficiency, healthy older adults usually function quite effectively in everyday nonstressful conditions, but their functioning is likely to be impaired under stressful conditions. That is, age-related deficits in behavioral function are most apparent when systems that are critical to maintaining performance are challenged or stressed.

The study of reserve capacity is useful for describing the effects of aging on a wide range of functions under challenged conditions. Along these lines, work by Baltes and colleagues has addressed how selected aspects of development can be enhanced or compensated for in situations or domains where there is optimal support.

Biological and social processes

Another main theme of life span developmental theory is the idea that aging is continuously and simultaneously influenced by a wide range of dynamic biological and social processes. Although it seems trivial to point out that aging has multiple causes, most theories of aging emphasize the nonmalleable aspects of aging. From a life span perspective, it is recognized that some of the antecedents of aging are universal and species-determined, and that some are idiosyncratic or cohort-specific, culture-specific, or specific to a segment of historical time. Further, some of the biogenetic and sociocultural aspects of development and aging are gender-specific, and some of the biological and social aspects of development and aging are gender-invariant. Some of the environmental influences on aging are or seem entirely unique to individuals.

It seems that life span researchers also find it useful to look for conceptual linkages across disciplines. Occasionally, such linkages lead to major advances in how we think about aging processes. Significant advances in the study of aging often reflect multidisciplinary integrations of ideas. For example, recent work in the area of developmental behavioral genetics goes beyond the standard position on organism-environment interaction by calling attention to nonadditive synergistic effects. That is, there are unique combinations of nature and nurture that produce synergistic or optimal outcomes for development. As an example of a synergistic interaction between environmental conditions and heritability, it has been reported that there is a significant increase in the heights of second-generation Japanese persons raised in the United States compared with second-generation Japanese persons raised in Japan. Second-generation Japanese persons raised in the United States were over five inches taller than the American-reared sons of short Japanese fathers and the Japan-reared sons of tall Japanese fathers (see Bronfenbrenner and Ceci).

In conclusion, life span developmental theory provides a basis for describing both gains and losses associated with aging. From a life span developmental perspective, researchers tend to consider the potentials as well as limits of intraindividual change across the life span. Due to a combination of influences, many developmental outcomes are possible for each person, some outcomes are more likely than others, some outcomes can be made more likely, and some outcomes are not possible. From a life span orientation, the understanding of specific aspects of human aging are best understood in a larger context that encompasses the influences of biological and sociocultural factors across time and age.

WILLIAM J. HOYER

See also AGE-PERIOD-COHORT MODEL; LIFE COURSE; LIFE SPAN THEORY OF CONTROL; PHYSIOLOGICAL CHANGES; SUCCESSFUL AGING.

BIBLIOGRAPHY

BALTES, P. B. "On the Incomplete Architecture of Human Ontogeny." *American Psychologist* 52 (1997): 366–380.

BALTES, P. B.; STAUDINGER, U. M.; and LINDENBERGER, U. "Lifespan Psychology. Theory and Application to Intellectual Functioning." *Annual Review of Psychology* 50 (1999): 471–507.

BRONFENBRENNER, U., and CECI, S. J. "Nature-nurture Reconceptualized in Developmental Perspective: A Bioecological Model." *Psychological Review* 101 (1994): 568–586.

ELDER, G. H.. "The Life Course as Developmental Theory." *Child Development* 69 (1998): 1–12.

GREENOUGH, W. T., and BLACK, J. E. "Induction of Brain Structure by Experience: Substrates for Cognitive Development." In *Minnesota Symposia on Child Psychology,* Vol. 24, *Developmental Behavioral Neuroscience*. Edited by M. R. Gunnar and C. A. Nelson. Hillsdale, N.J.: Erlbaum, 1992. 155–200.

HOYER, W. J., and RYBASH, J. M. "Characterizing Adult Cognitive Development." *Journal of Adult Development* 1 (1994): 7–12.

RAMACHANDRAN, V. S. "Plasticity in the Adult Human Brain: Is There Reason for Optimism?" In *Maturational Windows and Adult Cortical Plasticity*. Edited by B. Julesz and I. Kovacs. Reading, Mass.: Addison-Wesley, 1995. Pages 179–197.

RILEY, M. W. "On the Significance of Age in Sociology." *American Sociological Review* 52 (1987): 1–14.

ROWE, J. W., and KAHN, R. L. "Successful Aging." *The Gerontologist* 37 (1997): 433–440.

SCHAIE, K. W. "The Course of Adult Intellectual Development." *American Psychologist* 49 (1994): 304–313.

SCHULZ, R., and HECKHAUSEN, J. "A Life Span Model of Successful Aging." *American Psychologist* 51 (1996): 702–714.

LIFE-SPAN EXTENSION

Opinions about life-span extension range from the optimistic, fanciful thinking of Ben Bova, a noted science fiction writer, who wrote: "The first immortal human beings are probably living among us today. You may be one of them." (Bova, p. 3), to the realistic views of Steve Austad, a respected researcher on the evolution of aging processes, who wrote: "In Westminster Abbey. . . lie the bones of one rather ordinary man.. . .Thomas Parr's only claim to fame is that he managed to convince a gullible seventeenth-century public that he had been alive for more than 150 years" (Austad, p. 1). There has probably been no more consistent and heartfelt fantasy than to imagine living forever in a youthful body full of health and vigor. From the dawn of written language, there are references to such life extension. Do some people show extraordinary life extension? What can people do to maximize their own life potential? What is known about the mechanisms of life extension? These are some of the questions that will be addressed below.

Myths about life extension

Biblical, mythological, and other works frequently refer to long-lived human populations living at some remote time or place, typically during some "Golden Age" of humankind. References to long-lived populations in such far away places as Vilcabamba, Ecuador, the Himalayas, or Soviet Georgia are numerous, but are typically the result of sheer fabrication. Such reports are not scientific and have always failed to be verified. For example, those from the Asian state of Georgia were probable fabrications put in place to elude the Czar's draft during the Crimean War, or for other reasons, and were maintained by the Soviet Union for political purposes.

Scientific analysis of longevity

Demography is the science that deals with human longevity, among other things. Demographers have learned to be very careful about accepting claims of extraordinary longevity, because there is a very human tendency to exaggerate one's age after a certain point. A combination of good documentation and continual historical verification of identity help to rule out those who are making untruthful claims.

Demographers who work on human longevity have documented that the human life expectancy is going up rapidly, and has been doing so since about 1850. Overall mortality rate (the probability of death per year) has shown a consistent decline during the same period. Most of the increase in longevity in the nineteenth and early twentieth centuries resulted from better nutrition and from public health and sanitation measures used to prevent the spread of disease (e.g., inoculations to prevent early childhood diseases). These seemingly simple interventions have almost eliminated early causes of death and are responsible for the increased longevity and decreased early-life mortality seen throughout the twentieth century.

Since 1950, the increase in life expectancy has continued. In this period, the decline in mortality rate in developed countries has occurred largely in the older populations. Indeed, the population of adults age eighty-five and older showed the fastest rate of decline in mortality between 1950 and 2001. There is considerable debate about whether or not there is an upper limit to life span, but since mortality in the oldest cohorts is dropping most rapidly it seems unlikely that there are built-in limits to human longevity.

Centenarians

There are lots of people who manage to live a long time. The century mark has proven itself to be a useful measure of establishing a truly long life. The number of centenarians is growing rapidly, but the longest lived, so far, is Madam Jeanne Louise Calment, who had a validated life span longer than any one else in recorded history, living 122 years, 165 days. Calment was born in Arles, France on February 21, 1875 and died August 4, 1997. She once met Vincent Van Gogh in her father's shop. Calment rode a bicycle to the age of one hundred, but by the time of her death, she was blind, almost deaf, and confined to a wheelchair. Her genes may have contributed to her longevity, as her father lived to the age of ninety-four and her mother to the age of eighty-six.

Even thought Calment holds the record, there are an extraordinary number of centenari-

ans alive in the world today. There are 50,000 in the United States alone, and worldwide there are expected to be millions of centenarians alive by the year 2020. The Living to 100 Web site (www.livingto100.com) includes a method to calculate one's chances of reaching the century mark.

Life-extension strategies that work

Interventions that lead to a longer life span have been sought for ages. There is a huge amount of money to be made by selling over-the-counter drugs, dietary supplements, and nutraceuticals that claim some effect on life extension. Numerous companies and scientists are trying to develop dietary interventions that will prolong life. As of this writing however, there is no scientifically validated dietary supplement that has a significant effect on human longevity. One should be very careful before purchasing any agents that propose to extend longevity, and even more careful before consuming such a product. The FDA does not regulate dietary supplements, health foods, and nutraceuticals, and some of these agents could have a significant negative effect on one's health; others may be addictive.

Limiting total food intake, however, does have some beneficial effect. Around 1930, Clive McCay discovered that feeding rats a diet complete in vitamins and minerals, but low in total calories, resulted in a prolonged period of life. Since then, numerous studies have observed life extension in a variety of different species, both mammals and invertebrates, and the effects of caloric restriction (CR) on extending life span have been widely validated. There is anecdotal evidence that humans who practice CR are healthier and may have longer life spans; unfortunately, few people have the ability to eat 40 percent less than that eaten by the average person every day, for the rest of their lives. At least one start-up biotech company is attempting to overcome this problem using pharmaceuticals that will mimic the effect of CR.

Scientifically, caloric restriction (also called dietary restriction or food restriction) refers to the method of extending mean and maximal life span by reducing caloric intake of a test animal. This is the only widely validated means of life extension in mammals. (Genetic methods and drug interventions are beginning to be studied in invertebrates.) CR is not starvation, but a reduction in caloric intake that typically results in consumption of only about 60 percent of the normal *ad libitum* diet. Numerous physiological functions are changed by CR; indeed, it is difficult to find a change associated with aging that is not slowed by CR. This has been one of the real difficulties in studying CR, for almost everything responds. Typical CR animals look and behave much younger than their chronological age would suggest, and this is true at the organ, cellular, and molecular levels. CR works best if the animal is restricted early in life (just after puberty), but even CR initiated late in life can have an effect on longevity that is almost proportional to the amount of time the animal is on CR. A typical CR mouse or rat lives about 30 percent longer and is much more lean and active at later stages of life. However, CR is often associated with reproductive sterility.

It has been quite difficult to reliably study CR in humans, or to convince people to initiate a CR diet for themselves. Numerous proponents have tried to maintain CR for themselves, but the results are not systematic or generally convincing. The National Institutes of Health (NIH) is currently funding CR research on macaques and rhesus monkeys to see if the observations made in rodents can be extended to primates. The results seem to suggest that CR works in primates as well.

Lifestyle choices to maximize life span

Choosing long-lived parents is currently the best method of insuring one's longevity. For now, there's not much people can do to ensure that the genes they got from their parents were the best possible. Each of us is responsible for maximizing our own life span (or not) as we see fit. Interventions to rectify such hereditary defects are probably at least a few decades away; but there's a lot a person can do to maximize the effect of his or her genes. The most important things to do to ensure that one reaches a maximum life span are to avoid unhealthy habits, such as smoking; excessive use of drugs like alcohol, narcotics, or marijuana; and overeating or consuming fatty foods. Regular exercise is also recommended.

Assuming that one wants to extend his or her life, as the comedian Woody Allen put it, "by not dying," rather than through one's children or works, what can be done? Not smoking, eating a healthy diet that's light in fats and total calories,

getting plenty of exercise, staying happy, and having friends all may help. Some people recommend certain dietary supplements, such as vitamin E and a half an aspirin tablet daily. There are no magic bullets, however, at least not yet. Advice changes, and it's best to stay up to date; several websites maintained by responsible organizations include those of the American Federation for Aging Research (www.infoaging.org), the National Institute on Aging (www.nih.gov/nia/), and the Gerontological Association of America (www.geron.org).

Evolution of longevity

After the end of the reproductive period, an organism, be it mouse or human, can no longer contribute to the evolutionary pool in any sort of direct way, so there is little reason to think that evolution would select for individuals who live well past the age of reproduction. Moreover, since most organisms in the wild die from infection, accident, or predation, most scientists working on aging think that there is no selection for a program that kills an organism. Genes that regulate longevity also function to do other things as well, and their effects on longevity are thought to be secondary to these other actions. A small, but very vocal, subgroup disagrees strongly with this view, arguing that aging is genetically programmed. One of the best arguments against genetic programming is that no one has been able to eliminate the aging program in any species. In other words, no immortal organisms have been found, and most scientists think that they never will be. Other processes sometimes associated with aging *are* programmed, including programmed cell senescence, also called the *Hayflick limit,* and programmed cell death (*apoptosis*). These processes can be completely eliminated in the lab, but no one has turned a mortal organism into an immortal one.

Ben Bova was right about one thing—all people have the potential to be immortal. To be more precise, one part of each person has that potential: the germ line. Obviously, one part of the human must in some sense be immortal or human life would not exist today. However, the indefinite life of the germ line does not mean that any biological component in the process is really immortal. The somatic part of the germ line wears out; men accumulate mutations in their sperm, and women go through menopause. Menopause is not something that is unique to humans; numerous other species also show a cessation of reproduction in females late in life. Numerous arguments have been put forward arguing that menopause provides advantages to humans over evolutionary time periods, but there is little direct support for this notion and certainly no need that it be true. Modern medical interventions have already extended the reproductive life of women into their sixties using a variety of in vitro fertilization technologies and appropriate hormone treatments.

Genetic effects on life extension

Scientists have discovered that the genetic constitution of an organism can have a significant effect on its longevity. In humans, only a small fraction of the life span seems to be under genetic control, but this estimate could be wrong for many reasons. Geneticists who study humans are interested to know how much of the variation in individual longevity is controlled by the genes of the individual and how much is environmental. To answer this question, geneticists estimate something called *heritability.* For example, if on average, two Americans chosen at random will differ in life span by ten years, then heritability is a way of saying how much of that variation is due to environment and how much is due to genetic influences. (In this case, *environment* means the external environment as well as the stochastic differences within the animal, tissue or cell). The best current estimates are that genetics has a significant, but modest, effect on overall longevity, explaining only about 20 percent of the variation.

This estimate does not mean that aging is controlled by 20 percent of the genes, or that 20 percent of life is genetically programmed and the rest determined by environment. There are good reasons to suppose that centenarians have been blessed with very good genes (actually we all have the same genes, but centenarians have good versions called *alleles*). So in a centenarian, forty or fifty years of life could result from genetic effects. It's impossible to be certain, but many groups are looking for these genes.

Life extension as a way to find aging genes

Scientists use life extension as a way to find genes that affect aging. Johnson and Wood proposed in 1982 that genetic variants that lengthen

life could be found. Most genetic alterations shorten life, because these mutants reduce overall health and fitness. Indeed, it is counterintuitive that a genetic mutant could actually lead to longer than normal life, because mutations are generally thought of as bad. However, to the species, the length of an individual life does not matter at all. Scientists have used this strategy very effectively and have discovered numerous genes that lengthen life span.

Aside from caloric restriction, genetic manipulation is the only intervention that has been widely shown to actually extend longevity. Initial studies used naturally occurring genetic variants of longevity genes and combined them to yield longer-lived populations. Later, mutations in individual genes were shown to generate even longer life spans than possible in strains developed using this polygenic approach. In invertebrates, and especially in the small nematode worm called *Caenorhabditis elegans,* genetic variants leading to prolonged life have been produced for almost two decades. Other model organisms, in addition to the nematode, that are used to study genetic interventions include yeast and the fruit fly. These studies are yielding dozens of genes that affect longevity and slow down the rate of aging.

Several steps must be taken to characterize a longevity mutant. First, it must be verified that the longevity change is real and is passed on to the offspring. If it is, and if the mutation can be assigned a position in the chromosomes of the animal, then a mutational event has likely been found. Then the scientist would want to fish out the larger piece of DNA that carries the genetic mutants and figure out what this larger piece of DNA (the gene) does. Since almost all genes code for protein, this means finding out what the protein does, using both biochemical and genetic tricks.

The future

Many companies are trying to extend the life of short-lived species by using drug treatments. Such a strategy could possibly lead to drugs that lead to life prolongation and slower rates of aging. It was shown in 2000 that life extension can be achieved by drug treatment, at least in invertebrates. This is a natural extension of the genetic approach, using life span as a marker. Such a strategy could possibly lead to drugs that prolong life and slow rates of aging. For now, this still seems a distant pipe dream. However, the production of such drugs could be common in the future.

THOMAS E. JOHNSON

See also CENTENARIANS; COMPRESSION OF MORBIDITY; EVOLUTION OF AGING; FRUIT FLIES, DROSOPHILIA; GENETICS: LONGEVITY ASSURANCE; LIFE EXPECTANCY; NEMATODES; NUTRITION; NUTRITION, CALORIC RESTRICTION; PATHOLOGY OF AGING, ANIMAL MODELS.

BIBLIOGRAPHY

ALLARD, M.; LEBRE, V., and ROBINE; J.-M. *Jeanne Calment: From Van Gogh's Time to Ours*. New York: W. H. Freeman, 1998.

AUSTAD, S. N. *Why We Age*. New York: John Wiley, 1997.

BOVA, B. *Immortality*. New York: Avon Books, 1998.

FINCH, C. E. *Senescence, Longevity, and the Genome*. Chicago: University of Chicago Press, 1990.

FINCH, C. E., and TANZI, R. E. "Genetics of Aging." *Science* 278 (1997): 407–411.

GUARENTE, L., and KENYON, C. "Genetic Pathways that Regulate Ageing in Model Organisms." *Nature* 408 (2000): 255–262.

JOHNSON, T. E., and WOOD, W. B. "Genetic Analysis of the Life-Span of Caenorhabditis Elegans." *Proceedings of the National Academy of Sciences U.S.A.* 79 (1982): 6603–6607.

MARTIN, G. M.; AUSTAD, S. N.; and JOHNSON, T. E. "Genetic Analysis of Ageing: Role of Oxidative Damage and Environmental Stresses." *Nature Genetics* 13 (1996): 25–34.

MELOV, S.; RAVENSCROFT, J.; MALIK, S.; WALKER, D. W.; CLAYTON, P. E.; WALLACE, D. C.; MALFROY, B.; DOCTROW, S. R.; and LITHGOW, G. J. "Extension of Life-Span with Superoxide Dismutase/Catalase Mimetics." *Science* 289 (2000): 1567–1569.

OLSHANSKY, J. S.; CARNES, B. A.; and BUTLER, R. N. "If Humans Were Built to Last." *Scientific American* 284 (2001): 50–55.

PERLS, T. T., and SILVER, M. H. *Living to 100: Lessons in Living to Your Maximum Potential at Any Age*. New York: Basic Books, 1999.

RICKLEFS, R. E., and FINCH, C. E. *Aging: A Natural History*. New York: Scientific American Library, 1995.

ROSE, M. R. *Evolutionary Biology of Aging*. Oxford, U.K.: Oxford University Press, 1990.

VAUPEL, J. W.; CAREY, J. R.; CHRISTENSEN, K.; JOHNSON, T. E.; YASHIN, A. I.; HOLM, N. V.; IACHINE, I. A.; KANNISTO, V.; KHAZAELI, A. A.;

LIEDO, P.; LONGO, V. D.; ZENG, Y; MANTON, K. G.; and CURTSINGER, J. W. "Biodemographic Trajectories of Longevity." *Science* 280 (1998): 855–860.

WEINDRUCH, R., and WALFORD, R. L. *The Retardation of Aging and Disease by Dietary Restriction*. Springfield, Ill.: Charles C. Thomas, 1988.

LIFE-SPAN THEORY OF CONTROL

The evolutionary origin of control-related behavior lies in the universal strive to achieve outcomes in the environment by one's own activity. Control behavior should be distinguished from perceptions or beliefs about control. Perceived control exclusively addresses mental representations of the degree of control available to the individual. Control behavior, by contrast, encompasses behavior directed at producing effects in two realms: the environment and the inner world of the individual. Control behavior directed at the external world is conceptualized as *primary control,* whereas control behavior addressing one's mental states, emotion, and motivation is referred to as *secondary control*.

In all activities relevant for survival and procreation, such as foraging, competing with a rival, or attracting a mate, organisms strive for control in terms of bringing about desired outcomes and preventing undesired ones. The most fundamental and universal motivational tendencies relate to this basic strive to control the environment, or in more specific terms, to produce contingencies between behaviors and events in the environment. This striving to produce behavior-event contingencies is referred to as *primary-control striving*.

Striving for control is shared by a broad range of species and goes back far into the phylogenetic past; at least as far as to those species that first acquired a notable flexibility in their behavior programs (Gallistel, 1990; Rumbaugh and Sterritt, 1986; see review in Heckhausen, 2000). This assumption converges with White's classic 1959 article on the motivation for competence, effectance, and mastery as a universal striving of humans and mammals in general. For example, both children and rats prefer response-elicited rewards to receiving the same rewards without having to respond.

Particularly in humans, primary-control striving can encompass multiple steps and bridge extended time periods, such as in long-term career goals. This capacity rests on the human ability to have long-term goals and on the ability to reflect on the self as the originator of goals and goal attainments. However, this capacity also renders humans vulnerable to the negative effects of failure on conceptions about the self. Failure and loss of control may undermine an individual's motivation to pursue goals in the future. In order to protect motivational resources for primary-control striving, individuals need to regulate their internal responses to experiences of failure and loss. The system of control behavior in humans therefore needs to involve processes that protect and restore conceptions of competence and mastery. Heckhausen and Schulz, in their life-span theory of control (Heckhausen and Schulz, 1995; Schulz and Heckhausen, 1996), subsume diverse, mostly cognitive, processes that serve to protect motivational resources and focus on a given goal (e.g., volitional commitment) of primary-control striving, under the construct of *secondary-control striving*. Among such secondary-control processes are those that help the individual to disengage from a futile goal (e.g., devalue the goal, increase the value of alternative goals) or protect the self against unfavorable implications of failure and loss. Examples for self-protective secondary control strategies are downward social companions, when the individual compares herself with inferior others, and egotistic casual attributions, where success is attributed to one's own ability, whereas failure is blamed on external factors. In addition, secondary-control strategies are also needed for generating and maintaining motivational commitment to a chosen goal (e.g., enhance the value of the chosen goal, devalue alternatives, overestimate the perceived control for goal attainment).

Research about control striving and behavior

The study of actual control behavior and control striving, as distinct from perceived control, is an emergent field of research. The life-span theory of control proposes that the desire to exert control over one's environment, and thus realize primary control, rules the system of control behavior in humans and, in mammals in general (for phylogenetic roots of control behavior, see Heckhausen, 2000). The life-span theory of control elaborates on the distinction between primary and secondary control, originally proposed by Rothbaum, Weisz, and Snyder (1982),

and applies it to the human life span. Primary-control striving is seen as the dominant motivator of behavior across the life span, while the potential to realize primary control undergoes radical changes. During childhood, adolescence, and young adulthood, primary-control potential increases substantially, reaching a maximum plateau during midlife and declining with the loss of social roles and physical fitness associated with old age. The increasing discrepancy between primary-control striving and primary-control potential at older ages provides a challenge for the individual, in that it can only be managed by disengaging from age-inappropriate goals and engaging in more age-adapted goals. Such cycles of goal disengagement and engagement can only be mastered when the individual employs specific secondary-control strategies related to goal hierarchies and motivational commitment.

Heckhausen and Schulz (Heckhausen and Schulz, 1993, 1995; Heckhausen, 1999) distinguish between four types of control strategies: *Selective primary control* refers to the investment of internal behavioral resources such as effort, time, and skills in the pursuit of a goal. *Compensatory primary control* is required when internally available behavioral resources of an individual are insufficient to attain the goal and external resources have to be recruited. Specifically, compensatory primary control addresses the recruitment of help or advice from others, the use of technical aids (e.g., a wheelchair), or the employment of unusual behavioral means typically not involved in the activity (e.g., lip reading to compensate for a hearing disability). *Selective secondary control* serves to enhance and maintain motivational commitment to a chosen action goal, particularly when it is challenged by unexpected obstacles or attractive alternatives. Selective secondary-control strategies include enhanced valuation of the chosen goal and devaluation of nonchosen alternatives. In addition, the goal engagement is served by enhancing one's perceptions of control and self-efficacy. *Compensatory secondary control* is required when an individual experiences a loss of control or when the goal becomes unattainable or excessively costly. Compensatory secondary control can be attained by disengaging from the obsolete goal, possibly in favor of engaging in an alternative or substitute goal. In addition, compensatory secondary control involves specific self-protective strategies, such as deflating one's perceptions of control and attributing the failure to external forces (thereby avoiding self-blame) and downward social comparisons, which deflect the potential negative effects of failure on important motivational resources of affective balance and self esteem.

The theory of control behavior can be integrated with modern motivational action theory, which views motivation behavior as organized in action cycles of goal engagement and goal disengagement (Heckhausen, 1991). Specifically, goal engagement involves the strategies of selective primary and selective secondary control, as well as (in dealing with obstacles), compensatory primary control. Goal disengagement relies on the compensatory secondary-control strategies of goal distancing and self-protection.

Several studies have examined the use of primary- and secondary-control strategies in various developmental ecologies during the life span. Heckhausen (1997) found in a socially heterogeneous sample of East German and West German adults that striving for primary control remained constant across age groups, whereas the flexibility of adjusting one's goals, a key component of compensatory secondary control, increased at older ages. In the particularly challenging context of German reunification, East German adults activated primary-control striving when they were in early adulthood, and resorted to compensatory secondary control when they were close to or past retirement age. Women and men who were in their early fifties during German reunification were "caught in the middle" and lost ground in terms of both primary and secondary control. Chipperfield and colleagues (Chipperfield et al., 1999) investigated the effectiveness of primary- and secondary-control strategies in a sample of older adults experiencing either acute temporary or chronic severe health stress. They found that primary-control strategies had positive health implications for the young-old, but that the same strategies appeared to be detrimental to health in more advanced old age.

Heckhausen and colleagues developed the paradigm of developmental regulation around developmental deadlines to study control strategies in different action phases. Developmental regulation across the life span is organized along a timetable of waxing and waning opportunities to attain important developmental goals, such as graduating from school, building a career, finding a permanent partner, and having a child.

The age-graded opportunity structures for various developmental goals involves final time constraints, conceptualized as developmental deadlines. An example is the so-called biological clock for child-bearing. In a series of studies, developmental deadlines were shown to be the watersheds between urgent predeadline goal engagement and postdeadline goal disengagement and self-protection. Individuals approaching a developmental deadline, such as the early forties in the case of child-bearing, activated goal engagement strategies of control (e.g., selective primary control, selective secondary control, compensatory primary control), fervently striving to attain the goal before time ran out. In contrast, once a deadline has been passed, (e.g., women in their late forties or fifties with regard to child-bearing) control strategies of goal disengagement, such as devaluing the goal and self-protective downward comparison with others, were preferred. Moreover, it was shown that the employment of phase-congruent control strategies (i.e., goal engagement in the predeadline phase and goal disengagement in the postdeadline phase) was associated with greater psychological well-being and mental health (e.g., less depressive symptoms, more positive affect) than phase-incongruent control strategies.

Future research about control behavior can exploit the model of action cycles. In both developmental and nondevelopmental contexts, control processes associated with goal engagement and goal disengagement can be investigated in terms of their congruence with control opportunities. This approach also allows the study of individual differences in the ability to recognize changes in opportunity structures and in the flexibility of switching between goal engagement and goal disengagement. This may provide an avenue to investigate differences in vulnerability and resilience to developmental transitions.

JUTTA HECKHAUSEN

See also DEVELOPMENTAL PSYCHOLOGY; DEVELOPMENTAL TASKS; LIFE SPAN DEVELOPMENT; SELECTIVE OPTIMIZATION WITH COMPENSATION THEORY (SOC).

BIBLIOGRAPHY

CHIPPERFIELD, J. G.; PERRY, R.; and MENEC, V. H. "Primary and Secondary Control Enhancing Strategies: Implications for Health in Later Life." *Journal of Aging and Health* 11 (1999): 517–539.

DIEWALD, M.; HUININK, J.; and HECKHAUSEN, J. "Lebensverläufe und Individuelle Entwicklung im Gesellschaftlichen Umbruch: Kohortenschicksale und Kontrollverhalten in Ostdeutschland nach der Wende." (Life Courses and Individual Development during Societal Transformation: Cohort Differences and Control Behavior in East Germany after Reunification). *Kölner Zeitschrift für Soziologie und Sozialpsychologie* 48 (1996): 219–248.

GALLISTEL, C. R. *The Organization of Learning*. Cambridge, Mass.: MIT Press, 1990.

GOLLWITZER, P. M., and KINNEY, R. F. "Effects of Deliberative and Implemental Mind-Set on Illusion of Control." *Journal of Personality and Social Psychology* 56 (1989): 531–542.

HECKHAUSEN, H. *Motivation and Action*. New York: Springer, 1991.

HECKHAUSEN, J. "Entwicklungsziele und Kontrollüberzeugungen Ost- und Westberliner Erwachsener." (Developmental Goals and Control Beliefs in East- and West-Berlin Adults). In *Psychologische Aspekte des Sozio-Politischen Wandels in Ostdeutschland*. Edited by G. Trommsdorff. Berlin: DeGruyter, 1994. Pages 124–133.

HECKHAUSEN, J. "Developmental Regulation across Adulthood: Primary and Secondary Control of Age-Related Challenges." *Developmental Psychology* 33 (1997): 176–187.

HECKHAUSEN, J. *Developmental Regulation in Adulthood: Age-Normative and Sociostructural Constraints as Adaptive Challenges*. New York: Cambridge University Press, 1999.

HECKHAUSEN, J. "Evolutionary Perspectives on Human Motivation." *American Behavioral Scientist* 43 (2000): 1015–1029.

HECKHAUSEN, J., and SCHULZ, R. "Optimization by Selection and Compensation: Balancing Primary and Secondary Control in Life Span Development." *International Journal of Behavioral Development* 16 (1993): 287–303.

HECKHAUSEN, J., and SCHULZ, R. "A Life Span Theory of Control." *Psychological Review* 102 (1995): 284–304.

HECKHAUSEN, J., and SCHULZ, R. "The Primacy of Primary Control is a Human Universal: A Reply to Gould's Critique of the Life Span Theory of Control." *Psychological Review* 106 (1999): 605–609.

HECKHAUSEN, J.; WROSCH, C.; and FLEESON, W. *Developmental Regulation before and after a Developmental Deadline: The Sample Case of "Biological Clock" for Childbearing*. Berlin: Max Planck Institute for Human Development, 2000.

HUININK, J.; DIEWALD, M.; and HECKHAUSEN, J. "Veränderungen im Erwerbsverlauf nach

1989 und ihr Zusammenhang mit Kontrollüberzeugungen und Kontrollstrategien (Changes in Employment Patterns after 1989 and Their Relation to Control Beliefs and Control Strategies)." In *Zwischenbilanz der Wiedervereinigung: Mobilität im Transformationsprozess*. Edited by M. Diewald and K. U. Mayer. Leverkusen: Leske + Budrich, 1996. Pages 251–267.

ROTHBAUM, F.; WEISZ, J. R.; and SNYDER, S. S. "Changing the World and Changing the Self: A Two-Process Model of Perceived Control." *Journal of Personality and Social Psychology* 42 (1982): 5–37.

RUMBAUGH, D. M., and STERRITT, G. M. "Intelligence: From Genes to Genius in the Quest for Control." In *Integrating Scientific Disciplines*. Edited by W. Bechtel. Dordrecht: Martinus Nijhoff, 1986.

SCHULZ, R., and HECKHAUSEN, J. "A Life Span Model of Successful Aging." *American Psychologist* 51 (1996): 702–714.

SINGH, D. "Preference for Bar-Pressing to Obtain Reward over Freeloading in Rats and Children." *Journal of Comparative and Physiological Psychology* 73 (1970): 320–327.

WHITE, R. W. "Motivation Reconsidered: The Concept of Competence." *Psychological Review* 66 (1959): 297–333.

WROSCH, C., and HECKHAUSEN, J. "Control Processes before and after Passing a Developmental Deadline: Activation and Deactivation of Intimate Relationship Goals." *Journal of Personality and Social Psychology* 77 (1999): 415–427.

WROSCH, C.; LACMAN, M. E.; and HECKHAUSEN, J. "Primary and Secondary Control Strategies For Managing Health and Financial Stress Across Adulthood." *Psychology and Aging* 3 (2000): 387–399.

LITERATURE AND AGING

Since the early 1970s, adult literature has been transformed, creating what Constance Rooke has called "a new paradigm of hope." Modern medicine has extended the life span while improving the later years. Editors, publishers, and authors have recognized that a sizable proportion of the reading and writing public is over sixty. A few writers, such as poet Virginia Adair and novelists Penelope Fitzgerald, Mary Wesley, and Molly Keane, have forged literary careers beginning in their sixties, seventies, or eighties. Ninety-five-year old poet Stanley Kunitz was appointed Poet Laureate to the Library of Congress on 31 July, 2000. He signed three book contracts at the age of ninety-two. Others, such as Kingsley Amis, Elizabeth Spencer, Ellen Douglas, Toni Morrison, John Updike, David Lodge, Margaret Drabble, Pat Barker, and Gail Godwin, have continued professions begun in youth or midlife. No longer is it necessary for writers to exaggerate their youth, as Anzia Yezierska did in the 1920s and 1930s, in order to attract an audience. And as a result of expanded fictional careers older characters appear in adult novels more frequently, playing more varied roles than in earlier days. In many cases they are the chief protagonists of fiction.

In contrast, even as early as the nineteenth century, most stories composed primarily for children include older characters, who rarely dominate the plots but are subordinated to the child heroes. Many of these figures appear weak, greedy, or cruel (see Mangum, 2000). Such characters contribute to children's fear of aging, death, and the ugliness of old bodies. We must carefully analyze these negative depictions to avoid contributing to a mindless "age ideology," one that carelessly stigmatizes all stages of life, but especially midlife and old age (Gullette, 1997, 2000). At the same time positive examples of aging characters can be located in literature for the young, and, it is hoped, even play a healing role. This concern to overcome the barriers separating old and young will continue through the twenty-first century. Young readers still seek a safe space for themselves, to explore what it means to be a child in postindustrial society, and to discover in fiction evidence of warm human relationships that may well be missing in their daily lives. Since literature written for children shapes lifelong attitudes as much as adult fiction, both kinds need analysis.

The themes of children's literature pertinent to aging include the following: redemptive grandchildren, animal families, the search for parental substitutes, and epic heroes. Adult themes of aging involve: life crises and life review, retirement concerns, illness, mourning and death, and occasional instances of epic courage. Of course new trends in society affect the conventions of fiction, but several of the intergenerational themes in adult fiction have antique roots.

Redemptive grandchildren

The redemptive grandchild theme is developed in Johanna Spyri's *Heidi* (1880), Frances

Hodgson Burnett's *Little Lord Fauntleroy* (1886), and Annie Fellows Johnston's *The Little Colonel Series* (1895). At the start of each story, the grandfathers have severed relations with the next generation, claiming their children have married inappropriately. The grandchildren appear on the scene and through their innocent affection rekindle the familial love and pride that the grandfathers thought had died forever. Older women rarely need such reeducation. Indeed, they sometimes intercede and help the children manage the isolated old men. The grandfathers in *Fauntleroy* and the *Little Colonel* are obsessed with issues of class and race. Unlike the mountain-dwelling grandfather of *Heidi* they have little useful to teach their grandchildren outside of what contemporary readers regard as snobbish elitism. Fortunately, children can still respond to *Heidi's* hopeful message that children have the power to reconcile families torn by strife.

Animal family life

The stories that best represent intergenerational animal family life are often written for the youngest children. Older characters are mostly benign, though sometimes absentminded figures. For example, in Margot Austin's *Gabriel Churchkitten* (1942), tiny Peter Churchmouse and Gabriel Churchkitten team up to outwit Parson Pease-Porridge. When sleepwalking he eats the food he has just laid out for Peter and Gabriel. Margaret Wise Brown's *The Runaway Bunny* (1942) and *Goodnight Moon* (1947) feature older women who reassure young children that they will be nurtured no matter what. A very rich elderly lady plays an instrumental role in Jean de Brunhoff's *The Story of Babar* (1933). The love she feels for the little elephant is instantaneous and unqualified, as befits an idealized grandmother. The mother in Else Holmelund Minarik's *Little Bear* (1957) loves her cub unconditionally. Frances Badger is also lucky in her parents. In Russell Hoban's *Bedtime for Frances* (1960), they tolerate many trips to the bathroom and drinks of water but eventually insist that she settle down and go to sleep.

Orphans and substitute parents

Although occasional orphans, such as detective Nancy Drew, seem untroubled by the death of a parent, others struggle to come to terms with their loss. For instance, L. M. Montgomery's Anne of *Anne of Green Gables* (1908) is desperate to be accepted by Matthew and Marilla Cuthbert, an elderly brother and sister, who need help on their farm. J. K. Rowling also shows great sensitivity to Harry Potter's feelings of bereavement in *Harry Potter and the Sorcerer's Stone* (1998), a most unusual boarding school novel. Not only does his school train aspiring witches and wizards, but its headmaster plays a positive role rather than merely being a disciplinarian. The elderly head assists the boy unobtrusively, while teaching him to accept death as "the next great adventure" (p. 297). Evil older characters abound, but with the assistance of the headmaster and other friendly helpers, the boy hero and his friends prevail.

Epic adventures and magical transformations

Adventurous characters such as Lewis Carroll's Alice and Alf Prøysen's *Little Old Mrs. Pepperpot* (1959) suggest that young and old share a concern about bodily transformations. Midlife characters rarely suffer these indignities. Alice alternates between being tiny and very tall, thus mirroring the feelings of young girls, who may seem short one year and tower over their classmates the next. Older women are unappealing in *Alice's Adventures in Wonderland* (1865) and *Through the Looking Glass* (1871). John Tenniel's comic line drawings stress the absurdity of all older characters (Mangum, 1999, 2000), but the drawings of the Duchess and the Red Queen emphasize their ugly and frightening demeanor. The King's face may be weak, but compared to the Queen he appears to be relatively attractive and mild-mannered. Portrayals of witchlike women make it easy for children to believe older women are dragons who must be conquered (Gullette, 1988). In contrast, old Mrs. Pepperpot shares the worries of young children. Returning home from collecting bilberries to make jam, she shrinks unexpectedly. Lacking strength to carry the pail, she has to trick a fox, wolf, and bear into helping her. Robert McCloskey's hero in *Burt Dow: Deep-Water Man* (1963) undergoes an experience like that of the Old Testament's Jonah rather unexpectedly one fine day. He puts a colorful Band-Aid on an injured whale. When a storm threatens Burt's old boat, his friend the whale swallows him whole. Burt smears the whale's insides with all the bilge and paint he has aboard his boat to encourage the forgetful whale to disgorge him. In the end the old boatman puts striped Band-Aids on all of the whale's friends

and then chugs home to his sister under his own steam.

In most of these stories young children make allies of older characters, who are often idealized. Few writers for that age group would introduce the possibility that grandparents and children might not get along, a problem examined in Peter Taylor's short story "In the Miro District" (1977). Instead grandparents in children's fiction generally lack any desires of their own that might conflict with the needs of the young.

Life crises and life review

Appealing to older readers with experience of life's dilemmas, adult fiction grapples with sometimes unresolvable problems. In adult fiction, characters in their fifties, sixties, and seventies often begin to reflect on their life experiences as a response to crises they cannot otherwise resolve. For example, Toni Morrison's *Jazz* (1992) unexpectedly becomes "a midlife progress novel" (Gullette, 1988). The African American protagonists are in their fifties. The husband has murdered his teenage lover, and his wife has to be restrained from carving up the corpse's face. Morrison's plot gradually reveals the roots of their problems. Perfect understanding eludes the characters, yet healing does occur. Other novels with similar themes include Madeleine L'Engle's *A Severed Wasp* (1982), Paule Marshall's *Praisesong for the Widow* (1983), Wallace Stegner's *Crossing to Safety* (1987), and David Lodge's *Therapy* (1995). Reviewing one's life, however, may well increase one's pain. Stevens, the butler in Kazuo Ishiguro's *The Remains of the Day* (1989), discovers that the principles by which he has conducted himself have left him in a lonely old age. He never realized that his employer was a fascist or that Miss Kenton, the housekeeper, loved him dearly.

Life review plays an especially important role in the lives of characters who have emigrated from their countries, often under harrowing circumstances. One fascinating example is *Mercy of a Rude Stream* (1994–1998), Henry Roth's four-volume continuation of *Call It Sleep* (1934). The complex narrative structure of *Mercy* emphasizes the feelings of the old narrator, who looks back upon the literary and sexual adventures of his youth with a mixture of pride and dismay. In order to write about the shameful episodes, the old man confides in his computer, Ecclesias, as if it were a psychotherapist or a father confessor. Much emphasis is placed on the thoughts and feelings of the narrator during three separate moments in his life: his youth, his seventies when he is composing the first draft of this novel sequence, and his mid-eighties when he is revising the manuscript in anticipation of his imminent death.

Life review also appears in the novels of younger immigrant writers, who explore the past of their families in order to understand their lives in the present. The weight of the past tyrannizes the young protagonist in Anzia Yezierska's *Bread Givers* (1925). Sara Smolinsky feels obliged to rebel against what she regards as the irrational demands of her Polish-born father, Reb Smolinsky, who grows out of touch with the alien world of America. In the last sentence of the novel, however, she expresses a more knowing and complicated view of his behavior. Although she does not regret her rebellion, she now sees her father as a victim of the "generations who made" him (p. 297). Yezierska treats minor aging female characters, such as Muhmenkeh in *Arrogant Beggar* (1927), more generously than the immigrant fathers or middle-aged, American-born men who populate her novels.

Protagonists in three novels of the 1990s attempt to recreate their parents' youth. Sophie Caco, the heroine of Haitian-American novelist Edwidge Danicat's *Breath, Eyes, Memory* (1994), cannot come to terms with her mother's nightmares and her own sexual phobia until she temporarily returns to Haiti and Grandmè Ifé. Virginity tests, a Haitian custom designed to keep young girls pure, cause Sophie's distress. After revisiting her grandmother, Sophie realizes how helpless Haitian women have always been in the face of male domination. Her mother could not eradicate the memory of being raped by a member of the *Macoutes*, a paramilitary force in Haiti. In her vulnerability, she feels driven by a powerless love to inflict this test on her daughter, even though it had failed to protect her purity years before. When her mother, newly pregnant, commits suicide to escape from unbearable nightmares, Sophie once again returns to Haiti for the burial. There she learns to accept her mother's stunted life and death, for only in death *ou libéré*, are you free.

Cristina Garcia's *Dreaming in Cuban* (1992) describes the bond between a Cuban grandmother and an American granddaughter, feelings that long distance can attenuate but not destroy.

Pilar, who is reared in Brooklyn, returns to Cuba to visit her grandmother Celia. After the visit cements their affectionate relationship, Celia feels ready to abandon her family by walking into the sea. Pilar, who has learned enough to understand her heritage, is now ready to enter adulthood. The necessity of reviewing one's life receives a new twist in Elie Wiesel's *The Forgotten* (1992). Forty-year-old Malkiel Rosenbaum attempts to reconstruct the Romanian Holocaust experiences of his father, Elhanan Rosenbaum. The old professor suffers from increasing dementia. If his son is to understand the family past, he must attempt to recreate the story by himself.

Retirement: forging a new community

In real life anticipating retirement may turn out to be more problematic than the experience itself. It is not a simple matter to choose where and with whom one should spend the final days of one's life. Shakespeare explored these and other issues in *King Lear* (1606) and *The Tempest* (1611). Sara Deats (1999) points out that both Prospero and Lear "are sustained by their love for a young daughter" (p. 31), much as the alienated grandfathers in children's fiction are rejuvenated by their newly discovered grandchildren. Moreover, Deats remarks, Prospero, as the play ends, makes plans to return to Milan and reenter his active life.

Several novels and diaries written from the 1970s to the 1990s have explored a few of the questions Shakespeare examined in *Lear* and *The Tempest*. Even if one is not a king or a duke, choosing the wrong time or place to retire can be disastrous. The outcomes, however, vary from novel to novel, and the perspective of novelists are sometimes contradicted by real-life accounts in journals. On the whole, however, nursing homes make a most problematic location. Simon, a retired professor in Jon Hassler's *Simon's Night* (1979), has prematurely committed himself to a rest home where he is moldering. At the novel's end he is reunited with the wife who had deserted him many years before.

Joyce Horner's diary (1982), which describes her two years in a nursing home, makes sad reading. Like the better known *The Measure of My Days* by Florida Scott-Maxwell (1968), her journal extends not only our understanding of frailty in old age but also old-age writing itself. Crippled with arthritis, Horner, a poet, novelist, and a retired professor of English literature, moved into a nursing home to avoid burdening her friend. Death and disability threaten her moments of joy. Nursing homes, she acknowledges, represent a prison. Not once in the course of writing does Horner forget that her real home is elsewhere, an Eden from which she has been ejected because of disability. At one point she reads May Sarton's *As We Are Now* (1973) and agrees with Sarton "that nursing homes are purgatory" (Horner, 1982, p. 185). At the same time her institution, she insists, is not like the one Sarton depicts. Indeed, Sarton and novelist Ellen Douglas's *Apostles of Light* (1973) paint unredemptive pictures of destructive caretakers. The corrupt institutions deserve the conflagrations with which they are destroyed. Still, bad as nursing homes may be, even expensive extended care facilities do not fare much better in James Michener's novel *Recessional* (1994). The residents need always be vigilant lest the administration take advantage of their lack of oversight. The most encouraging view of a nursing home can be found in detective writer Jane Langton's *Good and Dead* (1986). Thanks to the willingness of family and friends to visit an institutionalized man frequently, a new sense of community is created.

Although few wish to end their days in a nursing home, other options are not necessarily superior. For example, living in the community does not protect the hapless Marcia Ivory in Barbara Pym's *Quartet in Autumn* (1977). Marcia is sufficiently demented that she resists the efforts of friends and social workers to protect her from starving to death. Fortunately her three companions, Letty, Norman, and Edmund, become better friends as a result of their attempts to save Marcia from herself. Another character, Lucy Smalley in Paul Scott's *Staying On* (1977), finds herself marooned in Pankot, India, after her husband's death. The Raj has collapsed, but Mrs. Smalley lacks the money to return to an English country cottage. At the novel's conclusion she murmurs to his shade, "how can you make me stay here by myself while you yourself go home?" (p. 255). May Sarton herself learned that ill-health could take its toll, even though she remained in her own house being taken care of by loyal friends. The journals she composed in her last years (1992–1996) depict the continuing pain she endured and the difficulties of increasing frailty (see Berman).

Relatively healthy elders have problems with retirement as well. For example, since the late 1970s the English countryside has not been much of a haven for old people living on their own. The isolation that some older characters seek turns out to contribute to their plight. Moving to the country can cause one's death, as widow Phyllis Muspratt discovers in Penelope Mortimer's *The Handyman* (1983). This novel breaks new ground for Mortimer. For the first time in her career she writes sympathetically about older women. The ending of Penelope Lively's *Spiderweb* (1998) is less grim. Stella Brentwood, a retired anthropologist, rejects a marriage proposal and an offer to share a house with a friend. Valuing her independence, she leaves for parts unknown when the stresses of country life threaten her peace of mind. For those who have money and value friendship, however, retirement has its joys. Happiness, however, must be earned. The Welshmen in Kingsley Amis's *The Old Devils* (1986) are mostly retired and in their sixties, preoccupied with their deteriorating health, and drinking at the pub. After Alun Weaver dies, however, his widow is free for the first time to settle down with an old lover. This ending suggests that progress narratives are not restricted to midlife. Moreover, in *The Last Resort* (1998) Alison Lurie portrays Key West as a transformative place, much like Prospero's island. The forty-six-year-old heroine Jenny survives her depressed older husband's sexual rejection, by beginning a new partnership with Lee Weiss, an energetic divorcée of fifty. Jenny does not abandon her husband, who needs her editorial skills, but looks forward each year to a return to Key West and Lee's bed. On the whole, however, in fiction retirement appears to be a potentially dangerous transition.

Illness, death, and mourning

The chief quality that separates the treatment of death in the early twenty-first-century from earlier times is the willingness of contemporary writers to include some of the grim details gleaned from the experience of watching others die. For example, Halvard Solness plunges off a tower at the conclusion of Henrik Ibsen's *The Master Builder* (1892) in a dramatic finale. Old Jolyon Forsyte expires in a garden in John Galsworthy's *The Indian Summer of a Forsyte* (1918). In a later novel, *Swan Song* (1928), Soames Forsyte dies heroically. He pushes his daughter out of harm's way during a raging fire, but he is struck by the falling painting that had threatened her life. The death of Old Mrs. Moore is reported in a telegram at the end of E. M. Forster's *A Passage to India* (1924). Readers of these novels and plays are spared from the somber details of death and the miseries of mourning. By the middle of the twentieth-century some writers were willing to risk including the pain that can make death seem a release.

Emotional deprivation appears to kill George, the gay hero of Christopher Isherwood's *A Single Man* (1964). Isherwood, who was sixty at the time, suggests that emotional losses can hasten one's death. Like Kingsley Amis he stresses his hero's physical disabilities. A less relentless view of life and death appears in Gail Godwin's *The Good Husband* (1994). On the first page Magda Danvers, a fifty-eight-year-old professor of English literature, bluntly informs her department chair that her teaching days are over: "It seems the Great Uncouth has taken up permanent residence inside me.. . . Well, I always was a good student; now I must see what I can learn from my final teacher" (p. 3). Not only is Magda fortunate in her husband's sensitive caretaking, but she has some happy memories of the past to ease her journey. These recollections provide a respite from too relentless a focus on Magda's current state. Nonetheless, we learn many details of her progressing cancer.

Two other important novels develop similar themes. Carol Shield's prize-winning *The Stone Diaries* (1993) takes her protagonist Daisy Flett from birth to death. Although Daisy's midlife is by far her most productive part of her life, her retirement in Florida and her final days in a hospital and rest home are carefully depicted. Margaret Drabble's *The Witch of Exmoor* (1996) illuminates the effect of a powerful mother's death upon her children and grandchildren. Frieda Haxby Palmer, the grandmother, tries to write her memoirs but cannot come to terms with memories of her sister who committed suicide many years before. In the final envoi, which takes place in heaven, she recognizes that she has inflicted the same hurt on her children and grandchildren as her mother had imposed upon her.

Besides these novels, middle-aged and older memorists have described the death of kinfolk with remarkable empathy for the feelings and dignity of the failing person (see Wyatt-Brown and Waxman). Literary critic Nancy Miller has written movingly of her father's last years. More-

over, Madeleine L'Engle and Philip Roth (see Waxman, 1997) have poignantly recounted the death of near relations. L'Engle's *The Summer of the Great-Grandmother* (1974) depicts the decline of her ninety-year-old mother from dementia; in the second, *Two Part Invention* (1988), the death of her husband from cancer. Another important work is Philip Roth's *Patrimony* (1991), an account of the deterioration and demise of his once vigorous father. John Bayley reports what living with Alzheimer's disease can be like. His wife, the English novelist Iris Murdoch, was reduced to a second childhood, but Bayley found some joy in what otherwise might have been a desperate situation. Miller, L'Engle, Roth, and Bayley leaven misery by recalling happy episodes from their relatives' early lives. Their words challenge the power of disease and death to obliterate personality.

Miller, L'Engle, and Roth, not their parents, described their final days. Like Elinor Fuchs who dramatizes her mother's vigorous ten-year battle with Alzheimer's disease, however, they tried hard not to substitute their own feelings for parental ones (see Gullette, 2000). Scholars, such as Ruth Ray, have organized writing groups in which they encourage older people to begin the task of creating their own memoirs. Dying people are rarely able to chronicle their own decline, desirable as that might be. One exception is Claire Philip (1995) whose "Lifelines: A Journal and Poems" illustrates her changing feelings as she approaches an imminent death. Philip's training as a clinical social worker provided her the necessary detachment to analyze her emotions after her midlife was disrupted by the news that she had developed an incurable cancer.

Epic adventure

Two novels and a diary shed light on the possibility of heroism in our times. The novels come to different conclusion. Ernest Gaines's *A Gathering of Old Men* (1983) takes place in Louisiana in the 1970s. It chronicles the resistance of a group of elderly African American men to white supremacy. In contrast, Aharon Appelfeld's *The Iron Tracks* (1991) suggests that for some Holocaust survivors heroism is not possible. The depressed survivor finally tracks down the elderly SS officer who killed his parents. He shoots him, but vengeance brings no pleasure. He resolves to return to the place of his liberation, to burn the town down. Grandiose as his plan is, he entertains no hope of mastering the crippling shame, which has ruined his life.

Real life, however, sometimes offers surprising opportunities. Victor Klemperer and his wife Eva undertook a heroic journey at the end of World War II. His diaries describe the daily life of Jews whose marriage to Aryans spared them from a concentration camp. He and his wife were in their late fifties when the war broke out. Stubborn Germanophiles, they had refused to leave Dresden for possible emigration to the United States. For them the American bombing of Dresden was fortuitous. The Nazis were about to deport the last remnants of the Jewish community to a concentration camp, hoping to exterminate as many as possible in the waning moments of the war. Eva, who in her early sixties was not in robust health, masterminded their escape. She encouraged Klemperer to remove his Jewish star. The two elderly, half-starved survivors took trains, hitched rides, and walked from Dresden to Munich. Going from friend to friend, they sought refuge until the American forces entered Munich. As soon as the Allies declared victory, the Klemperers began the long trek back to Dresden to reclaim the house and job they had lost during the Nazi terror. One can only admire the intrepidity of this aging couple for undertaking so perilous a journey in the closing years of their lives.

ANNE M. WYATT-BROWN

See also AGEISM; CREATIVITY; IMAGES OF AGING; NARRATIVE; VISUAL ARTS AND AGING.

NOVELS AND DIARIES

AMIS, K. *The Old Devils*. New York: Summit Books, 1986.

APPELFELD, A. *The Iron Tracks*. Translated by Jeffrey M. Green. New York: Schocken Books, 1998.

AUSTIN, M. *Gabriel Churchkitten*. New York: E. P. Dutton and Company, Inc., 1942.

BROWN, M. W. *The Runaway Bunny*. New York: Harper & Row, Publishers, 1942.

BROWN, M. W. *Good Night Moon*. New York: Harper & Row, 1947.

BURNETT, F. H. *Little Lord Fauntleroy*. New York: Charles Scribner's Sons, 1886.

DANICAT, E. *Breath, Eyes, Memory*. New York: Vintage Contemporaries, 1994.

DE BRUNHOFF, J. *The Story of Babar: The Little Elephant*. 1933. Translated by Merle S. Haas. New York: Random House, 1960.

DOUGLAS, E. *Apostles of Light*. Boston: Houghton Mifflin Company, 1973.

DRABBLE, M. *The Witch of Exmoor*. New York: Harcourt Brace & Company, 1996.

FORSTER, E. M. *A Passage to India*. 1924. London: Edward Arnold, 1978.

GAINES, E. *A Gathering of Old Men*. New York: Vantage Books, 1983.

GALSWORTHY, J. *The Man of Property and Indian Summer of a Forsyte*. 1918. New York: Charles Scribner's Sons, 1969.

GALSWORTHY, J. *Swan Song*. 1928. New York: Charles Scribner's Sons, 1969.

GARCIA, C. *Dreaming in Cuban: A Novel*. New York: Ballantine Books, 1992.

GODWIN, G. *The Good Husband*. New York: Ballantine Books, 1994.

HASSLER, J. *Simon's Night*. 1979. New York: Ballantine Books, 1992.

HOBAN, R. *Bedtime for Frances*. New York: Harper & Row, 1960.

HORNER, J. *That Time of Year: A Chronicle of Life in a Nursing Home*. Amherst: University of Massachusetts Press, 1982.

IBSEN, H. "The Master Builder." In *Six Plays by Henrik Ibsen: A Doll's House, Ghosts, An Enemy of the People, Rosmersholm, Hedda Gabler, The Master Builder*. New York: Modern Library, 1892. Pages 429–510.

ISHERWOOD, C. *A Single Man*. 1964. New York: Bard, 1978.

ISHIGURO, K. *The Remains of the Day*. New York: Alfred A. Knopf, 1989.

JOHNSTON, A. F. *Little Colonel Series*. 1895. Boston: The Page Company, 1921.

KLEMPERER, V. *I Will Bear Witness: A Diary of the Nazi Years, 1933–1941*. Translated by Martin Chalmers. New York: Random House, 1995.

KLEMPERER, V. *I Will Bear Witness: A Diary of the Nazi Years, 1942–1945*. Translated by Martin Chalmers. New York: Random House, 1995.

LANGTON, J. *Good and Dead*. New York: Penguin Books, 1986.

L'ENGLE, M. *The Summer of the Great Grandmother*. San Francisco: Perennial Library, Harper & Row, 1974.

L'ENGLE, M. *A Severed Wasp*. New York: Farrar, Straus, Giroux, 1982.

L'ENGLE, M. *Two-Part Invention: The Story of a Marriage*. San Francisco: HarperSanFrancisco, 1988.

LIVELY, P. *Spiderweb*. New York: HarperFlamingo, 1998.

LODGE, D. *Therapy*. New York: Viking, 1995.

LURIE, A. *The Last Resort: A Novel*. New York: Holt, 1998.

MARSHALL, P. *Praisesong for the Widow*. New York: Plume, 1983.

MCCLOSKEY, R. *Burt Dow: Deep-Water Man*. New York: The Viking Press, 1963.

MICHENER, J. A. *Recessional*. New York: Random House, 1994.

MILLER, N. K. *Bequest and Betrayal: Memoirs of a Parent's Death*. New York: Oxford University Press, 1966.

MINARIK, E. H. *Little Bear*. New York: Harper & Row, 1957.

MONTGOMERY, L. M. *Anne of Green Gables*. 1908. New York: Grosset & Dunlap, 1935.

MORRISON, T. *Jazz*. New York: Alfred A. Knopf, 1992.

MORTIMER, P. *The Handyman*. London: Allen Lane, 1983.

PHILIP, C. E. "Lifelines: A Journal and Poem." *Journal of Aging Studies* 9, no. 4 (1995): 265–322.

PRØYSEN, A. *Little Old Mrs. Pepperpot and Other Stories*. Translated by Björn Berg. Harmondsworth, Middlesex England: Puffin Books, 1961.

PYM, B. *Quartet in Autumn*. New York: E. P. Dutton, 1977.

ROTH, H. *Call It Sleep*. 1934. New York: Farrar, Straus and Giroux, 1991.

ROTH, H. *Mercy of a Rude Stream: A Star Shines Over Mt. Morris Park*. Vol. 1. New York: St. Martin's Press, 1994.

ROTH, H. *Mercy of a Rude Stream: A Diving Rock on the Hudson*. Vol. 2. New York: St. Martin's Press, 1995.

ROTH, H. *Mercy of a Rude Stream: From Bondage*. Vol. 3. New York: St. Martin's Press, 1996.

ROTH, H. *Mercy of a Rude Stream: Requiem for Harlem*. Vol. 4. New York: St. Martin's Press, 1998.

ROWLING, J. K. *Harry Potter and the Sorcerer's Stone*. New York: Scholastic, 1998.

SARTAN, M. *Endgame: A Journal of the Seventy-ninth Year*. New York: W. W. Norton and Company, 1992.

SARTAN, M. *Encore: A Journal of the Eightieth Year*. New York: W. W. Norton and Company, 1993.

SARTAN, M. *At Eighty Two: A Journal*. New York: W. W. Norton and Company, 1996.

SCOTT, M. F. *The Measure of My Days*. New York: Penguin Books, 1968.

SCOTT, P. *Staying On*. London: Granada, 1977.

SHIELDS, C. *The Stone Diaries*. New York: Viking, 1993.

SPYRI, J. *Heidi*. 1880. Translated by Eileen Hall. Harmondsworth, Middlesex, England: Puffin Books, 1956.

STEGNER, W. *Crossing to Safety*. New York: Random House, 1987.
TAYLOR, P. "In the Miro District." In *In the Miro District and Other Stories*. New York: Alfred A. Knopf, 1977. Pages 159–204.
WIESEL, E. *The Forgotten*. Translated by Stephen Becker. New York: Schocken Books, 1992.
YEZIERSKA, A. *Bread Givers*. 1925. New York: Persea Books, 1975.
YEZIERSKA, A. *Arrogant Beggar*. 1927. Durham: Duke University Press, 1996.

BIBLIOGRAPHY

BERMAN, H. J. *Interpreting the Aging Self: Personal Journals of Later Life*. New York: Springer Publishing Company, 1994.
DEATS, S. M. "The Dialectic of Aging in Shakespeare's *King Lear* and *The Tempest*." In *Aging and Identity: A Humanities Perspective*. Edited by Sara Munson Deats and Lagretta Tallent Lenker. Westport, Connecticut: Praeger, 1999. Pages 23–32.
FUCHS, E. "Making an Exit." In *Figuring Age: Women, Bodies, Generations*. Edited by Kathleen Woodward. Bloomington: Indiana University Press, 1999. Pages 340–348.
GULLETTE, M. M. *Safe at Last in the Middle Years: The Invention of the Midlife Progress Novel: Saul Bellow, Margaret Drabble, Anne Tyler, and John Updike*. Berkeley: University of California Press, 1988.
GULLETTE, M. M. *Declining to Decline: Cultural Combat and the Politics of the Midlife*. Charlottesville: University Press of Virginia, 1997.
GULLETTE, M. M. "Age Studies as Cultural Studies." In *Handbook of the Humanities and Aging*. Edited by Thomas R. Cole, Robert Kastenbaum, and Ruth E. Ray. New York: Springer Publishing Company, 2000. Pages 214–234.
MANGUM, T. "Little Women: The Aging Female Character in Nineteenth-Century British Children's Literature." In *Figuring Age: Women, Bodies, Generations*. Edited by Kathleen Woodward. Bloomington: University of Indiana Press, 1999. Pages 59–87.
MANGUM, T. "Literary History as a Tool of Gerontology." In *Handbook of the Humanities and Aging*. Edited by Thomas R. Cole, Robert Kastenbaum, and Ruth E. Ray. New York: Springer Publishing Company, 2000. Pages 62–76.
RAY, R. E. *Beyond Nostalgia: Aging and Life-Story Writing*. Charlottesville: University Press of Virginia, 2000.
ROOKE, C. "Old Age in Contemporary Fiction: A New Paradigm of Hope." In *Handbook of the Humanities and Aging*. Edited by Thomas R. Cole, David D. Van Tassel, and Robert Kastenbaum. New York: Springer Publishing Company, 1992. Pages 241–257.
WAXMAN, B. F. *To Live in the Center of the Moment: Literary Autobiographies of Aging*. Charlottesville: University Press of Virginia, 1997.
WYATT-BROWN, A. M., and WAXMAN, B. F. *Aging in Literature, Brief Bibliography: A Selected Bibliography For Gerontological Instruction*. Washington, D.C.: Association for Gerontology in Higher Education, 1999.

LIVING ARRANGEMENTS

Factors that determine living arrangements over the course of late life are diverse and complex. Living arrangements have important implications for an older adult's emotional, financial, and physical health, and historical changes in elderly living arrangements, the range of housing options available, and factors that predict living arrangements all have consequences for the well-being of older adults.

Historical perspective

Over the course of the twentieth century, living arrangements changed dramatically for older adults. In the early 1900s, the majority of older adults lived with one of their adult children. In 1910, only 12 percent of widows age sixty-five or older lived alone. Following World War II, there was a dramatic increase in the percentage of elderly people living alone. In the 1990s, most older adults either lived with their spouses or, if not married, alone.

Today, the majority of males age sixty-five and over live with a spouse (72 percent) while 20 percent live alone or with nonrelatives. Only a small proportion of older men live with other relatives (8 percent). On the other hand, most women age sixty-five and over tend to live alone or with nonrelatives (43 percent), and another 40 percent live with a spouse. A small percentage of older women (17 percent) live with other relatives.

Types of living arrangements

Various housing choices are available for independent, semi-independent, and dependent older adults. These categories provide rough approximations of the ability of housing types to support older persons with differing functional abilities.

Housing choices for independent older persons. In the United States, most independent older persons with few or no problems related to self-care, activities of daily living (ADLs), or instrumental activities of daily living (IADLs) reside in conventional homes or apartments. Those who choose this living arrangement tend to be younger, married, have a spouse present, have children living in the home or nearby, and own their own home.

Over three-quarters (77 percent) of older adults in the United States own their own homes. While rates of home ownership decrease with advancing age, 67 percent of older adults over age eighty-five still own their own homes. Nationally, more than 5 million elderly households rent their housing. In comparison to owners, renters tend to have lower incomes and to be women or minorities who live alone.

In government-subsidized housing, the federal government provides housing for low-income older persons by financing housing for the elderly and providing rent subsidies. Approximately 1.7 million older persons live in federally subsidized housing nationwide. The largest program serving low-income older persons is public housing, in which approximately 500,000 elderly reside, primarily in special housing for the elderly. Another program benefiting older adults is Section 202 housing, which has provided funds for non-profit sponsors to develop about 325,000 units in which over 387,000 tenants live (as of 2001).

Accessory apartments, created within single-family homes, are complete living units, including a private kitchen and bath. Elder cottage housing opportunities (ECHO) provide private housing arrangements adjacent to single-family housing. These two options can encourage economic and personal support between households, while at the same time allowing privacy. The number of older adults living in these types of housing is unknown, but is generally considered small. The growth of these options has been very slow, partly due to consumer reluctance, the physical difficulty of placing units in areas such as inner cities and inner suburbs, and restrictive zoning codes.

Retirement communities are designed for persons sixty years of age or older and provide a variety of social and recreational opportunities. While retirement communities exist in Australia, Japan, and Europe, they are more prevalent in the United States (Liebig). These communities target independent older adults and generally provide a minimum of supportive services. It is estimated that 7 percent of seniors in the United States live in this type of housing. These communities tend to be concentrated in metropolitan areas and in the southeast and western regions of the United States. The likelihood of moving to these types of communities decreases if there is an adult child available who lives less than an hour away. One study found that healthy, non-Hispanic white individuals tend to favor this living arrangement.

Another study, however, found that older adults with moderate disability are also attracted to retirement communities. The probability of moving to a retirement community increases as one's degree of difficulty performing IADLs (meal preparation, shopping, using the telephone, managing money, doing housework) changes from mild to moderate, but declines as such disabilities become severe. Although services are not provided by these communities, older adults may view this move as an opportunity to live among other older adults who can provide informal support. Silverstein and Zablotsky suggest that one move can serve two different needs: the desire for amenities and the need for support with daily tasks.

Housing for semi-independent older persons

Various housing options exist for semi-independent older adults who require some assistance with daily tasks. These options, which provide a supportive setting linked with services, can take place either in the home or in housing built for the expressed purpose of providing services.

Aging in place. Since most older adults prefer to remain in their own homes despite increasing frailty, bringing services into the home is an option for semi-independent older adults. *Home care* describes a situation in which an older person receives help in his or her home from an organization or another individual who is not a family member. As of March 2000, there were about 20,000 home care providers serving approximately 8 million individuals of all ages nationwide.

Persons preferring home care tend to have difficulties with ADLs or IADLs. This arrange-

ment tends to be favored by persons who are divorced, separated, or widowed. The presence of children nearby decreases the likelihood of choosing home care.

A second option for receiving assistance within the home is *shared housing*, an arrangement in which two or more unrelated people share a house or apartment. Each person usually has his or her own sleeping quarters, with the rest of the house being shared. Members of the household can benefit from the potential for mutual assistance with chores and tasks. Surveys suggest that 2.5 percent of older adult households have at least one nonrelative living in their home, and almost 20 percent of older adults would consider living with someone they did not know. This living situation may occur naturally when individuals decide to form a household, through matches facilitated by an agency, or in small group-type homes operated by nonprofit or private organizations.

Older adults who have difficulties with activities of daily living, instrumental activities of daily living, and those without children living nearby tend to favor a shared arrangement. Divorced, separated, widowed, and persons who have never married are more likely to live in shared housing than married persons. Minorities, especially blacks and Asians, are also more likely to choose this arrangement.

Supportive housing. Frail older persons are likely to need a more physically supportive dwelling unit, greater supervision (e.g., with medications), more services, or more companionship than can be efficiently provided in conventional homes or apartments. While these options require older adults to relocate, they can offer the benefits of a built environment that is physically supportive and linked with services. These housing types tend to attract older adults and those who do not have children living nearby. Persons with difficulties climbing stairs are also more likely to select supportive housing. Supportive housing options include congregate housing, board and care homes, assisted living, and continuing care retirement communities.

Congregate housing refers to a wide range of multi-unit living arrangements for older persons in both the private and public sector. Older persons who live in this type of housing generally have their own apartments that include kitchens or kitchenettes and private bathrooms. Most of this housing has dining rooms and provides residents with at least one meal a day, which is frequently included in the rent. The housing also has common spaces for social and educational activities and, in some cases, provides transportation.

Congregate housing generally does not offer personal-care services or health services, and therefore attracts older persons who can live independently. It especially appeals to older persons who no longer want the responsibility of home maintenance and meal preparation, and who positively anticipate making new friends and engaging in activities.

Board and care homes are residential facilities that generally offer on-site management, supervision, a physically accessible environment, meals, and a range of services for physically or mentally vulnerable older people, as well as younger disabled people who experienced difficulties living independently in their previous residences. In facilities that primarily serve seniors, the average age of older persons in these settings is approximately eighty-three, about eight years older than residents of government-assisted housing.

Studies suggest that over 30,000 board and care homes exist in the United States, more than double the number of nursing homes. However, owing to their smaller size (usually between 5 and 20 dwelling units), board and care facilities house only about 400,000 residents (one-fourth the number of residents in nursing homes) and include about 200,000 persons under age sixty-two.

Assisted living is a housing option prevalent in the U.S. and northern Europe (Regner and Scott) that involves the delivery of professionally managed supportive services and, depending on state regulations, nursing services in a group setting that is residential in character and appearance. During the 1990s, assisted living was the fastest growing segment of the senior housing market. It has the capacity to meet unscheduled needs for assistance and is managed in ways that aim to maximize the physical and psychological independence of residents.

In 1999, there were approximately 30,000 to 40,000 assisted-living facilities in the United States, housing approximately one million individuals. A variety of services can be provided, including meals, housekeeping, transportation, medication management, laundry services, and

recreation activities. Assisted living is intended to accommodate physically and mentally frail elderly people without imposing on them a heavily regulated, institutional environment. For many residents, assisted living has served as an alternative to nursing homes.

Also referred to as life care communities, *continuing care retirement communities* (CCRCs) are unique in that they offer various levels of care within one community to accommodate residents who have changing needs. Most CCRCs offer independent living areas, assisted living, and skilled nursing care. A variety of services are offered, including transportation, meals, housekeeping, and physician services. While some communities provide most of their own services, others obtain many of them through contracts with outside organizations.

By 1992, there were approximately 1,000 CCRCs in the United States, housing approximately 350,000 to 450,000 older persons. Each community houses between 400 and 600 older persons, often in campus-type settings. CCRCs generally require, as a condition for entry, that new residents be in reasonably good health.

The growth of housing types for semi-independent older adults provides increasing options for older adults who face increasing frailty in later life. In addition, home-care agencies, which provide needed assistance with household tasks and personal-care needs coupled with environmental modifications, can enable older adults to remain in their own homes.

Dependent older adults

Nursing homes provide an option for older adults whose functional limitations and chronic needs are severe. These facilities provide skilled nursing care and rehabilitation services to the elderly as well as younger individuals who are disabled or mentally ill. These are generally stand-alone facilities, but some are operated within a hospital or retirement community. There were approximately 1.56 million nursing home residents in the United States in 1996.

Those living in nursing homes tend to be women (72 percent), over age eighty-five (49 percent), white (89 percent), and widowed (60 percent). A vast majority of residents receive help with three or more ADLs, such as bathing, dressing, toileting, transfers, feeding, and mobility. The majority of residents also tend to have some form of memory loss (71 percent). The most frequently occurring health conditions for nursing home residents over age sixty-five are dementia (51 percent), heart disease (48 percent), and hypertension (40 percent)

Relocation effects

There has long been concern that relocation to a nursing home may adversely affect physical and mental health due to the disruption of daily routines and connections to family and friends. Recent research has demonstrated higher mortality rates among those who have recently relocated to a nursing home, compared with persons remaining at home. This problem has been labeled *relocation stress syndrome,* defined as physiological or psychosocial reactions resulting from transfer from one environment to another. Symptoms include anxiety, apprehension, confusion, depression, and loneliness. Acceptance to institutionalization generally begins within six to eight weeks, and adjustment is usually complete within three to six months.

It could be argued that it is not the relocation itself that leads to a greater likelihood of mortality, but the admission of largely high-risk persons who are already near death. However, one study found that those institutionalized for reasons other than poor health also experienced an increase in mortality immediately following admission to a nursing home (Aneshensel et al., 2000), suggesting that there are factors inherent in the relocation itself that elevate the postadmission mortality rate.

There are a range of housing types available to older adults, and the factors that influence moves seem complex. Most research has focused on predictors of relocation to different geographical areas (to be closer to or with family members), or to institutions. Future research needs to explore predictors of relocation into specific housing types, such as assisted living or CCRCs. The rapid growth of the older adult population necessitates an understanding of determinants of living arrangements and its implications for the elderly.

CHRISTY M. NISHITA
JON PYROOS

See also AGING IN PLACE; ASSISTED LIVING; BOARD AND CARE HOMES; CONGREGATE HOUSING; CONTINUING CARE RETIREMENT COMMUNITIES; CORESIDENCE; GOV-

ERNMENT ASSISTED HOUSING; HOME CARE AND HOME SERVICES; HOUSING; MIGRATION, GEOGRAPHIC MOBILITY AND DISTRIBUTION; NURSING HOMES; RETIREMENT COMMUNITIES.

BIBLIOGRAPHY

AARP. *Understanding Senior Housing into the Next Century: Survey of Consumer Preferences, Concerns, and Needs*. Washington, D.C.: AARP, 1996.

ANESHENSEL, C. S.; PEARLIN, L. I.; LEVY, S. L.; SCHULER, R. H. "Transition from Home to Nursing Home Mortality among Persons with Dementia." *Journals of Gerontology Series B* 55B, no. 3: S152–S162.

Assisted Living Federation of America. *The Assisted Living Industry 1999: An Overview*. Fairfax, Va.: ALFA, 1999.

BEAN, F. D.; MYERS, G. C.; ANGEL, J. L.; and GALLE, O. "Geographic Concentration, Migration, and Population Redistribution of the Elderly." In *Demography of Aging*. Edited by L. G. Martin and S. H. Preston. Washington, D.C.: National Academy Press, 1994.

Joint Center for Housing Studies. *Housing America's Seniors*. Boston, Mass.: JCHS, Harvard University, 2000.

KANE, R. A., and WILSON, K. B. *Assisted Living in the United States: A New Paradigm for Residential Care for Frail Older Persons?* Washington, D.C.: AARP, 1993.

KRAMAROW, E. A. "The Elderly Who Live alone in the United States: Historical Perspectives on Household Change." *Demography* 32 (1995): 335–352.

KRAUSS, N. A., and ALTMAN, B. M. *Characteristics of Nursing Home Residents 1996*. Rockville, Md.: Agency for Health Care Quality and Research, 1996.

MANION, P. S., and RANTZ, M. J. "Relocation Stress Syndrome: A Comprehensive Plan for Long-term Care Admissions." *Geriatric Nursing* 16, no. 3 (1995): 108–112.

National Association of Home Care. World Wide Web document, 2001. www.nahc.org.

SCHAFER, R. *Determinants of the Living Arrangements of the Elderly*. Boston, Mass.: Joint Center for Housing Studies, Harvard University, 1999.

SILVERSTEIN, M., and ZABLOTSKY, D. L. "Health and Social Precursors of Later Life Retirement-Community Migration." *Journal of Gerontology: Social Sciences* 51B, no. 3 (1996): S150–S156.

SIRROCCO, A. *Nursing Homes and Board and Care Homes*. Hyattsville, Md.: National Center for Health Statistics, 1994.

WOLINSKI, F. D.; STUMP, T. E.; and CALLAHAN, C. M. "Does Being Placed in a Nursing Home Make You Sicker and More Likely to Die?" In *Societal Mechanisms for Maintaining Competence in Old Age*. Edited by S. L. Willis, K. W. Schaie, and M. Hayward. New York: Springer, 1997. Pages 94–130.

U.S. Department of Housing and Urban Development, Office of Policy Development and Research. *The Challenge of Housing Security: Report to Congress on the Housing Conditions and Needs of Older Americans*. Washington, D.C.: HUD, 1999.

LIVING WILL

See ADVANCE DIRECTIVES FOR HEALTH CARE

LONELINESS

Definition and theory

Loneliness is an affective emotional condition experienced when a person feels apart from familiar social supports. It is a psychosocial condition that is differentially experienced within different cultures. Most developments in this condition have been observed in the United States and Europe. Among those not in institutions, studies show that less than 20 percent of older persons experience loneliness. There is some evidence to suggest that loneliness increases with increasing totality of institutionalization. Over the life span, loneliness seems to vary curvilinearily by age. It is highest among adolescents, declines into late middle age, then increases again with advancing older age.

Theoretical conceptualizations of loneliness can be categorized as: 1) the social needs approach, with foundations in the social developmental approaches and the social support perspectives; 2) the behavioral-personality approach; and 3) the cognitive processes approach. Common to these approaches are three points. Loneliness is: 1) a subjective emotional experience that may be unrelated to actual social isolation, that is, aloneness; 2) an aversive psychological condition; and 3) caused by some form of social relationship deficit.

Measurement instruments to assess loneliness include scales developed by Russell, Peplau, and Cutrona (1980), van Tilburg and de Jong Gierveld (1999), and Vincenzi and Grabosky (1989).

The loneliness related to emotional isolation results from the absence of a person with whom one is emotionally connected. The loneliness experienced is a psychological state characterized by feelings of loss, distress, separation, and isolation. Loneliness resulting from social isolation is related to a person's perceived isolation from those around him or her. The emotional condition of loneliness in this regard is influenced by a deficit in the quantity of relationships, and/or the lack of relatedness to the social environment.

Loneliness and selected factors

Background issues related to loneliness include the following:

- *Gender*. Gender is a more consistent predictor of loneliness than is age. Studies show that either gender has no effect on loneliness, or that women are more lonely than men.
- *Race and ethnicity*. Race and ethnicity have not been systematically examined with regard to loneliness. Cross-racial, or cross-ethnic, comparisons of loneliness and its antecedents have not yet been conducted in a manner that lends any clarity to interpretation.
- *Urban/rural residence*. It is commonly held that urban elders are more lonely and isolated than their rural counterparts, though research has not consistently confirmed this stereotype.
- *Health*. The overall weight of the evidence points to a reasonably strong and consistent association between poorer physical and/or mental health, and greater loneliness.

Interpersonal relationships also factor into an individual's potential loneliness.

- *Spouse*. Results indicate greater loneliness in the absence of a mate. Severe loneliness appears to be unusual among married men, somewhat more prevalent among married women, and quite prevalent among unmarried individuals of either sex.
- *Children*. Studies of the relationship between adult children and loneliness show conflicting results. Most have found no association between frequency of contact with children and loneliness. The commitment in the relationship seems to be more important than the actual contact.
- *Friends*. Research shows that close friends exert a positive influence on the emotional well-being of older persons. Older persons who have contact with their friends, and especially those who are satisfied with these relationships, are less lonely.

The two essential aspects of loneliness, i.e., the loneliness associated with social isolation and/or with emotional isolation, shows that they can be experienced as an affective emotional experience in which a person feels apart from other persons and from familiar support networks. In turn, this can lead to a realization that social contacts are diminishing, lacking, or not at a level that are emotionally supportive or satisfying.

LARRY C. MULLINS

See also DEPRESSION; SOCIAL SUPPORT.

BIBLIOGRAPHY

ANDERSSON, L. "A Model of Estrangement—Including a Theoretical Understanding of Loneliness." *Psychological Reports* 58 (1986): 683.

HALL-ELSTON, C., and MULLINS, L. "Social Relationships, Emotional Closeness and Loneliness among Older Meal Participants." *Social Behavior and Personality* 27 (1999): 503.

JOHNSON, D., and MULLINS, L. "Growing Old and Lonely in Different Societies: Toward a Comparative Perspective." *Journal of Cross-Cultural Gerontology* 1 (1987): 257.

MARANGONI, C., and ICKES, W. "Loneliness: A Theoretical Review with Implications for Measurement." *Journal of Social Psychology* 116 (1989): 269.

PEPLAU, L., and PERLMAN, D., ed. *Loneliness: A Sourcebook of Current Theory, Research and Therapy*. New York: Wiley, 1982.

RUSSELL, D.; PEPLAU, L.; and CUTRONA, C. "The Revised UCLA Loneliness Scale: Concurrent and Discriminant Validity Evidence." *Journal of Personality and Social Psychology* 39 (1980): 472.

VAN TILBURG, T., and DE JONG GIERVELD, J. "Cesuurbepaling van de Eenzaamheidsschall [Cutting Scores on the De Jong Gierveld Loneliness Scale]." *Tijdschrift voor Gerontologie en Geriatrie* 30 (1999): 158.

VENCENZI, H., and GRABOSKY, F. "Measuring the Emotional/Social Aspects of Loneliness and Isolation." In *Loneliness: Theory, Research, and Applications*. Edited by M. Hojat and R. Crandall. Newberry Park, Calif.: Sage, 1989. Pages 257–270.

WEISS, R. *Loneliness: The Experience of Emotional and Social Isolation*. Cambridge, Mass.: MIT Press, 1973.

LONGEVITY: REPRODUCTION

Reproduction is one of the most important influences on longevity. This influence is both direct, within the life of single individuals, and indirect, through the impact of reproduction on the evolution of longevity, mortality, and related characters. Both effects are considered here.

The direct cost of reproduction

Reproduction generally reduces survival, more reproduction shortening life span, less reproduction increasing life span. This effect is not absolutely universal, but it is one of the better established patterns in the biology of aging.

The most extreme experiments that demonstrate the cost of reproduction for longevity involve castration. In annual plants, such as soybean, stripping the plant of flowers often prolongs life by months. In animals that reproduce just once, castration before reproduction can increase longevity by years. In Pacific salmon, it was possible to extend the life of a castrated fish by more than a decade. In marsupial mice of the genus *Antechinus,* castrated males live months longer than intact males. There is some evidence that castrating institutionalized human males increases their life span. The records of the British aristocracy also suggest that females who have fewer children also live longer, although much of this data antedates modern medicine. All these examples indicate that reproduction affects longevity within the lives of single organisms, but they do not indicate how reliable the effect is.

Classic experiments using the fruit fly *Drosophila subobscura* illustrate the consistency with which reproduction reduces survival. Normal, mated, fruit fly females lay many eggs and die fairly soon, most between five to seven weeks of adulthood. Three kinds of females that lay fewer eggs all live longer on average: (1) flies that lack ovaries because of a genetic mutation, (2) flies that are denied access to males, and (3) flies that have been sterilized but are allowed to mate. The generality of the effect on longevity of reproduction is revealed by the fact that three such different manipulations of reproduction all increased longevity.

Indirect effects of reproduction on longevity

Reproduction also affects longevity by a different type of biological mechanism, through its effects on the evolution of aging. These evolutionary effects are twofold: reproduction determines the force of natural selection; and reproduction may be genetically connected to survival by an evolutionary trade-off. These effects will be discussed in order.

Reproduction and the force of natural selection. The evolutionary theory of aging is based on the force of natural selection. The force of natural selection is a function that indicates the impact on fitness of a change to age-specific survival. When this force is strong, natural selection is expected to favor genetic changes that improve survival. When it is weak, natural selection is expected to allow the evolution of poor survival. The key determinant of the strength of the force of natural selection is reproduction. Before reproduction occurs in a population, the force of natural selection acts on survival with full force. For example, a dominant allele that kills its carrier before adulthood will eliminate itself from a population in one generation. This is a case where the force of natural selection is very strong. When a population has completely finished reproduction, the force of natural selection acting on survival is zero. In this case, an allele that kills only after this age is not affected by natural selection, because natural selection has ceased. Between these two ages, the force of natural selection steadily falls. Evidently, the key factor determining the evolution of survival, and thus longevity, is the timing of reproduction.

This abstract theory can be made more concrete by considering experiments in which the timing of reproduction is deliberately manipulated for many generations, making the evolutionary impact of reproduction on survival obvious. These experiments have been performed a number of times in fruit flies. When early reproduction is prevented by discarding eggs laid by younger females, and sired by younger males, over many generations, increased longevity evolves. The experimenter does not need to impose any additional manipulation. Evolution automatically reshapes longevity, because the shift in reproduction to later ages increases the force of natural selection at later ages. In this sense, the pattern of reproduction is the ultimate determinant of aging.

Similar experiments have been performed with mice. Though the results are not as striking, they also show that delayed reproduction leads to the evolution of increased longevity.

Evolution and the cost of reproduction. In some cases, the evolution of aging depends on the cost of reproduction. If a single genetic change alters both early fertility and later survival, but does so in opposite directions, then the evolution of reproduction may affect the evolution of longevity in a different way. The most important case is when a genetic change increases early reproduction at the expense of later survival. This is expected to occur whenever genetic effects emulate the effects of a direct cost of reproduction, described above. The force of natural selection is strong at early ages, but weak at later ages, so any early beneficial effect should be more important than a later bad effect. This, then, should lead to the evolution of decreased longevity as a side-effect of selection for increased early reproduction. Metaphorically, natural selection is choosing early reproduction over later survival.

There is a reasonable amount of evidence that supports this evolutionary cost of reproduction for longevity. Fruit flies that have evolved increased longevity in the laboratory tend to have decreased early fertility, though this effect depends on environment and inbreeding. In nematodes of the genus *Caenorhabditis,* there has been some inconsistency in the experimental data, but recent experiments seem to show that there is an early physiological cost associated with increased longevity, a cost that may be related to reproduction. It is not expected, however, that there will always be an evolutionary trade-off between reproduction and longevity. In many cases, there may be no such trade-off. But whenever there is such a trade-off, the evolution of longevity will be bound up with the evolution of reproduction.

MICHAEL R. ROSE

See also ENDOCRINE SYSTEM; EVOLUTION OF AGING; LONGEVITY: SELECTION.

BIBLIOGRAPHY

FINCH, C. E. *Longevity, Senescence, and the Genome*. Chicago: University of Chicago Press, 1990.

ROSE, M. R. *Evolutionary Biology of Aging*. New York: Oxford University Press, 1991.

ROSE, M. R., and BRADLEY, T. J. "Evolutionary Physiology of the Cost of Reproduction." *OIKOS* 83 (1998): 443–451.

WALKER, D. W.; MCCOLL, G.; JENKINS, N. L.; HARRIS, J.; and LITHGOW, G. J. "Evolution of Lifespan in C. elegans." *Nature* 405 (2000): 296–297.

WESTENDORP, R. G. J., and KIRKWOOD, T. B. L. "Human Longevity at the Cost of Reproductive Success." *Nature* 396 (1998): 743–746.

LONGEVITY: SELECTION

One way scientists study a phenomenon is that they change it. In the study of aging, organisms with altered longevity are systems of choice for the unraveling of the biological mechanisms controlling aging. Selection is one of the tools that biologists use to alter the characteristics of organisms, from their size to their shape to their physiology. In this context, it is only natural to strive to alter longevity using selection, as a preamble to detailed analysis of the genetic control of longevity.

Design problems

It is one thing to select on coat color in mammals or bristle number in insects, but another to select on a functional character that depends on many distinct biochemical pathways. As dog breeding shows, it is possible to select stringently on relatively arbitrary features, like the color or oiliness of fur. But dog breeding also shows that selection programs that use a small number of breeders run into problems of *inbreeding depression*: infertility, structural defects, blindness, deafness, and so on. This is not a special problem to the breeding of dogs or even mammals. Breeding insects for increased fecundity using small selected groups usually runs into problems of inbreeding depression, such as inviability, reduced male fertility, and reduced longevity.

A further problem arises when selection breeds for reductions in functional characters. Sexual outbreeding populations carry numerous recessive deleterious alleles at very low frequencies. When there is no deliberate breeding, natural selection keeps these alleles rare, and they play little role in the physiology or development of most organisms in the population. Human populations are good examples of this. There are many human genetic diseases caused by recessive deleterious alleles: cystic fibrosis, Tay-Sach's dis-

ease, and so on. But most people do not develop ailments due to such genes. They die instead of commonplace diseases, both contagious and degenerative, that do not depend on such genes. But populations that undergo selection for *reductions* in functional characters will show rises in the frequencies of alleles that are generally deleterious, alleles that do not play an important role in shaping these characters for most individuals in the population.

For this reason, it is unlikely that selection for reduced longevity or selection using small population sizes will reveal the genetics of longevity in the vast majority of individuals within a population. Thus, for example, the 1920s studies of longevity by Raymond Pearl using *Drosophila* mutants are of no value for uncovering the genetics of longevity in fruit flies that have not been inbred or mutated. Longevity is not a well-defined character like eye color, which can be analyzed using mutations of large effect or selective screening for pathological extremes. Longevity is not unique in this respect. The same problem applies to such characters as fecundity and developmental speed.

This makes the appropriate experimental design for selection on longevity some type of mass selection for *increased* longevity. Unfortunately, this experimental design will usually be very difficult to sustain, because it takes a long time to collect longevity data and it has to be done every generation in a selection experiment. Furthermore, if longevity is defined as the age at death, selection requires the collection of progeny from the selected group before that group has actually died. Many of these problems can be overcome by the use of laborious experimental designs, but these are rarely used in selection studies.

Fortunately, there are experimental designs for selection on longevity that evade many of these problems, yet produce healthy animals with greater mean and maximum longevities. We turn to these designs now.

Selection design for postponed aging

Longevity is difficult to select on because it is tied up with the action of natural selection. One way out of this difficulty is to turn it on its head. Since natural selection acts to mold survival automatically, then perhaps it can be used to do the work in selecting on longevity.

This basic strategy is the foundation of most successful schemes to select on longevity. It is implemented in the following way. Natural selection acts powerfully to screen out alleles that reduce survival before the onset of reproduction. The reason for this is simple. If organisms do not survive long enough to reproduce, then the genes that they bear will be eliminated from the population. In the case of organisms with lethal genetic disorders, when those disorders kill before the start of reproduction, the alleles that cause these disorders will be completely eliminated from the population in a single generation. An example of this is Hutchinson-Guilford progeria, a human genetic disease. This is one of the rarest of genetic diseases. Only a few dozen victims are alive at any one time. All of these progerics die before they can reproduce. It is thought that it is caused by a dominant allele, because the disorder does not increase in frequency with inbreeding, unlike disorders caused by recessive alleles. The alleles that causes progeria are eliminated every time they occur, so all cases represent new mutations. Natural selection's stringent elimination of all the victims of this disease reveals its power to maintain high survival before the onset of reproduction.

The key to this selective process is the point at which reproduction occurs. In laboratory populations, culture reproduction usually occurs at an arbitrary age that is convenient for the experimenter. The adults that have reproduced are then usually discarded. But the age at which cultures are reproduced can be changed by altering culture methods. When the age of reproduction is early, natural selection stops working to screen genes affecting survival that have effects at later ages. When the age of reproduction is later, natural selection will screen the genes affecting survival at all ages before the reproduction of the culture. This will take place automatically, without the experimenter having to measure the longevities of individual organisms. This allows selection for increased survival in very large laboratory populations, forestalling the problem of inbreeding.

Selection on *Drosophila* aging

While there are other organisms that have been subjected to this type of selection, some insects and mice in particular, most of the studies that use natural selection to increase longevity have employed *Drosophila melanogaster,* the common laboratory fruit fly. Though a handful of experiments of similar design were performed in

the period before 1980, none were designed specifically to increase longevity using natural selection. Since 1980, a variety of laboratories have employed the basic method of delaying fruit fly culture reproduction to increase longevity using natural selection.

The most consistent result found in these experiments is an increase in adult longevity, often by more than 50 percent. Another common result has been improvement in stress resistance in flies that live longer, although not all laboratories have found identical results with respect to increased stress resistance. A few laboratories have studied other aspects of the functional biology of longer-lived fruit flies. Such fruit flies appear to conserve water and store calories. There is no general reduction in metabolic rate: longer-lived fruit flies do not appear to "live less, longer." This is a notable contrast with nematode mutants having increased longevity, but decreased metabolic rate. Longer-lived fruit flies also appear to have improved flight stamina, along with increased reproductive performance in mid- and late-life. The general impression that the data give is that longer-lived fruit flies are more robust adults.

There are some controversies, however. The most prominent of these concerns the relationship between early fertility and longevity. In some of the populations selected for increased longevity, early female fecundity has been reduced. But in other populations that have shown increased longevity, early female fecundity has not been reduced. To some extent this disparity has been put into perspective by the experimental demonstration that the correlation between selection for increased longevity and any secondary effect on early reproduction depends on the specific environment in which early fecundity is measured. The same population may show a trade-off between early reproduction and longevity, or an absence of this trade-off, depending on such details as the amount of dietary yeast, the period of egg-laying, and so on. The most reasonable conclusion is that the trade-off between early reproduction and longevity is environment-dependent, rather than universal.

Overall, *Drosophila* have been successfully selected for increased longevity by manipulating natural selection. These organisms are largely free of inbreeding depression. Another notable feature of these experiments is that they have been extensively replicated, in several laboratories, with multiple selected populations and multiple control populations. This makes them excellent material for further research.

Use of populations with selectively increased longevity

The key to the use of organisms with increased longevity is that they must have slowed or abrogated the normal processes of aging. Organisms with reduced longevity may die because of novel pathologies, unrelated to normal mechanisms of aging. But this problem does not apply to longer-lived organisms. Consistent differences between organisms with increased longevity and closely related, normal-lived, controls must be related in some way to the control of aging.

An important qualification is the term *consistent*. If one longer-lived population is compared with one control population, then there may be genetic or physiological differences between them that are due solely to genetic drift. This problem can be solved, however, by replication of selected and control populations, since such random differentiation will separate selected populations from each other, as well as differentiating controls from each other. Such differentiation can then be partitioned out using analysis of variance techniques, leaving only the differences between selected and control that are specifically associated with the effects of selection. This method is now routinely used in studies of increased longevity in fruit flies.

An additional qualification is that some changes that are produced by selection for increased longevity may not themselves increase longevity. They could instead be side-effects of the changes that increase longevity. This problem may be resolvable through the use of further selection. For example, one character associated with increased longevity in some fruit fly populations is resistance to dying from total starvation. Additional selection for increased starvation resistance also increases longevity, indicating that starvation resistance is part of a mechanism controlling longevity.

One benefit of the comparison of longer-lived with normal organisms is that any kind of character can be studied. In fruit flies, researchers have already studied life-history characters, behavioral performance, organismal physiology, biochemical composition, single-locus genetics, and gene expression. A general pattern is that,

while many characters and genes have little association with increased longevity, a moderate number of characters are associated with increased longevity. This shows that selection can indeed be used to reveal the controls on longevity.

Human applications

A common misunderstanding of research that uses selection to increase longevity is that the researchers propose to select on humans as a next step. But this approach is not only unethical, it would also be extremely inefficient. Humans have only a few generations each century, making the prospect of a significant response to selection on human longevity dim within the near future.

A more appropriate approach is to use selection on other animals as a tool to learn about the genetics and physiology of increased longevity, with a view to applying that knowledge to the postponement of human aging using pharmaceutical and other medical approaches. The prospects for such applications are now much greater with the complete sequencing of the *human genome* as well as the nematode and fruit fly genomes. Nematodes and fruit flies with increased longevity have been created by mutagenesis and selection. Some concerns have been raised about the value of the nematode mutants, but no such concerns apply to selected fruit flies. If genomic research applied to selected *Drosophila* reveals the specific loci controlling aging in fruit flies, there may well be homologues for those genes in humans. These homologues could be found by analyzing the full genomic sequences of the two species. Such human homologues would then be useful targets for research targeted at the problem of increasing human longevity. In this way, the humble fruit fly could, by way of selection, be of major medical value for increasing human lifespan, even though humans themselves would never be a target of selection.

MICHAEL R. ROSE

See also GENETICS; LIFE SPAN EXTENSION; PATHOLOGY OF AGING: ANIMAL MODELS.

BIBLIOGRAPHY

LEROI, A. M.; CHIPPINDALE, A. K.; and ROSE, M. R. "Long-Term Laboratory Evolution of a Genetic Trade-off in *Drosophila melanogaster*. I. The Role of Genotype x Environment Interaction." *Evolution* 48 (1994): 1244–1257.

LUCKINBILL, L. S.; ARKING, R.; CLARE, M. J.; CIROCCO, W. C.; and BUCK, S. A. "Selection for Delayed Senescence in *Drosophila melanogaster*." *Evolution* 38 (1984): 996–1003.

PARTRIDGE, L., and FOWLER, K. "Direct and Correlated Responses to Selection on Age at Reproduction in *Drosophila melanogaster*." *Evolution* 46 (1992): 76–91.

ROSE, M. R. "Laboratory Evolution of Postponed Senescence in *Drosophila melanogaster*." *Evolution* 38 (1984): 1004–1010.

ROSE, M. R. *Evolutionary Biology of Aging*. New York: Oxford University Press, 1991.

ROSE, M., and CHARLESWORTH, B. "A Test of Evolutionary Theories of Senescence." *Nature* 287 (1980): 141–142.

ROSE, M. R.; VU, L. N.; PARK, S. U.; and GRAVES, J. L. "Selection for Stress Resistance Increases Longevity in *Drosophila melanogaster*." *Experimental Gerontology* 27 (1992): 241–250.

VAN VOORHIES, W. A., and WARD, S. "Genetic and Environmental Conditions that Increase Longevity in *Caenorhabditis elegans* Decrease Metabolic Rate." *Proceedings of the National Academy of Science USA* 96 (1999): 11399–11403.

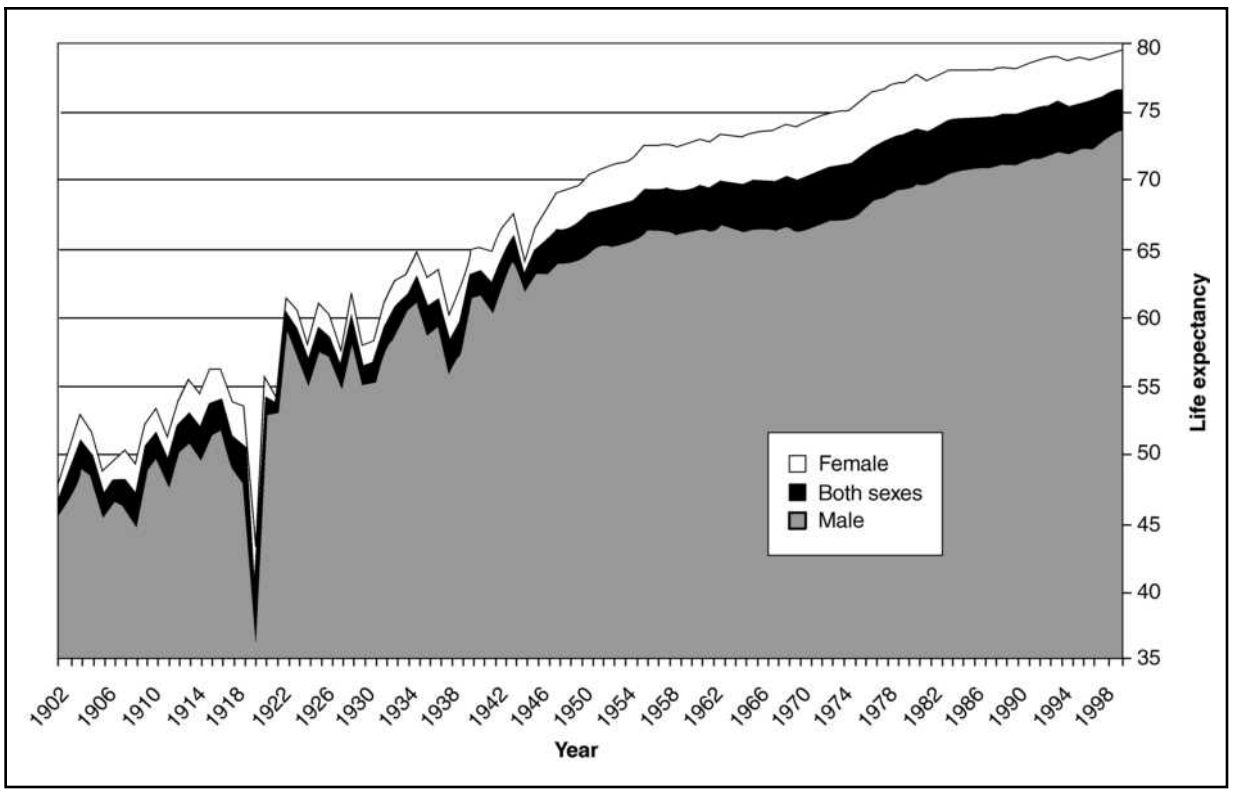
WATTIAUX, J. M. "Cumulative Parental Age Effects in *Drosophila subobscura*." *Evolution* 22 (1968): 406–421.

LONGEVITY: SOCIAL ASPECTS

The population of the United States enjoys one of the highest life expectancies in the world, and throughout the twentieth century the life expectancy of Americans increased remarkably. When the twentieth century began, U.S. newborns could expect to live an average of 47 years (see Figure 1). By 1960, that number had risen to 70 years, and it had increased to 76.7 years by the year 1998 (Anderson; Murphy).

Earlier in the twentieth century, life expectancies were volatile. For example, between 1917 and 1918, life expectancy plummeted 24 percent, from 48.4 to 36.6 years, due to the influenza epidemic. Since the introduction of infectious disease–fighting antibiotics in the 1930s, life expectancies have become more stable as they increased. Improvements in health care, social programs, and living conditions have further contributed to increasing life expectancies.

Figure 1
Life expectancies by sex and for the total population, United States



SOURCE: Adapted from: Murphy, S. L. "Deaths: Final Data for 1998." *Monthly Vital Statistics Report* 48 (2000): 1–108. Also from: Anderson, R. N. "United States Life Tables, 1998." *National Vital Statistics Reports* 47 (2001): 1–38.

Over time, both males and females have enjoyed substantial improvements. Females have experienced life expectancy gains from 48.3 years in 1900 to 79.5 years in 1998; males life expectancy increased from 46.3 years to 73.8 years during this same period. The life expectancy sex gap gradually widened from 2 years in 1900 to 7.8 years in 1975. It has been closing gradually since, narrowing to 5.7 years in 1998.

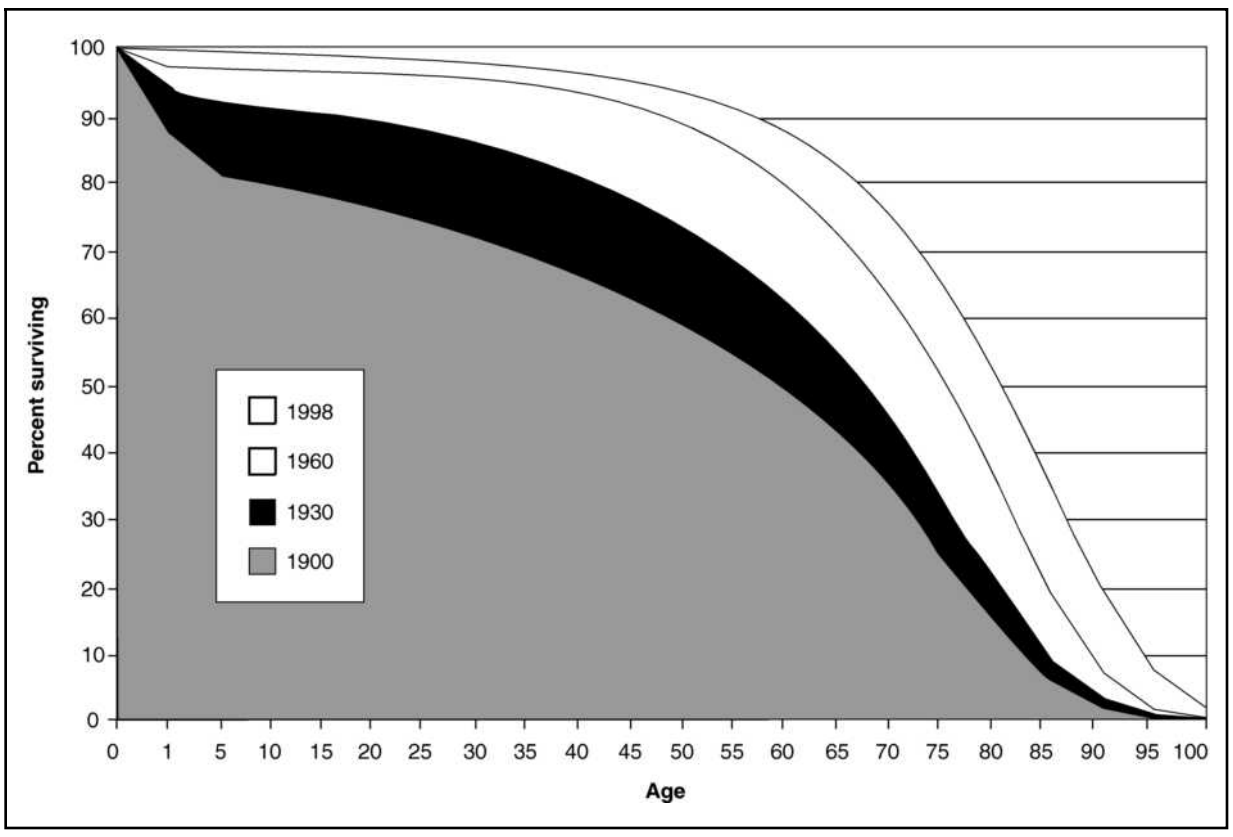
Life expectancy in the United States also differs for persons with different social characteristics. For example, racial and ethnic groups vary such that African-Americans have the lowest life expectancy in the United States, Hispanics and non-Hispanic whites have higher life expectancies, and Asian Americans have the highest (Rogers et al., 2000). Persons in higher status educational, income, and occupational groupings also have substantial life expectancy advantages over those in lower socioeconomic statuses.

Survival curves

Mortality trends by age may be visually represented through survival curves, which follow a hypothetical birth cohort of one hundred to show what proportion survives to later ages. Figure 2 compares survival curves for selected years. Note that in the bottom curve, survival probabilities are relatively low, particularly at young ages. In 1900, 20 percent of individuals died between birth and age ten; today, less than 1 percent face a similar fate (also see Table 1). Thus, one distinguishing feature between survival rates of 1900 and today is substantial improvement among infants and children.

In 1900, survival chances were also lower across the entire life span. Out of one hundred newborns, only seventy-seven were expected to reach age twenty, fewer than half were expected to attain age sixty, and just thirty-two were expected to reach age seventy. In contrast, based

Figure 2
Percent surviving by age: United States, selected years



SOURCE: Adapted from: Murphy, S. L. "Deaths: Final Data for 1998." *Monthly Vital Statistics Report* 48 (2000): 1–108. Also from: Anderson, R. N. "United States Life Tables, 1998." *National Vital Statistics Reports* 47 (2001): 1–38.

on 1998 survival rates, almost 90 percent of newborns can expect to reach age sixty.

Between 1900 and 1930, survival drastically improved for infants and children, and also improved for other ages. Between 1930 and 1960, survival improved substantially for middle-aged individuals. And between 1960 and 1998, mortality improvements were significant at the older ages. In fact, individuals aged eighty-five and older have experienced remarkable declines in mortality over the last several decades. Out of one hundred individuals born, just three could expect to live to age ninety in 1930; by 1960, this number doubled, to six; and between 1960 and 1998, this percentage more than tripled.

Rectangularization of mortality

Note the changing shape of the survival curves with time (Figure 2). From 1900 to the present, the survival curve has become more rectangular due to increased survival at all ages, but especially at the young and middle ages. To describe the changing shape of the survival curve over time, Fries coined the concept "rectangularization of mortality."

Debate centers around future reductions in mortality and whether there is a limit to the human life span. Fries argued that while continued improvements will occur at the younger ages, we have witnessed most of the possible mortality improvements at the oldest ages. But based on current survival curves, there is still ample room for improvement in the fifties, sixties, and seventies.

Fries also suggested that greater proportions of individuals will survive to age eighty-five, with few individuals surviving beyond this age. Similarly, Olshansky and others asserted that life ex-

Table 1
Percentage survivors by age, United States, various years

	Year			
Age	**1900**	**1930**	**1960**	**1998**
10	80.05	91.11	96.18	99.05
20	77.24	89.09	95.37	98.60
30	72.04	85.30	93.92	97.65
40	65.89	80.56	91.65	96.27
50	58.51	73.32	86.59	93.49
60	47.95	61.56	75.92	87.44
70	32.39	42.77	56.99	74.20
80	13.53	18.58	29.31	50.52
90	1.87	3.00	6.14	18.61
100	0.03	0.06	0.20	1.76

SOURCE: Adapted from: Murphy, S. L. "Deaths: Final Data for 1998." *Monthly Vital Statistics Report* 48 (2000): 1–108. Also from: Anderson, R. N. "United States Life Tables, 1998." *National Vital Statistics Reports* 47 (2001): 1–38.

pectancies will continue to increase, but at a slow pace, noting that even though mortality has declined for older age groups, neither the right tail of the age distribution nor the age of the verified longest-lived individual has substantially increased. Newer evidence, however, suggests that the survival tail will continue to lengthen. Indeed, there have been noticeable changes in the percentage of individuals in the United States and other countries surviving to the ages of ninety-five, one hundred, and beyond. Some researchers also raise the possibility of much higher future life expectancies, with more and more individuals living to one hundred and beyond (see National Research Council).

It seems reasonable to consider that the life span is not fixed, and can be extended through incremental advances. For example, if life span is currently 122 years and 165 days based on the documented length of life of a French woman named Jeanne Calment (National Research Council), then it seems reasonable for other individuals to live the same length of time plus one day, and so on. In fact, at the oldest ages, mortality has declined and the distribution of ages of death has lengthened for more than a century. From 1870 through 1990 in Sweden, a country with excellent documentation of births and deaths, the oldest reported age has increased about one year for every twenty years of time (Wilmoth and Lundstrom 1996).

Mortality by cause

Life expectancy changes are affected by trends in specific causes of death. Through the early part of the twentieth century, mortality due to infectious and parasitic diseases was dominant, especially among infants and children. In the latter part of the century, there was a shift to mortality due to chronic diseases (especially cardiovascular diseases and cancer) as primary causes of death (Omran).

Table 2 shows cause-specific mortality information for the top ten causes of death in the United States in 1998. The major cause of death was heart disease, which was the triggering cause for almost one-third of all deaths. Cancer was the main cause for almost one-quarter of all deaths. Other major killers include chronic obstructive pulmonary diseases (COPD), contributing to 7 percent of all deaths; accidents, comprised of motor vehicle and other accidents; pneumonia and influenza; diabetes; suicide; nephritis; and chronic liver disease and cirrhosis.

Some causes of death are more important at younger ages than for the total population. For example, among individuals aged fifteen to twenty-four in 1998, the top three causes of death were accidents, homicide, and suicide, respectively. Within this age group, human immunodeficiency virus (HIV) was the ninth leading cause of death. Deaths due to HIV, although still important, dropped 20.7 percent between 1997 and 1998 (Murphy).

Even though a particular disease may represent a large portion of all deaths, its elimination does not assure huge gains in life expectancy. On the contrary, it may result in only modest life expectancy increases, a phenomenon called "The Taeuber Paradox" (Taeuber). For example, even though cancer represents about one-quarter of all deaths, its elimination would add only two to three years to life expectancy at birth (Keyfitz). This paradox results because most cancer deaths occur at older ages; thus, preventing or curing this one disease provides an opportunity for death to occur from other diseases.

Longer lives and better health

A crucial question is whether individual lives are increasing in length and quality: are people

Table 2
Death rates, percentage of deaths by cause, and numbers of deaths for both sexes (all races and ages), United States, 1998

Rank	Cause of Death	Rate	Percentage of all deaths	Number
1	Diseases of the heart	268.2	31.0%	724,859
2	Malignant neoplasms	200.3	23.2	541,532
3	Cerebrovascular diseases	58.6	6.8	158,448
4	Chronic obstructive pulmonary diseases	41.7	4.8	112,584
5	Accidents and adverse effects	36.2	4.2	97,835
	Motor vehicle accidents	16.1	1.9	43,501
	All other accidents	20.1	2.3	54,334
6	Pneumonia and influenza	34.0	3.9	91,871
7	Diabetes mellitus	24.0	2.8	64,751
8	Suicide	11.3	1.3	30,575
9	Nephritis, nephrotic syndrome, and nephrosis	9.7	1.1	26,182
10	Chronic liver disease and cirrhosis	9.3	1.1	25,192
	All other causes	171.5	19.8	463,427
	TOTAL	864.7	100.0	2,337,256

SOURCE: Adapted from: Murphy, S. L. "Deaths: Final Data for 1998." *Monthly Vital Statistics Report* 48 (2000): 1–108.

not only living longer, but enjoying additional years of health and functional ability, or are they experiencing more chronic conditions and physical disability? Fortunately, most recent research suggests that individuals are enjoying longer years with better health (see Rogers, Rogers, and Belanger). However, there are also race/ethnic differences in this relationship, such that African-Americans and Native Americans live many of these additional years in poor health (Hayward and Heron).

Factors related to mortality

A large range of factors exert strong impacts on the prospects of longevity, including social, economic, cultural, psychological, biological, public health, and medical characteristics. The public health and medical communities have reduced or prevented many infectious diseases: diphtheria, measles, and typhoid fever have declined substantially, and smallpox has been eradicated (Link and Phelan). Biomedical interventions have prolonged life through such developments as pharmaceuticals, surgery, transplants, and other technological developments.

Biological research has also taught us more about genetically linked diseases. The methods of recombinant DNA have led to the familial tracking of cancer genes, including breast cancer; to the tracking from person to person of infections, including HIV and tuberculosis; and to the detection of both viral and genetic components in insulin-dependent diabetes (Susser and Susser). New developments uncovered by the human genome project promise future increases in life expectancy.

Health behaviors also influence longevity. Cigarette smoking is considered the single most important preventable determinant of mortality in developed nations. Cigarette smokers experience a mortality gradient: as the number of cigarettes smoked increases, the risk of death increases. The immense mortal effects of cigarette smoking in U.S. society will continue through much of this century, with literally millions of lives prematurely lost due to cigarette smoking (Nam et al.).

Heavy alcohol use also increases the risk of death via accidents and violence and through certain organic diseases. However, moderate drinking has been shown to have a beneficial effect on health and survival from circulatory diseases (Rogers et al., 2000). Some studies have shown other health behaviors, particularly exercise frequency, to be related to mortality risk. Even as we identify behavioral risk factors, individual habits are often so deeply entrenched that knowledge of this increased risk does not always motivate change. For example, even though obesity is known to increase the risk of death, the prevalence of obesity in the general population has been increasing.

Socioeconomic status can increase longevity by providing both knowledge about health risks and ways to avoid them, and the means with which to manage risks and undergo treatment (Link and Phelan). High socioeconomic status is often coupled with beneficial health behaviors. Other important factors that increase longevity

include favorable social ties—to family, friends, and the community; stable mental health; and religious involvement.

Implications of past and future longevity

Increased longevity has affected kin ties, retirement, the population age distribution, and overall population size (White and Preston). Added years of life increase opportunities to accumulate life experiences, complete or change roles, extend relationships with others, and increase the potential for rich and complex social networks. Indeed, kinship, friendship, and community networks can be extended and expanded (Riley). Unlike earlier time periods, children born today can expect to survive into young adulthood with all of their siblings, parents, and grandparents. Moreover, it is increasingly common for children to know their great-grandparents and even great-great-grandparents.

Changes are also afoot in educational and career trajectories. Because of longer lives, many individuals are going to school longer before embarking on a career, and some individuals now plan for multiple careers. Longer lives also mean that most individuals will live to see retirement and will spend a substantial number of years in retirement. These changes abet further change; for example, some retired individuals decide to return to the labor force.

The population age distribution is also changing. In previous centuries, the U.S. age structure resembled a pyramid, with large numbers of individuals at the youngest ages and few individuals at the oldest ages. Today, the distribution approximates a pillar, with similar numbers of individuals in each age. Although there are advantages to this new age distribution, there are also potential disadvantages. For instance, because there is a lower proportion of people in the working years to contribute to Social Security, and a higher proportion of Social Security recipients, the basic age requirement for Social Security is gradually increasing from sixty-five to sixty-seven years of age.

Future trends in life expectancies

Few researchers assert that there will be no future mortality improvement. Although there have been periodic setbacks in life expectancy increases, say, with AIDS, such setbacks are usually of short duration and are compensated for by later improvements in controlling and treating infectious diseases and by further improvements in other causes of death. Thus, the question is not whether mortality will improve in the future, but by how much it will improve, and what age, sex, race/ethnic, and socioeconomic status groups will reap the greatest improvements. Overall, continued changes in health behavior, developments in medical technology, and improved quality of life bode for a generally bright future, most likely with steady increases in average length of life accompanied by an increasingly healthy population.

RICHARD G. ROGERS
ROBERT A. HUMMER

See also LIFE EXPECTANCY; LIFE SPAN EXTENSION; LONGEVITY: REPRODUCTION; LONGEVITY: SELECTION; POPULATION AGING.

BIBLIOGRAPHY

ANDERSON, R. N. "United States Life Tables, 1998." *National Vital Statistics Reports* 47 (2001): 1–38.

FRIES, J. F. "Aging, Natural Death, and the Compression of Morbidity." *New England Journal of Medicine* 303 (1980): 130–135.

HAYWARD, M. D., and HERON, M. "Racial Inequality in Active Life among Adult Americans." *Demography* 36 (1999): 77–91.

KEYFITZ, N. "What Difference Would it Make if Cancer Were Eradicated? An Examination of the Taeuber Paradox." *Demography* 14 (1977): 411–418.

LINK, B. G., and PHELAN, J. "Social Conditions as Fundamental Causes of Disease." *Journal of Health and Social Behavior* Extra Issue (1995): 80–94.

MURPHY, S. L. "Deaths: Final Data for 1998." *Monthly Vital Statistics Report* 48 (2000): 1–108.

NAM, C. B.; ROGERS, R. G.; and HUMMER, R. A. "Impact of Future Cigarette Smoking Scenarios on Mortality of the Adult Population in the U.S., 2000–2050." *Social Biology* 43 (1996): 155–168.

National Research Council. *Between Zeus and the Salmon: The Biodemography of Longevity*. Edited by K. Wachter and C. Finch. Washington, D.C.: National Academy Press, 1997.

OLSHANSKY, S. J.; CARNES, B. A.; and CASSEL, C. "In Search of Methuselah Estimating the Upper Limits to Human Longevity." *Science* 250 (1990): 634–640.

OMRAN, A. R. "The Epidemiologic Transition: A Theory of the Epidemiology of Population

Change." *Milbank Memorial Fund Quarterly* 49 (1971): 509–538.

RILEY, M. W. *Aging in the Twenty-first Century*. Boettner Lecture, 1990. Bryn Mawr, Pa.: Boettner Research Institute, 1991.

ROGERS, R. G.; HUMMER, R. A.; and NAM, C. B. *Living and Dying in the USA: Social, Behavioral, and Health Differentials in Adult Mortality*. New York: Academic Press, 2000.

ROGERS, R. G.; ROGERS, A.; and BELANGER, A. "Active Life among the Elderly in the United States: Multistate Life-table Estimates and Population Projections." *The Milbank Quarterly* 67 (1989): 370–411.

ROGERS, R. G.; HUMMER, R. A.; NAM, C. B.; and PETERS, K. D. "Demographic, Socioeconomic, and Behavioral Factors Affecting Ethnic Mortality by Cause." *Social Forces* 74 (1996): 1419–1438.

SUSSER, M., and SUSSER, E. "Choosing a Future for Epidemiology: I. Eras and Paradigms." *American Journal of Public Health* 86 (1996): 668–673.

TAEUBER, C. "If Nobody Dies of Cancer." *Kennedy Institute Quarterly Report* 2 (1976): 6–9.

WHITE, K. M., and PRESTON, S. H. "How Many Americans are Alive Because of Twentieth-Century Improvements in Mortality?" *Population and Development Review* 22 (1996): 415–429.

WILMOTH, J. R., and LUNDSTROM, H. "Extreme Longevity in Five Countries: Presentation of Trends with Special Attention to Issues of Data Quality." *European Journal of Population* 12 (1996): 63–93.

LONGITUDINAL STUDY

See PANEL STUDY; PHYSIOLOGICAL CHANGES; SURVEYS

LONG-TERM CARE

Long-term care includes an array of services used by persons who need assistance to perform daily activities that are basic to living independently. These daily activities include self-care activities (e.g., eating, dressing, bathing, and getting around the house) and household tasks (e.g., shopping, preparing meals, managing money, using the telephone, housecleaning, and taking medications). The term "long-term care" encompasses the range of services needed to perform these activities; it may also include supervision and monitoring for safety and some medical care. Long-term care services are provided in private homes, nursing homes, and a variety of other settings. Conditions that can create a need for long-term care services include physical disability, frailty, chronic illness, mental retardation, mental illness, and cognitive disabilities such as Alzheimer's disease.

The growing need for long-term care

The number of persons who need long-term care depends on how that need is defined. A broad definition would include anyone who has difficulty performing a range of daily activities expected of his or her age group. In 1994 an estimated 12.8 million Americans of all ages said they needed assistance with everyday activities as a result of chronic conditions. The majority of Americans in need of long-term care, approximately 57 percent (7.3 million), were adults age sixty-five or older. Forty percent (5.1 million) were working-age adults age eighteen to sixty-four. Three percent were children under age eighteen who were limited in their ability to engage in play or school activities expected for their age due to physical or mental disabilities (GAO, 1994). In 1994 approximately 6.6 million persons age sixty-five or older received help with one or more daily activities (Kassner and Bectel). Many other adults live independently with little or no assistance from others.

The need for long-term care services in the United States is likely to increase dramatically as a result of an increasing older population. Individuals age eighty-five and older are the most rapidly growing age group in the nation. The eighty-five and older population is expected to rise from 3.9 million in 1997 to 8.5 million in 2030 and to eighteen million in 2050. Estimates of the number of baby boomers (Americans born between 1946 and 1964) who will need long-term care range from two to four times the number of disabled older persons in the late 1990s, depending on the impacts of medical advancements on increasing longevity and on treating and preventing disability (GAO, 1998). Indeed, the proportion of Americans age sixty-five or older with a chronic disability declined from 24 percent in 1982 to 21 percent in 1994 (Federal Interagency Forum on Aging-Related Statistics).

Although most older people do not need long-term care, older persons are the primary users of long-term care services. Three percent of all persons age fifty and older, and 11 percent of persons age eighty-five and older, receive help

with two or more daily activities (Kassner and Bectel). An estimated 39 percent of persons who turned sixty-five and 56 percent of persons who turned eighty-five in 1995 will use a nursing home during their lifetime (Murtaugh et al.). The average length of stay for nursing home residents sixty-five years and over is 290 days, but half stay no more than about two months (63 days) (Gabrel).

Women have a longer life expectancy than men and are more likely than men, at every age, to have a disability (Kassner and Bectel). Older women also tend to have lower incomes and are more likely to live alone than older men. As a result, the majority of nursing home and home care users are women. In 2000 women comprised an estimated 58 percent of the population age sixty-five and older and 70 percent of persons age eighty-five and older (Federal Interagency Forum on Aging-Related Statistics). Women accounted for about 75 percent of nursing home residents aged sixty-five and over (Gabrel) and 70 percent of older home care consumers (Munson 1999).

Where is long-term care provided?

In 1994 nearly 80 percent of older persons who reported needing assistance with one or more daily activities lived in their own home or another community setting. Just over 20 percent lived in nursing homes. Of those living in homes and communities, an estimated one million lived in supportive housing that provided some long-term care services, such as assisted living facilities (GAO, 1998).

The bulk of long-term care, however, is provided by unpaid family members or friends (GAO, 1994). Between 1987 and 1997 the proportion of U.S. households involved in unpaid caregiving activities for a person over the age of fifty jumped from approximately 8 percent (seven million households) to 22 percent (more than twenty-one million households).

Caregivers varied in the amount of time they spent caregiving and in the scope of care provided. While the average unpaid caregiver provided eighteen hours of care per week, nearly one in five (18 percent) provided forty or more hours of care per week (NAC/AARP, 1997). Nearly all caregivers surveyed (98 percent) said they helped with at least one household management activity, such as transportation, grocery shopping, housework, preparing meals, or managing finances, or giving medication. More than four in five (81 percent) helped with three or more of these activities. Over half (51 percent) helped with at least one personal care activity, such as getting in or out of chairs, dressing, bathing, toileting, or feeding. Over a fourth (29 percent) helped with three or more of these activities. In 1996 more than seven in ten unpaid caregivers (73 percent) were women, and 12 percent were age sixty-five or older (NAC/AARP).

Because many members of the baby boom generation have remained single longer and have had fewer children than their parents, a smaller proportion of this generation will have a spouse or adult children available to provide unpaid caregiving when they are older. In addition, families are more likely to be geographically dispersed, and women are more likely to work outside the home than they were formerly. As a result of these demographic changes, it is predicted that older persons of the future will have fewer unpaid caregivers available and will be more dependent on paid long-term care services (GAO, 1998).

Individuals who need more assistance than unpaid caregivers can provide may receive long-term care in a range of settings, including home care, adult day services, supportive housing, and nursing homes. *Home care* refers to a range of services, including nursing care, personal care, assistive devices, meals, and home modifications, provided to people with disabilities in their own homes. Many unpaid caregivers use one or more home care services to help with caregiving. For example, 47 percent of caregivers reported acquiring a wheelchair, walker, or other assistive device. In addition, many caregivers reported purchasing personal or nursing care services (38 percent), home modification (28 percent), home delivered meal services (16 percent), assistance with housework (16 percent), and respite care (14 percent) (NAC/AARP 1997).

Adult day centers provide a range of services to physically impaired or mentally confused adults who live at home, thus allowing caregivers to have respite or go to work during the day. Adult day centers provide less than twenty-four-hour care and typically operate during normal business hours five days a week. As of 1996, there were an estimated four thousand adult day centers operating in the United States (NADSA).

Supportive housing refers to care in a homelike setting in the community for people in need of

assistance with daily activities or protective oversight. Supportive housing can be an alternative to nursing homes for some. Typically, however, supportive housing offers only very limited nursing care. The major types of supportive housing settings include assisted living, adult foster care, congregate housing, and continuing care retirement communities (Blanchette).

Assisted living is a rapidly growing option for individuals with long-term care needs who prefer to live in the community and who generally do not require the level of skilled nursing or custodial care provided in a nursing home (GAO, *Assisted Living,* 1999). While definitions of assisted living vary, the term generally refers to a residential, homelike setting that provides or coordinates personal care services, twenty-four-hour supervision, social activities, and some health-related services. Although the lack of consensus on a definition precludes an exact count of assisted living residents, states reported a total of 32,886 licensed assisted living facilities with 795,391 units or beds in 2000, a 30 percent increase since 1998. These numbers include board-and-care homes, which are often similar to assisted living but usually provide no health-related services (Mollica).

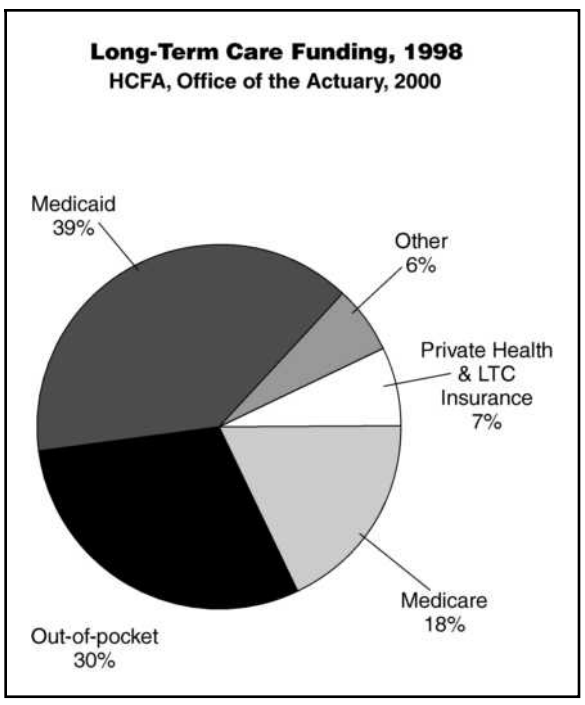
Nursing homes are the most easily recognized form of long-term care, although far more people receive long-term care in their own home or in other community settings. The National Nursing Home Survey defines nursing homes as "facilities with three or more beds that routinely provide nursing care services." In 1997 approximately 1.5 million persons sixty-five years and over lived in nursing homes (Bishop).

As opportunities have expanded for care in the community (often termed *home and community-based care*), the proportion of older people residing in nursing homes has declined. Between 1985 and 1995 the number of nursing home residents per thousand individuals age sixty-five and older fell from 46.2 to 42.4, an 8.2 percent decline. In 1995 nursing home residents tended to need more intensive care than did their counterparts in 1985, because individuals with fewer impairments were more likely to receive care in the home or another community setting, such as an assisted living facility (Bishop).

Financing of long-term care

In 1998 the average cost of care in a nursing home was $56,000 per year. National spending for nursing home and home health care in 1998 totaled $117 billion dollars (HCFA, "Table 7." 2000; "Table 9," 2000). These expenditures do not include much of the spending on home and community-based long-term care services, much of which is spending by older persons themselves and their families (termed *out-of-pocket expenditures*).

Figure 1



SOURCE: HCFA, Office of the Actuary, 2000

Nearly a third (30 percent) of home health and nursing home care expenditures were paid by older persons themselves and their families, and the largest portion (39 percent) was paid by Medicaid (see Figure 1). Long-term care services are usually not covered by private health insurance policies or Medicare. Moreover, few people have private long-term care insurance, which is unaffordable for many and often provides only limited coverage.

Costs to family caregivers. These expenditures for long-term care do not include any accounting of unpaid caregiving. If unpaid caregivers had to be replaced by paid workers, the estimated cost would be $196 billion as of 1997 (Arno et al.). This amount is far more than national spending on home health and nursing

A home care worker assists an elderly woman as she walks with the aid of a walker. (The Terry Wild Studio, Inc.)

home care combined in the same year ($115 billion) (HCFA, "Table 9," 2000).

These unpaid caregivers often incur both direct and indirect costs. In a national survey of caregivers to older persons, half had regularly spent their own money on caregiving. The average amount spent was $171 a month per caregiver, or approximately $1.5 billion per month in direct costs to caregivers nationwide. More than half of all caregivers reported that their caregiving responsibilities caused them to have less time for other family members or for personal activities. More than half made at least some work-related changes (e.g., modifying their work schedule or taking time off during the day) to accommodate the demands of caregiving. Fifteen percent of caregivers reported suffering physical or mental health problems as a result of caregiving, and one in four found caregiving to be emotionally stressful (NAC/AARP).

Private long-term care insurance. Although private long-term care insurance is a growing form of financing of long-term care, relatively few older persons have coverage. The number of long-term care insurance policies sold doubled from about three million in 1992 to almost six million by mid-1998 (Coronel). People are often reluctant to buy long-term care insurance because they believe that they will never need long-term care or believe, erroneously, that care will be covered through Medicare or private health insurance. The cost of long-term care insurance premiums is unaffordable for many people. *Consumer Reports* estimated that only 10 to 20 percent of older persons could afford long-term care insurance ("Long-Term Care Insurance Special Report").

Medicaid. The federal- and state-financed Medicaid program contributes to the cost of care for about two-thirds of nursing home residents (GAO, 1998). Medicaid has strict financial and functional eligibility requirements. These requirements vary from state to state, but in all states, individuals must be impoverished before they can qualify for benefits. In most states, nursing home residents can have no more than $2,000 in liquid assets to be financially eligible for Medicaid coverage of their care. In addition, individuals who need long-term care due to cognitive or mental impairments often have difficulty meeting Medicaid's functional eligibility standards. In most states, Medicaid will not cover long-term care services for individuals who need prompting, physical cueing, or supervision to perform activities of daily living or who need supervision due to mental impairments, unless they meet other nursing or functional criteria (O'Keefe).

People of all ages prefer to receive long-term care services in their own homes, if possible, or in homelike supportive housing settings, such as assisted living. Historically, however, Medicaid has covered long-term care primarily in institutions. The federal government and the states have limited Medicaid coverage of home and community-based long-term care out of concern about the potential cost of covering services for the large number of people with disabilities who are cared for by their families at home (GAO, 1998). In 1965, when the Medicaid program was developed, there were few alternatives to institutions for people who needed more long-term care than their families could provide (Kassner).

Today, however, there is a growing movement to expand Medicaid coverage of home and community-based long-term care services (Kassner). The 1981 Omnibus Budget and Reconciliation Act gave states the option of applying for Medicaid *waiver programs* to fund home and com-

munity-based services for people who meet Medicaid eligibility requirements for nursing homes (GAO, 1998). Waiver programs allow states to offer services not covered under the regular Medicaid program and to waive certain Medicaid requirements. Specifically, services do not have to be statewide; states can use more liberal financial eligibility criteria; and designated groups can be given benefits that other groups are not eligible to receive (Lutzky et al.). All states now have waiver programs or a program similar to a waiver. Through these programs, states are increasingly offering services in the home or in the community that enable older persons and persons with physical disabilities, developmental disabilities, or mental retardation to avoid living in an institution.

Unlike nursing home residents, most assisted living residents pay entirely out of their own incomes. Average monthly rates for assisted living facilities range from less than $1,000 to over $4,000 (GAO, *Assisted Living,* 1999). Many states are now providing Medicaid coverage of assisted living, though this coverage remains limited. In 2000 Medicaid programs in thirty states covered assisted living or residential care services for approximately 58,544 beneficiaries, a nearly 50 percent increase since 1998. Still, Medicaid covered only a small fraction of the 795,391 licensed assisted living and board-and-care units or beds (Mollica).

The growth of Medicaid waiver services was partly a result of laws and court rulings, including the 1990 Americans with Disabilities Act (ADA), which required that states provide services to people with disabilities in the "most integrated setting appropriate" (Lutzky et al.) In 1999, in *Olmstead* vs. *L.C.,* the Supreme Court ruled that unnecessary institutionalization of persons with disabilities constitutes discrimination based on disability under the ADA. However, the decision allows states some flexibility in making placement decisions as long as a state has an equitable plan to provide care in less restrictive settings and moves people off waiting lists for such services at a reasonable pace.

Despite growing coverage of home and community-based care, Medicaid still has an institutional bias. In 1999 only 26 percent of Medicaid long-term care funds were spent on home and community-based services. Such services cost less than nursing home care, thereby allowing more persons to receive care for lower total costs. In fact, 64 percent of Medicaid recipients who were older and disabled long-term care clients received some type of home and community-based services (Doty). In several states, financial eligibility standards are stricter for home and community-based long-term care services. This gives individuals an economic incentive to choose a nursing home over home care. Also, the federal government requires states to provide nursing home services under Medicaid, whereas providing home and community-based services is optional (Kassner). Many states have waiting lists because the demand for waiver services exceeds the capacity of waiver programs (Lutzky et al.).

Medicare. Medicare plays a limited role in long-term care. Unlike Medicaid, the federally funded Medicare program does not have financial eligibility requirements. Medicare provides limited coverage of nursing home care, paying for only up to a hundred days of skilled nursing care following a three-day hospital stay; after twenty days, beneficiaries must contribute a copayment of up to $97 per day (HCFA, *Medicare and You,* 2001). In 1998 Medicare accounted for $10.4 billion of the $87.8 billion in national expenditures on nursing home care (HCFA, "Table 7," 2000).

Due to court decisions and administrative changes in the late 1980s, Medicare has expanded coverage of home and community-based long-term care through its home health care benefit (GAO, 1998). In 1991 Medicare spending on home health care totaled $4.2 billion, about a quarter (26 percent) of national spending on home health care. By 1998 Medicare spending on home health care more than doubled to $10.4 billion and accounted for over a third (35 percent) of national spending on home health care (HCFA, "Table 9," 2000). The Balanced Budget Act of 1997 changed the Medicare reimbursement system in order to control spending, encourage efficiency, and decrease fraud and waste (HCFA, *National Health Expenditures Projections,* 2000).

Ensuring quality of long-term care

Monitoring quality of long-term care services has been a long-standing challenge, especially in nursing homes. The Nursing Home Reform Act of 1987 set new standards for care and established rights of nursing home residents, in response to numerous reports of neglect and abuse in nursing homes. A notable impact of the act is

a substantial reduction in the unnecessary use of physical restraints and chemical restraints (drugs) in nursing homes.

The Nursing Home Reform Act has been difficult to enforce, however, and has often failed to protect nursing home residents from poor care and unsafe conditions. Federal and state inspections showed that more than one in four nursing homes nationwide had deficiencies that caused harm to residents or placed them at risk of death or serious injury each year from 1995 to 1998 (GAO, *Nursing Homes,* 1999).

Because the picture is often bleak in nursing homes, home and community-based services may offer better quality of life. These services allow individuals to receive care in a home or community setting rather than in an institution. In 1987 federal law mandated new quality standards for home health care agencies that are reimbursed by Medicare and Medicaid. States also have their own licensing laws for home health services covered by state-funded programs. Within the same state, several government agencies may be involved in regulating or contracting for home care services. In addition, there are hundreds of unlicensed agencies, such as agencies that provide temporary home care workers for private-paying consumers, operating in every state. Many researchers are skeptical that the fragmented regulatory system can effectively enforce quality home care (Coleman).

Quality of home care has been difficult to assess. Studies have found that clients reported high levels of satisfaction and at the same time reported serious deficiencies in worker performance. These inconsistencies suggest that clients may overstate their levels of satisfaction (Coleman).

A new movement called *consumer-directed care* presents an opportunity to empower individuals to manage their own home care. Many publicly funded programs now give beneficiaries the option to choose their own care providers and to manage their own plans of care, much as privately paying individuals do. Consumer-directed care is advocated primarily by younger adults with disabilities, who want to live in the least restrictive environment possible and to direct their own care. While some advocates contend that providing consumers with autonomy and control will improve care quality, others are concerned about potential health and safety risks. Experts have noted that long-term care often involves a trade-off between maximizing consumer choice and ensuring safety (Coleman).

Assisted living facilities often emphasize a philosophy of facilitating residents' privacy, autonomy, independence, and dignity, and promoting care in a homelike environment (Lewin-VHI). They are licensed and regulated by the states rather than the federal government, and standards and oversight approaches vary across the states. In a 1999 study of assisted living in four states, the General Accounting Office found that more than a quarter of facilities were cited by state oversight agencies for having five or more quality-of-care or consumer protection deficiencies or violations during 1996 and 1997. Frequently identified serious problems providing insufficient care to residents; having insufficient, unqualified, and/or untrained staff; not providing residents the appropriate medications or storing medications improperly; and violating state admission and discharge regulations (GAO, *Assisted Living,* 1999). Nonetheless, older persons and their families frequently choose assisted living for persons who do not need the more intense services of nursing homes, because the quality of life in assisted living is typically preferred over that in nursing homes.

BERNADETTE M. WRIGHT

See also ADULT DAY CARE; ASSISTED LIVING; CAREGIVING, INFORMAL; CONSUMER DIRECTED CARE; HOME CARE AND HOME SERVICES; MEDICAID; MEDICARE; NURSING HOMES.

BIBLIOGRAPHY

ARNO, P. S.; LEVINE, C.; and MEMMOTT, M. M. "The Economic Value of Informal Caregiving." *Health Affairs* 18, no. 2 (March/April 1999): 182–188.

BISHOP, C. E. "Where Are the Missing Elders? The Decline in Nursing Home Use, 1985 and 1995." *Health Affairs* (July/August 1999): 146–155.

BLANCHETTE, K. *New Directions for State Long-Term Care Systems*. Vol. II: *Supportive Housing*. Washington, D.C.: AARP, Public Policy Institute, 1997.

COLEMAN, B. *Assuring the Quality of Home Care: The Challenge of Involving the Consumer*. Washington, D.C.: AARP, Public Policy Institute, 2000.

CORONEL, S. A. *Long-Term Care Insurance in 1997–1998*. Washington, D.C.: Health Insurance Association of America, 2000.

DOTY, P. *Cost-Effectiveness of Home and Community-Based Long-Term Care Services*. Washington, D.C.: U.S. Department of Health and Human Services, Assistant Secretary for Planning and Evaluation; Office of Disability, Aging and Long-Term Care Policy, 2000.

Federal Interagency Forum on Aging-Related Statistics. *Older Americans 2000: Key Indicators of Well-Being*. Hyattsville, Md.: FIFARS, 2000.

GABREL, C. S. *Characteristics of Elderly Nursing Home Current Residents and Discharges: Data from the 1997 National Nursing Home Survey*. Hyattsville, Md.: National Center for Health Statistics, 2000.

GAO (U.S. General Accounting Office). *Long-Term Care: Diverse, Growing Population Includes Millions of Americans of All Ages*. Washington, D.C.: GAO, 1994.

GAO (U.S. General Accounting Office). *Long-Term Care: Baby Boom Generation Presents Financing Challenges*. Washington, D.C.: GAO, 1998.

GAO (U.S. General Accounting Office). *Assisted Living: Quality of Care and Consumer Protection Issues in Four States*. Washington, D.C.: GAO, 1999.

GAO (U.S. General Accounting Office). *Nursing Homes: Additional Steps Needed to Strengthen Enforcement of Federal Quality Standards*. Washington, D.C.: GAO, 1999.

HCFA (Health Care Financing Administration). *Medicare and You 2001*. Washington, D.C.: HCFA, 2000.

HCFA, Office of the Actuary. *National Health Expenditures Projections: 1998–2008*. Washington, D.C.: HCFA, 2000.

HCFA, Office of the Actuary. "Table 7: Nursing Home Care Expenditures Aggregate and Per Capita Amounts and Percent Distribution, by Source of Funds: Selected Calendar Years 1960–98." 2000. www.hcfa.gov

HCFA, Office of the Actuary. "Table 9: Personal Health Care Expenditures, by Type of Expenditure and Source of Funds: Selected Calendar Years 1991–98." 2000. www.hcfa.gov

KASSNER, E. *Medicaid Financial Eligibility for Older People: State Variations in Access to Home and Community-Based Waiver and Nursing Home Services*. Washington, D.C.: AARP, Public Policy Institute, 2000.

KASSNER, E., and BECTEL, R. W. *Midlife and Older Americans with Disabilities: Who Gets Help?* Washington, D.C.: AARP, Public Policy Institute, 1998.

Lewin-VHI, Inc. *National Study of Assisted Living for the Frail Elderly: Literature Review Update*. Washington, D.C.: U.S. Department of Health and Human Services, Office of the Assistant Secretary for Planning and Evaluation and Administration on Aging, 1996.

"Long-Term Care Insurance Special Report: How Will You Pay for Your Old Age?" *Consumer Reports* (October 1997): 35–50.

LUTZKY, S.; ALECXIH, L. M. B.; DUFFY, J.; and NEILL, C. *Review of the Medicaid 1915c Home and Community Based Services Waiver Program Literature and Program Data: Final Report*. Washington, D.C.: Health Care Financing Administration, 2000.

MOLLICA, R. *State Assisted Living Policy: 2000*. Portland, Me.: National Academy for State Health Policy, 2000.

MUNSON, M. L. *Characteristics of Elderly Home Health Care Users: Data from the 1996 National Home and Hospice Care Survey*. Hyattsville, Md.: National Center for Health Statistics, 1999.

MURTAUGH, C. M.; KEMPTER, P.; SPILLMAN, B. C.; and CARLSON, B. L. "The Amount, Distribution, and Timing of Lifetime Nursing Home Use." *Medical Care* 35, no. 3 (1997): 204–218.

NAC/AARP (National Alliance for Caregiving/ American Association of Retired Persons). *Family Caregiving in the U.S.: Findings from a National Survey*. Bethesda, Md., and Washington, D.C.: NAC/AARP, 1997.

NADSA (National Adult Day Services Association). "Adult Day Services Fact Sheet." 2000, www.ncoa.org

O'KEEFE, J. *People with Dementia: Can They Meet Medicaid Level-of-Care Criteria for Admission to Nursing Homes and Home and Community-Based Waiver Services?* Washington, D.C.: AARP, Public Policy Institute, 1999.

LONG-TERM CARE AND WOMEN

Many older persons today are healthier, better educated, and wealthier than earlier generations. Still, a significant number of older persons are economically and physically vulnerable—especially older women.

Long-term care is, in essence, a women's issue. This is because it is predominantly women who need care and provide care. Women make up 75 percent of all nursing home residents age sixty-five and older. Two-thirds of consumers who receive home-care services are women, and nearly two out of three prescriptions are filled out for women. Women have a greater likelihood of suffering from illness or disability than men, and women are overwhelmingly the caregivers

for relatives and friends who need assistance with daily activities in the home.

Several factors contribute to the increased vulnerability of women as they age. For one thing, women have a longer life expectancy than men, about seven years. Women who reached age sixty-five in the year 2000 could expect to live an average of nineteen more years, compared to thirteen years for men. Women make up 72 percent of the population age eighty-five and older. Because women live longer than men, nearly four out of five people age eighty-five and older who receive help for two or more disabling conditions are women.

Secondly, many older women live alone. This occurs because women often outlive their husbands, while their children live in different communities and their families are scattered. In 1998, nearly 60 percent of women age sixty-five and older were either widowed, divorced, or had never married, compared to 25 percent of older men. Widows in 1998 outnumbered widowers four to one (8.4 million widows, 2 million widowers.) Of the elderly widows, seven in ten lived alone.

An additional factor is that women often have lower incomes than men. Being able to live an independent life depends on having enough income to meet needs. Women age 65 and older are twice as likely to be poor as are older men. According to an AARP study on the impact that pay inequality and segregation in low-paying jobs have on the retirement income of women, "by the time women are in their fifties, they have spent fewer years working, have earned less over their lifetimes, and have held lower quality jobs than similar-aged men" (Mitchell et al.).

High costs of long-term care

Long-term care is costly. In 1999, the average annual cost of care in a nursing home was $56,000. Persons of moderate income and limited savings can exhaust their money if they pay out-of-pocket for nursing home care, and they then must turn to Medicaid, the federal-state program that pays for medical care for poor people. Medicaid covers the costs of nursing-home care for poor people or for people who become impoverished as a result of paying nursing-home bills.

In 1997, of the 1.5 million elderly nursing-home residents, about three-fourths were women with a mean age of eighty-five, according to data from the 1997 National Nursing Home Survey (see Gabrel, 2000). The survey reported that 38 percent of women nursing-home residents had Medicaid as their primary source of payment when they entered the nursing home, but the care of about 57 percent of women residents was paid for by Medicaid.

Senior housing called *assisted living* has rapidly become an alternative to nursing homes for people who need only assistance with daily activities like bathing and dressing, rather the skilled nursing and around-the-clock care of a nursing home. But assisted living can cost as much as $2,000 or $3,000 a month.

Home care can be very costly as well—the average cost of a home-care visit in 1998 was $77. Consider the situation of an eighty-two year-old woman who lives alone and fractures her hip. Medicare will pay for much of her hospital stay, but will pay for only a short stay in a nursing home if she needs rehabilitation before she can go home. At home, she might qualify for limited home health care, paid for by Medicare, but soon she will face paying out-of-pocket if she needs the help of a home-care aide to bathe and dress or to clean house and shop.

Women age sixty-five and older who are Medicare beneficiaries still face high out-of-pocket costs, averaging $2,520 a year in 1999—or about 20 percent of income, on average. This compares to $2,320 in out-of-pocket costs (17 percent of income) for older men.

Married women, who are more likely to outlive their husbands than vice versa, must also face the prospect that a couple's joint income could be severely depleted if a husband enters a nursing home, where costs can quickly eat up their income and savings. A wife will not be forced to sell their house to pay her husband's nursing home bills, however. In 1988, Congress enacted provisions, as part of the Medicaid law, that prevent a spouse from becoming impoverished when one member of a couple enters a nursing home. These provisions are known as *spousal impoverishment protection*. If a wife remains at home when her husband enters a nursing home, she is able to retain about half the family's assets, up to about $87,000 and up to about $2,175 a month of income (in 2001). The amounts are indexed each year for inflation.

Long-term care insurance may be an option to protect oneself against the high costs of long-

term care services. However, long-term care insurance premiums increase with age and so must be initiated well before individuals may perceive a need for coverage. While a fifty-five year-old in the year 2000 might pay $1,500 a year for comprehensive benefits, a person who first purchases coverage at age seventy-five might pay $5,000 to $6,000 a year. In addition, even if she can afford a policy, an older woman with a pre-existing condition or disability may not be able to get coverage at all.

These numbers tell us that because of their longer lives and the high costs of care, older women face the prospect that an illness or a disabling condition can thrust them into difficult circumstances, or even into poverty. Their ability to continue living an independent life can thus be threatened. As they grow older, they are more likely to need long-term care services, and their ability to pay for such services becomes more uncertain.

The challenges of caregiving

More than seven out of ten unpaid caregivers are women. A 1996 national telephone survey conducted by the National Alliance for Caregiving and AARP showed the considerable burdens of caregiving on older women. The study reported that the average age of caregivers was forty-six, with about one in four caregivers being between fifty and sixty-four. More than one in ten of the caregivers was sixty-five or older.

Caregiving involves a range of activities, from helping a family member every day with bathing, dressing, and eating to providing transportation to a doctor or paying bills and handling other financial matters. Almost half of all the caregivers surveyed provided at least eight hours of care a week. Women caregivers made up almost four-fifths of the caregivers providing more than forty hours a week of care.

The future

Advances in public health and medical technology promise more productive and independent lives for all Americans in the future. Women, in particular, should benefit from potential breakthroughs in treating osteoporosis, arthritis, Alzheimer's disease, and stroke. However, these advances may well push the cost of health care and long-term care even higher, which could limit access to services for many women. It is clear that the future will continue to present major challenges to women to stay healthy and independent as they age, to find the resources to assist them if they need long-term care services, and to balance the demands of caregiving with their own needs.

BARBARA J. COLEMAN

See also CAREGIVING, INFORMAL; ECONOMIC WELL-BEING; LONG-TERM CARE FINANCING; LONG-TERM CARE INSURANCE; MEDICAID-MEDICARE; WIDOWHOOD.

BIBLIOGRAPHY

CHOUDHURY, S., and LEONESIO, M. V. "Life-Cycle Aspects of Poverty Among Older Women." *Social Security Bulletin* 60, no. 2 (1997): 17–36.

COSTELLO, C. B.; MILES, S.; and STONE, A. J., eds. *The American Women: 1999–2000*. New York: W. W. Norton & Company, 1998.

GABREL, C. S. "Characteristics of Elderly Nursing Home Current Residents and Discharges: Data from the 1997 National Nursing Home Survey." Advance Data, no. 312. Hyattsville, Md.: National Center for Health Statistics, 2000.

GIBSON, M. J., and BRANGAN, N. "Out-of-Pocket Spending on Health Care by Women Age 65 and Over in Fee-For-Service Medicare: 1998 Projections." In *Public Policy Institute Fact Sheet* (FS72). Washington, D.C.: AARP, 1998.

GIBSON, M. J., and FOLEY, L. "FYI: Out-of-Pocket Spending on Prescription Drugs by Women and Men Age 65 and Older: 1999 Projections." In *Public Policy Institute FYI*. Washington, D.C.: AARP, 2000.

MITCHELL, O.; LEVINE, P. B.; and PHILLIPS, J. W. "The Impact of Pay Inequality, Occupational Segregation, and Lifetime Work Experience on the Retirement Income of Women and Minorities." *Public Policy Institute Issue Paper* (#9910). Washington, D.C.: AARP, 1999.

National Alliance for Caregiving/AARP. *Family Caregiving in the U.S.: Findings from a National Survey*. Washington, D.C.: NAC/AARP, 1997.

SMEEDING, T. M.; ESTES, C. L.; and GLASSE, L. "Social Security Reform and Older Women: Improving the System." *Income Security Policy Series Paper,* no. 22. Syracuse, N.Y.: Syracuse University Center for Policy Research, 1999.

SPRAGGINS, R. E. "Women in the United States: A Profile." *Current Population Reports*. Washington, D.C.: U.S. Bureau of the Census, 2000.

Elderly people dance outside the Cheshire Home for the Aged in Nairobi, Kenya in May 1999. As traditions change, older adults who used to be taken care of within the Kenyan family structure are having to make other living arrangements; with nearly 800,000 elderly Kenyans living without family support, facilities such as Cheshire Home have become more common. (AP photo by Sayyid Azim.)

U.S. Bureau of the Census. "Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995 to 2050." *Current Population Reports,* Series P-25, No. 1130. Washington, D.C.: U.S. Bureau of the Census, 1996.

LONG-TERM CARE AROUND THE GLOBE

The rate of population aging across developed countries varies considerably. For example, in the year 2000, the percentage of the total population age sixty-five and older was higher in Japan (17.1 percent), Germany (16.4 percent), the United Kingdom (16 percent), and France (15.9 percent) than in Canada (12.8 percent), the United States (12.5 percent), Australia (12.1 percent), and New Zealand (11.6 percent). By the year 2020, Canada, the United States, Australia, and New Zealand will catch up to or slightly surpass Japan, Germany, France and the United Kingdom in this regard. Meanwhile, population aging in Germany, France and the United Kingdom is anticipated to progress to the point where, as of 2020, one in five—and, in Japan, one in four—citizens will be in this age group. These and other differences in the extent and pace of population aging across developed countries may explain why the countries with the oldest and/or more rapidly aging populations (including Germany, Japan, and the United Kingdom) have given high political priority to reforming their long-term care financing and service delivery systems.

The central challenge facing policymakers seeking to reform their long-term care systems, is, according to many experts, striking a balance in the provision of long-term care for the elderly between the family, the marketplace, and the state. To understand why this is such a difficult task, it is useful to review the evolution of long-term care systems in developed countries.

History of Long-Term Care

Historically, long-term care for the elderly has been viewed as predominantly an individual and family, rather than a governmental responsibility. The role of government (and/or the

church) was residual, insofar as communities felt obliged to offer charitable assistance to destitute elders who did not have a family to take care of them. Until 2001, some European countries (e.g., Germany) continued to require financial contributions from adult children if elderly parents were admitted to institutional care. The United States and the United Kingdom continue to maintain the primacy of personal financial responsibility for long-term care by requiring elderly disabled persons to spend-down their own income and assets paying for care in nursing homes, and by means-testing access to home-delivered social support (as distinct from home-delivered nursing care, which is covered under medical insurance).

Within the family, eldercare has traditionally been defined as "woman's work," along with child-drearing and homemaking. Although more affluent households traditionally had domestic servants to help with these tasks, most home care was provided by female family members. The difficulty of assigning a monetary value to such nonmarket labor, especially in the context of shared living arrangements and pooling of household income and assets, had the unfortunate consequence of creating something of a societal blind spot with respect to recognizing the extent to which society has relied upon such informal eldercare. Nor can understanding the economic and political consequences if the availability and adequacy of this resource could no longer be taken quite so much for granted.

Even as economists have become more willing to try to estimate the monetary value of informal eldercare, they have debated how to do so. Should informal be valued at the average hourly wage rate of home care workers (which, in the United States is only slightly above the statutorily mandated minimum wage)? Or—given that a large number of working age women are now employed outside the home—should the value of informal elder care be measured in terms of the "opportunity cost" (i.e., the pay and benefits a particular woman forfeits when she leaves employment or reduces her hours of paid work to provide informal eldercare)? In Europe and Japan, public policy around long-term care is increasingly being evaluated in terms of the potential effect on women's labor force participation. Thus, policies favoring care at home rather than in residential facilities are subject to criticism for reinforcing traditional expectations that women will stay at home to provide informal eldercare.

In pre-industrial societies, the availability, ability, and willingness of family to provide whatever eldercare might be needed is largely taken for granted. Pre-industrial societies include ones that existed in the historical past of the United States, Western European and Japan as well as contemporary societies in developing countries. In these kinds of societies, people often live their entire lives close to where they were born; families tend to be large; whether they live in extended family households or in nuclear families, they live near other family members. Very few elders, disabled or nondisabled, live alone in pre-industrial societies. Among Western countries, the percentage of elderly living alone can serve as a proxy indicator of a country's level of economic development and how long ago the country made the transition from developing to developed. Thus, in Denmark and Sweden 42 and 41 percent, respectively, of older persons live alone as compared to 17 to 19 percent in Spain, Greece, and Portugal.

Cultural values favoring shared living arrangements were powerful enough to sustain the behavioral norm in Japan until well into a highly advanced stage of economic development. Nevertheless, the prevalence of extended family living arrangements in Japan has been declining and the rate of decline has accelerated in recent years. A shift toward nuclear family living arrangements is also occurring in Korea and other Asian countries undergoing rapid economic development.

The process of economic development everywhere is associated with decreased fertility rates and greater longevity. These demographic changes have significant consequences for elder care. The U.S. Census Bureau suggests that the ratio of people aged eighty and older per one hundred people aged fifty to sixty-four is a useful measure of the potential pressure on middle-aged persons to provide care to a parent generation which has reached the age when need for long-term care becomes increasingly likely. In South America, Eastern Asia, and Western Europe, this parent support ratio doubled between 1950 and 2000. The most pronounced changes occurred in the industrialized countries, twelve of which had parent support ratios of twenty or higher as of 2000 (although two less highly developed countries, Israel and Uruguay, also had similarly high ratios). The parent support ratio is expected to rise in most countries of the world between 2015 and 2030. However, Western Afri-

ca experienced little change in the parent support ratio over the past fifty years and the aggregate level is expected to remain low in 2030 despite rapid growth in absolute numbers of elders eighty and older.

Childlessness also becomes more common with economic development. Urbanization and other patterns of mobility or migration (such as immigration from less to more developed countries) may have much the same effect as childlessness if the geographic separation between adult children and elderly parents precludes reliance on informal eldercare.

Unlike most other developed countries, the United States underwent a privatization of residential eldercare beginning in the 1930s. This occurred as an outgrowth of reform efforts to close down county-run homes for the aged, many of which were rather Dickensian. Laws were enacted that shifted the financial burden of providing for the poor elderly away from local governments onto the states and the federal government and prohibited payments from going to public institutions. What American reformers intended was to encourage the placement of disabled elders in foster family settings, but what they actually did was to stimulate the growth of proprietary nursing homes. In most other countries, however, local government authorities and churches continued to build and operate most homes for the aged. Private, for-profit nursing homes did not appear until much later in the United Kingdom, and in most European countries they never developed.

Starting in the 1950s in the United States and somewhat later in other countries, residential eldercare facilities found themselves experiencing a different sort of demand than they were used to. Instead of catering almost exclusively to poor older adults without family caregivers, many of whom were only mildly or moderately disabled, residential facilities began to admit residents who were older (on average), had multiple chronic illnesses, and were more functionally dependent. Moreover, many of these elders and their families also had some (though not always enough) capacity to pay for care. In addition, many elders now sought admission to residential care not because they lacked grown children or other relatives to provide care, but because their families felt unable to give them the level of care required. This was largely because advances in medical science enabled more people to live to age eighty and beyond, when the risk of disabling illness (e.g., Alzheimer's) increases significantly, and because better medical care enabled more elders with chronic illnesses to stay alive longer, even as their functional status continued to deteriorate. During this same period, however, improvements in social welfare protections—especially Social Security, private pensions, and the availability of public assistance payments for the elderly—as well as rising standards of living for all members of society (i.e., better housing stock, transportation services, the rapid spread of electric lighting, running water, indoor plumbing, and telephone service) made it possible for growing numbers of low-income elderly persons to live alone outside of institutions, even with a certain amount of functional disability.

Because of these countervailing trends, it is surprisingly difficult to determine whether, or to what extent institutionalization rates of elderly persons actually increased. One U.S. government study (ASPE, 1981) examined census data from 1890 to 1980 and concluded that the age-adjusted percentage of elderly persons residing in institutions and group quarters had remained remarkably constant throughout most of the century. The only age group in which the use of residential eldercare clearly had increased was among those ages eighty and older, a phenomenon attributed to longer life expectancies among less-healthy elders resulting from improvements in medical care. In the United States, it appears that the percentage of elderly persons residing in institutions and group quarters during the twentieth century has probably never been much under 4 percent or much above 6 percent. Questions of definition (what kinds of facilities should be included in the count) and measurement error make more precise estimates impossible.

What is more certain is that the character of long-term institutional care began to change dramatically around 1950 when the percentage of medically oriented care facilities (nursing homes) rose and the percentage of social welfare facilities (homes for the aged) fell. The medicalization of residential eldercare was swift and dramatic in the United States, perhaps because privatization made facilities more responsive to market forces. Although medicalization was well underway before the passage of Medicare and Medicaid in 1965, the eligibility of nursing homes for this new medical insurance coverage accelerated the trend. In many European countries and in Japan, however, as medical insurance coverage

became available, it typically excluded eldercare facilities, which were mostly local public institutions, because these were viewed as part of the social services system. As a result, these welfare facilities were often very slow to adapt to change. Indeed, some barely modernized at all (in France, this eventually emerged as a serious problem that the national government addressed systematically in the early 1980s). Meanwhile, elders with chronic disabling medical conditions were increasingly hospitalized for long stays, which were covered by national health insurance. Over time, national health plan administrators came to see the use of high-cost hospitals to provide institutional long-term care as an unacceptable financial burden, as well as an inefficient use of resources.

Trends in Long-Term Care

The nature of residential eldercare has once again begun to change. A newer model emphasizing the availability of personal-assistance services, rather than nursing, was promoted and the balance between these types of facilities and medically oriented nursing homes shifted. In Europe and Australia, these residential care settings are being developed primarily under public auspices (both with respect to financing and service delivery). The terminology varies; in Europe, they were often described as *supportive housing* arrangements and often consist of specially designed (handicapped accessible) complexes of private rooms and apartments, along with congregate dining facilities, multiple communal areas for socialization, and locations where nurses and other care personnel are permanently stationed. In the United States, the growth of what are called *assisted-living facilities* developed primarily in the private-pay marketplace when for-profit and not-for-profit developers identified and responded to an emerging consumer demand for this service from affluent elders and their families.

As governmental authorities above the local level (i.e., national, state, and provincial governments) have assumed a greater share of the costs associated with eldercare provided in inpatient facilities (especially long-stay hospital or nursing-home care), the societal visibility of residential care increased. The complex and changing roles of poverty, family relationships, chronic illness, and functional disability in explaining the use of residential eldercare has resulted in a great deal of confusion in the minds of policymakers, professional experts, and the public about when, if ever, care in such settings is truly necessary or appropriate. In opinion surveys, most respondents readily agree that disabled elders prefer to, and should be able to, obtain the long-term care they need at home.

There is also a private-pay market developing for the newer social models of residential eldercare in some countries (e.g., assisted living in the United States, hostels in Australia). These facilities appeal to elders and families when it is clear that it is no longer possible for an elder to live alone safely, even with substantial amounts of formal and informal help. Governments in many countries are responding to this phenomenon by differentiating between payments for care and payments for accommodation. Increasingly, the care component is publicly funded, without means-testing, but residents are expected to pay room and board costs out of their own income and savings. However, low-income elders who cannot afford to pay all of the accommodation fees can apply for means-tested public assistance to cover the shortfall. This pattern now prevails in Germany and France for all forms of residential long-term care and in Australia for social model facilities (hostels, as distinct from nursing homes). Another common pattern is to require residents of care facilities to contribute most of their Social Security pension income toward the cost of care (in Canada, this is referred to as the user fee) with the remainder of the cost being borne by public programs (although residents may also have to pay supplemental charges from private income and savings for private rooms and other amenities and services). In the United States, there is growing interest in states to cover the care component of assisted-living facilities for low-income individuals under Medicaid, but not the room and board component, which federal Medicaid law prohibits.

Nevertheless, most disabled elders who need long-term care continue to receive it at home, and most functional assistance is still being provided by family caregivers. Institutionalization rates for older adults in eight developed countries (United States, United Kingdom, Australia, Canada, New Zealand, France, Germany, and Japan) are estimated to range between 5 and 7 percent of the total elderly adult population. Since the 1960s, the use of formal home care (primarily as a supplement to family care) has increased. Use rates of formal home care among

the population age sixty-five and older in these same eight countries are estimated to range from a low of 5 to 5.5 percent in Japan and the United Kingdom to a high of 16 to 17 percent in Canada and the United States. In the United States, data from the 1982, 1989, and 1994 National Long-Term Care Surveys on use of formal home care by older Americans with chronic functional disabilities residing in the community show an increase from 25 to 35 percent. Virtually all of the increase was in use of paid care to supplement informal care; the percentage of disabled elders who relied exclusively on paid home care remained at about 5 percent.

Funding Concerns

It is a matter of intense interest to policymakers, and much debated among experts, as to whether or not increases in public funding for formal home care result in a decreased use of residential eldercare, especially nursing home and long-stay hospital care. Certainly, there is clear historical evidence from the United States that hospital stays can be shortened by investing in home-delivered nursing and home health-aide services. According to Jacobzone (2000), institutionalization rates for the elderly in five countries for which data are available suggest that rates decreased during the 1990s. The United States is one of the countries cited as having experienced reductions in nursing home use.

According to the most recent (1995–1997) National Nursing Home Survey (NNHS), the total rate of nursing home residence among the U.S. population age sixty-five and older declined from the previous 1985 NNHS. The age-adjusted nursing home residence rate was forty-five persons per one thousand age sixty-five and older in 1997, as compared to forty-five per one thousand in 1985. Among older Americans age sixty-five to seventy-four, and those age eighty-five and older, the nursing home residence rates declined 14 and 13 percent, respectively. The greatest decline in nursing home residence (21 percent) occurred among older Americans age seventy-five to eighty-four.

The nursing home component of the 1996 Medical Expenditures Panel Survey found that the supply of nursing home beds per one thousand elders age seventy-five and older decreased by 19 percent between 1987 and 1996. Moreover, the average nursing home occupancy rate declined from 92.3 percent to 88.8 percent. Both surveys also found that nursing home residents were, on average, older and more severely disabled.

On the face of it, these statistics might appear to confirm that the significant increases in spending (primarily by government programs) for home and community-based services which also occurred over the 1980s through the mid 1990s, had the desired effect of reducing institutionalization. However, this conclusion would be simplistic.

What accounts for the discrepancy between the 1985–1995/97 National Nursing Home Survey finding of a small decline in prevalence of nursing home use among Ameiican elders and the National Long-Term Care Survey measures which show no change in institutional use? The NNHS is a provider survey, which focuses only on use of a particular type of eldercare facility (i.e., federally certified and/or state licensed nursing homes. In contrast, the NLTCS is person-based; it characterizes living arrangements of individual sample members, who are classified as living either in the community or in institutional settings, which are not limited to nursing homes.

It is noteworthy that in 1987, Congress enacted legislation that changed the definition of a nursing home. Since 1972 nursing homes could be certified for Medicaid reimbursement either as skilled nursing facilities (SNFs) or intermediate care facilitics (ICFs). The principal difference in these two levels of care was in nurse staffing requirements. By about 1990, nursing homes had to meet the skilled care standard to qualify for Medicaid as well as Medicare coverage. Just about the time this change went into effect, a new form of residential eldercare called "assisted living" began to proliferate. The 1997 National Survey of Assisted Living Facilities (Hawes et al., 1999) found 11,472 assisted living facilities (ALFs), accommodating 558,400 residents. Fifty-eight percent of ALFs had been in existence for ten or fewer years.

In 1997, there were approximately 1.5 million nursing home residents. Thus, if the residents of nursing homes and assisted living facilities were added together, ALF residents represented about one fourth of the total. Clearly, whether the percentage of the U.S. elderly population residing in eldercare institutions is perceived to have declined, stayed the same, or actually increased from the mid-1980s through

the mid-1990s is a matter of defining what kinds of living arrangements or care settings should be classified as institutions. Are all congregate facilities that purposefully serve disabled elders institutions or are some better characterized as community housing with supportive services?

Various criteria for differentiating institutions from supportive housing—size, amount of medical or nursing care provided, and privacy of accommodations—have been suggested. None of these clearly resolve the status of ALFs.

An alternative to trying to classify individual ALFs as institutions or community living based on characteristics such as larger or smaller size, availability of nurses on staff, or prevalence of private rooms or apartments is to refrain from using the term "institution" because it is not clearly defined and has such pejorative connotations. If both nursing homes and ALFs are viewed more neutrally as forms of specialized residential care for disabled elders, it seems clear that the growth of ALFs has more than offset the decreased use of nursing homes. In any event, patterns in residential eldercare in the United States are different than they were in the last decades of the twentieth century. Facilities licensed and certified as nursing homes now provide more short term, post-hospital convalescent and rehabilitative care and also serve a more severely disabled long-stay population. Nursing homes also cater more to public pay (Medicare, Medicaid) residents, whereas assisted living facilities serve predominantly private payers.

As previously mentioned, a comparable movement away from nursing homes (or their equivalent) toward alternative forms of residential eldercare is underway in other developed countries. Experts in other countries also struggle with how to characterize these newer residential settings. Up to the late 1980s, there was agreement that most eldercare facilities in Europe, Canada, Australia, and New Zealand were, like facilities in the United States, institution in character. Generally speaking, the ratio of nonmedical to medical institutions was higher in Europe than elsewhere. The movement to deinstitutionalize eldercare facilities began and is most advanced in Scandinavia., especially Denmark, which in 1987 passed a law prohibiting construction of any new nursing homes. New types of sheltered housing have developed, which offer independent living, but combined with services and care to an extent, which makes it hard to distinguish them from modern, noncustodial institutions. This type of accommodation is, to an increasing extent, being substituted for traditional residential homes. Perhaps the key difference affecting development of alternative forms of residential eldercare in the United States as compared to other developed countries, is that in other countries the new forms are being developed exclusively or primarily in the public sector (usually at the municipal or local government level), whereas, in the United States the newer forms of residential care have been developed by private, for-profit firms and nonprofit organizations for a private-pay market.

A 2000 Israeli study for the World Heath Organization reviewed the findings from an evaluation of Israel's social insurance coverage for home care, as well as other international evidence about whether increased public funding (especially non–means-tested funding) decreased admissions to nursing homes. The study concluded that, in the short term, insurance coverage for home care may cause increased nursing-home admissions because more elders who actually do need this level of care are identified when they apply to receive services at home. In the longer term, use of residential care facilities by elders with mild to moderate functional disabilities has decreased, but the admission rate for severely disabled elders has not decreased.

While New Zealand's spending for community-based care grew fourfold during the 1990s, the percentage of elderly New Zealanders residing in residential eldercare remained constant. Other countries which formerly had higher rates of institutional eldercare compared to others, have succeeded in reducing those rates in large part by refusing to build new nursing home beds, even to keep pace with growth in the oldest-old or as replacements for beds in aging facilities that closed. Denmark appears to be the only country in which an actual (and impressively sizable) shift of resources out of the institutional sector into home care can be documented. Between 1982 and 1996, the percentage of Danes age eighty and older in institutions dropped from 20 to 12 percent and the institutional use rate among the Danish population age sixty-seven and older went from 6.6 percent to 4.6 percent. Over the same period, provision of home care was expanded to nearly one quarter of Danish elderly. Yet the percentage of GDP spent on long-term care in Denmark decreased from 2.6 percent in 1982 to 2.3 percent in 1994.

The United States, United Kingdom, and Germany have long had lower prevalence rates for institutional eldercare than most other developed countries. It is still not known whether the community care reforms implemented in the United Kingdom or the introduction of social-insurance financing for long-term care in Germany, both of which occurred in the early 1990s, will eventually yield significant reductions in residential eldercare. In the United States, a number of individual states have claimed reductions in nursing home use as a result of expanded Medicaid funding of home and community-based care. The state of Oregon is the best known example; however, a closer look reveals that most of the decline in nursing home use in Oregon is attributable to substituting other forms of residential eldercare (assisted living and adult foster care) rather than to the major expansion of Medicaid-funded home care that took place. Kane and colleagues (1998) concluded that Oregon's experience was that 2.6 people needed to be served in home and community-based settings (including alternative forms of residential care) in order to eliminate a single nursing home bed.

Policymakers in countries that have moved toward a social insurance model of funding both institutional and noninstitutional long-term care (e.g., Germany, Japan) have been less narrowly focused on reducing nursing home use and achieving net savings through public investments in home care. They also value outcomes not associated with cost savings, such as reducing the stress on informal caregivers and improving the quality of care and quality of life for disabled elders and their families. These goals are often best accomplished by providing services or larger amounts of services to address elders' unmet or undermet needs for assistance regardless of whether or not the care recipients might have been able to remain at home without or with less publicly funded home care.

Policymakers in most developed countries describe the purpose of increasing investment in home care as that of achieving a more appropriate balance between government spending on institutional and noninstitutional services. Nevertheless, policymakers everywhere are concerned with overall cost containment and cost efficiency in service provision. Thus, even the countries with the most generous funding for long-term care across the continuum of service types have moved toward greater selectivity, or targeting. In Denmark, success in reducing nursing home use is often credited to the development of 24-hour, rapid-response, emergency services.

Residential Eldercare versus Home Care

Most advanced industrial countries have chosen to provide more generous public funding for home care than for nursing homes and other forms of residential eldercare. The United States is unusual, however, in taking a more dichotomous approach toward financing home care services that are perceived to be skilled nursing, rehabilitation therapy, and home health-aide services, as opposed to home and community-based services delivered by unskilled personnel. The former are covered generously, whereas coverage for the latter is strictly means-tested and is often limited to individuals considered to be at imminent risk of permanent placement in nursing homes if the services are not provided. Analyses of data from the 1994 National Long-Term Care Survey found that Medicare home health services are used disproportionately by the chronically disabled elderly.

An international opinion poll across five English-speaking countries (Donelan et al., 2000) found that significantly greater percentages of U.S. and New Zealand elders who used home care reported that the government paid for it. Numerous other surveys of older Americans conducted during the 1990s indicate that Americans are greatly confused about the extent to which Medicare's home health and skilled nursing facility benefits provide them with coverage for long-term care.

Long-Term Care Reform

Many advanced industrial nations enacted significant and comprehensive long-term care financing and service delivery reforms during the 1990s. Through the first half of the 1990s, the dominant trend in the organization of systems of publicly funded long-term care was decentralization and consolidation of responsibility for all, or most, long-term care services at the local or state/provincial government level. National government involvement was generally limited to providing broad framework laws establishing the bases for entitlement to care (though not necessarily guaranteeing access to specific service types or amounts) and providing funds to other levels of government, most often in the form of

block grants. Local, state, and provincial governments were usually expected to bear at least some of the financial cost of providing long-term care services.

More recent reforms have taken the form of social insurance coverage. This model of long-term care financing (i.e., nationally uniform eligibility and coverage—funded exclusively or predominantly from national revenues—most often via a dedicated payroll tax) was previously quite rare (existing only in the Netherlands, in Israel for home care only, and in the United States for skilled home health services). In 1994 Germany introduced comprehensive social insurance for both nursing home and home and community-based services. Japan's new social insurance coverage for long-term care, patterned on the German model, went into effect in 2000.

Several countries (i.e., Austria, France) have also introduced long-term care allowances, which, when they are financed out of national revenues, establish a universal, disability-related entitlement to benefits, based on standardized eligibility and coverage criteria. This is also a social insurance model. In Germany and the Netherlands, cash payments, or *individual service budgets*, are an available option within a long-term care insurance system that also arranges for formal services to be provided by authorized service providers. One purpose of conceptualizing benefits in terms of monetary allowances is to provide for greater flexibility in service options so that care plans may be more individualized. Another goal, when individuals and families have control over how the allowances are spent, is to offer more freedom of choice and give more autonomy to elders and their families. Ideally, public financing should make it possible for formal services to substitute for the traditional reliance on family care when family care is not available, as well as make it possible for formal caregivers to supplement family care when the amount of care required is too much for family caregivers alone. However, government also has an interest in rewarding and supporting those families that are willing and able to provide all or most of the care a disabled elder requires.

Canada and the United States are among the few advanced industrial countries that have not had significant reforms of their long-term care financing and service delivery systems for many years. Canadian leaders appear not to want to change the basic organizational structure of their system, which is a federal/provincial partnership approach to financing and administering coverage for health care, including long-term care services, with primary administrative responsibility in the hands of the provinces and federal cost subsidization via block grants. Throughout the 1990s, a high national deficit forced the federal government to cut back on its financial support. As a result, there was little movement to expand access to home care, even though Canadian officials recognized that some cost-containment measures with respect to acute-care services (e.g., policies that drove down the average length of hospital stays) increased the need for in-home services.

In the United States, President Clinton proposed a major expansion of federal support for home and community-based supportive services in his 1993 plan for comprehensive health care financing reform. The Clinton proposals followed the then dominant international trend toward decentralization of responsibility for publicly funded long-term care services, but with increased cost sharing by the federal government. However, the Clinton health reforms were not enacted and, in any case, contentious debate over the proposals for acute-care financing reforms limited the extent of attention given to the long-term care aspects of the president's plan. Since 1993 the attention of U.S. policymakers has been kept focused on other health care financing and service delivery concerns, specifically the sizable minority of Americans without any health insurance coverage; the desire to provide at least basic coverage for children; the need to address the solvency of Medicare with respect to existing benefits; and extending Medicare coverage to prescription drugs.

Policymakers have not, however, ignored the long-term care needs of the elderly. Experimentation has been taking place in Medicaid at the state level with, on the one hand, various consumer-directed models of home and community-based service delivery, including giving beneficiaries the right to decide how to spend cash allowances, and, on the other hand, attempts to finance integrated packages of acute and long-term care services, via risk contracting, under which all services are provided by managed care organizations and beneficiaries give up freedom of choice in favor of more comprehensive coverage for themselves and lower costs to the government.

Canada offers extensive tax subsidies to persons with disabilities and their family caregivers. President Bush's 2002 budget proposed a tax subsidy somewhat different from President Clinton's previous proposal, limited to adult children or grandchildren who provide care in their homes to their older relatives. President Bush's budget also proposed giving individual taxpayers a tax incentive to purchase private long-term care insurance. For a time, it appeared that Democrats in Congress might vote for tax incentives for private long-term care insurance as long as they were packaged together with supports for caregivers. These initiatives are still under active consideration by the Administration and the Congress; however, the effects of economic recession and the September 11, 2001 terrorist attacks have at least deferred their possible enactment into law.

Since the 1980s, the private long-term care insurance market in the United States has grown rapidly, but it remains small. Small markets for private long-term care insurance have also developed in the United Kingdom and Germany (high-income Germans are permitted to opt out of the public insurance system in favor of private coverage). In the United States, experts on long-term care remain divided, and even the industry itself professes uncertainty about the extent of growth in the private long-term care insurance market that might reasonably be expected to occur as a result of tax subsidies intended to promote the purchase of lower-cost, employer-sponsored group policies at younger ages.

In sum, the U.S. population is aging even though the extent and pace of population aging in the United States puts less pressure on American policymakers than on those in other advanced industrial countries that are aging even more rapidly. In such countries there is a more urgent need to address the health and social services needs of growing numbers of elderly citizens. While the immediate future of long-term care policy reform in the United States is very difficult to predict, it appears unlikely that U.S. policymakers can continue to postpone the challenge of seeking a new balance in reliance on the family, marketplace, and state to meet the long-term care needs of the elderly population.

PAMELA DOTY

See also ASSISTED LIVING; FILIAL OBLIGATIONS; NURSING HOMES.

BIBLIOGRAPHY

ANDERSON, G. F., and HUSSEY, P. S. "Population Aging: A Comparison among Industrialized Countries." *Health Affairs: How the World is Coping* 19, no. 3 (2000): 191–203.

BENJAMIN, A. E. "Consumer-Directed Services at Home: A New Model for Persons with Disabilities." *Health Affairs: Chronic Care in America* 20, no. 6 (2001): 8095.

BRODSKY, J.;, HABIB, J.; and MIZRAHI, I. *Long-Term Care Laws in Five Developed Countries: A Review*. Jerusalem: JDC-Brookdale Institute of Gerontology and Human Development, World Health Organization, 2000.

CAMPBELL, J. C., and LKEGAMI, N. "Long-Term Care Insurance Comes to Japan. *Health Affairs: How the World is Coping* 19, no. 3 (2000): 26–39.

CUELLAR, A. E., and WIENER, J. M. "Can Social Insurance for Long-Term Care Work? The Experience of Germany." *Health Affairs: How the World is Coping* 19, no. 3 (2000): 8–25.

DAATLAND, S. O. "Adapting the 'Scandanavian Model' of Care for Elderly People." *Organization for Economic Cooperation and Development (OECD) Caring for Frail Elderly People: Policies in Evolution*. Social Policy Studies No. 19. Paris: OECD. 1996.

Department of Health, United Kingdom. *The NHS Plan: The Government's Response to the Royal Commission on Long-Term Care*. CM4818-11. July 2000.

DOTY, P. "Long-Term Care in International Perspective." *Health Care Financing Review*. Annual Supplement. (1988): 145–155.

DOTY, P. "The Federal Role in the Move Toward Consumer Direction." *Generations* 2000. 24, no. 111 (2000): 22–27.

Federal Interagency Forum on Aging Related Statistics. *Older Americans 2000: Key Indicators*. Washington, D.C.: Author, 2000.

GERAEDTS, M.; HELLER, G. V. ; and HARRINGTON, C. A. "Germany's Long-Term-Care Insurance: Putting a Social Insurance Model into Practice." *The Milbank Quarterly* 78 (2000): 375–401.

HABER, C. *Beyond Sixty-Five: The Dilemma of Old Age in America's Past*. Cambridge: Cambridge University Press, 1983.

HAWES, C.; ROSE, M.; and PHILLIPS, C. D. *A National Study of Assisted Living for the Frail Elderly. Results of a National Survey of Facilities. Prepared for the Public Policy Institute, AARP, and the U.S. Department of Health and Human Services*. Washington, D.C.: U.S. Department of Health and Human Services, 1999.

HOWE, A. "Rearranging the Compartments: The Financing and Delivery of Care for Australia's Elderly." *Health Affairs* 19, no. 3 (2000): 57–71.

IGLEHART, J..K. "Family, Marketplace, and the State: Striking a Balance." *Health Affairs: How the World is Coping* 19, no. 3 (2000): 6–7.

JACOBZONE, S. "Coping with Aging: International Challenges." *Health Affairs: How the World is Coping* 19, no. 3 (2000): 213–226.

KANE, R. A.; KANE, R. L.; and LADD, R. C. *The Heart of Long-Term Care*. New York: Oxford University Press. 1998.

KINSELLA, Kz., and VELKOFF, V. A. *An Aging World: 2001*. Washington, D.C.: U.S. Government Printing Office, 2001.

MERLISZ, M. "Caring for the Frail Elderly: An International Review." *Health Affairs: How the World is Coping* 19, no 3 (2000): 141–149.

RHOADES, J. A., and KRAUSS, N. A. *Nursing Home Trends, 1987 and 1996*. Rockville, MD: Agency for Health Care Policy and Research, 1999.

SCHNEIDER, U. "Germany's Social Long-Term Care Insurance: Design, Implementation, and Evaluation." *International Social Security Review* 52, no. 2 (1999): 31–74.

SPILLMAN, B. C. *Changes in Elderly Disability Rates and the Implications for Health Care Utilization and Cost*. Washington, D.C.: U.S. Department of Health and Human Services, 2002.

SPILLMAN, B., and PEZZIN, L. E. "Potential and Active Family Caregivers: Changing Networks and the 'Sandwich Generation.' "*The Milbank Quarterly* 78, no. 3 (2000): 347–374.

TILLY, J.; WIENER, J. M.; and CUELLAR, A. E. "Consumer-Directed Home and Community-Based Services Programs in Five Countries: Policy Issues for Older People and Government." *Generations* 24, no. 111 (2000): 74–84.

WAIDMANN, T. A., and MANTON, K. G. *International Evidence on Disability Trends among the Elderly*. Washington, D.C.: U.S. Department of Health and Human Services, 1998.

WALSHE, K. "Regulating U.S. Nursing Homes: Are We Learning from Experience?" *Health Affairs: Chronic Care in America*. 20, no. 6 (2001): 128–144.

LONG-TERM CARE ETHICS

Long-term care decisions arise for elderly individuals and their families when the elder is no longer able to live independently. The loss of capacity for independent living is typically caused by changes in health that result in a decreased ability to care for oneself in the activities of daily living, such as cooking, eating, bathing, and toileting. These changes in health status can include dementia, paralysis resulting from stroke, or blindness. Rosalie Kane and Robert Kane, two of the world's leading authorities on long-term care, define it as "a set of health, personal care, and social services delivered over a sustained period of time to persons who have lost or never acquired some degree of functional capacity" (Kane and Kane, p. 4).

Long-term care decisions concern where the elder will live and what level of support he or she needs. Living options include staying in one's own home (with more support), moving in with one's relatives, such as children or siblings; or moving to a retirement center, group home, or nursing home. Support options include day care; services delivered to the elder in his or her home, such as meals-on-wheels; home services provided by family members (*informal caregivers,* in the language of gerontology); and home services provided by *formal caregivers,* such as visiting nurses. The range of services actually available to an elder will depend on his or her financial resources, as well as those of family members, and eligibility for public and private long-term care services and programs. Long-term care decisions should, therefore, not be equated with a decision to move from the elder's home to a nursing home.

Most long-term care services are provided to elders in the community setting by their family members. The common belief that older adults with long-term care needs are abandoned by their families to nursing homes is a myth with no foundation in fact. Families usually go to considerable lengths to provide these services as informal caregivers, often making significant personal, physical, psychological, and financial sacrifices in the process. These services can include preparing meals, regular visits to check on the elder's well-being and safety, and assisting with the activities of daily living—either in the elder's own home or in the family member's own home. These informal caregivers tend to be women who were in the workforce before the elder's long-term care needs led to the caregiving role. Under federal law, there is a limited period of time that employees can take unpaid time off from work to care for an elderly family member without risk of losing their jobs. In order to replace lost income, either from unpaid time off or reduced hours of work, the husbands of these women (if they are married) and teenage chil-

dren in the household often seek additional or new employment. Thus, the provision of long-term care by informal caregivers is both direct and indirect in its impact on families.

Long-term care decisions are made under constraints imposed by public policy regarding the public funding of long-term care services. These constraints concern eligibility for funding of long-term care services, especially those supported with local, state, and federal tax monies. There is an ongoing debate about whether these constraints satisfy the ethical requirements of various concepts and theories of justice.

Ethical issues in long-term care decision-making

A number of ethical issues arise in the long-term care decision-making process, no matter the policy constraints on that process. The order in which these issues are presented here should not be regarded as a temporal order. The complexity and urgency of long-term care decision-making mean that these issues can arise in any order and that the order in which they do arise is usually not under anyone's control.

The first ethical issue in long-term care decision-making concerns the nature and significance of the elder's diminished capacity for self-care and independent living. Older adults and their family members may not agree on the seriousness of an event, such as a fall from which an elder takes several hours to get up from the floor and call for help, or a fire in the kitchen caused by a cooking pot left on a lit burner on the stove. The elder may interpret such events as minor in nature, whereas a daughter summoned to an emergency room or by a fire department may think that the event is quite serious. They may also not agree on whether such events mean that a change in the elder's living arrangements (location and level of support) is needed. The elder may think that he or she can continue to live at home alone or to cook for himself or herself without supervision.

The second ethical issue concerns whether an older adult should continue to live at home. For elders who are married, this option can raise serious questions about the ability of the spouse to provide informal long-term care services. The elder's spouse may be ill or have significant reduced functional status—he or she may be too frail to help with such activities as moving from the bed to bathroom or even helping to lift his or her spouse into a sitting position. Adult children may have major responsibilities within their own families, e.g., taking care of their own children and providing financial security for them. Such circumstances raise the issue for informal caregivers of setting ethically justified limits on their obligation to provide informal long-term care services.

This is an important ethical issue, because many family members see only two alternatives: doing everything, which may be beyond their ability, or doing nothing, which may make them feel hard-hearted and selfish. There is a large middle ground that has two ethical bases. The first is setting limits based on the need to fulfill obligations to others, such as one's own children. The second is setting limits based on legitimate self-interest, such as avoiding the predictable and preventable loss of one's own health from the physical demands of long-term caregiving.

A third, and directly related, ethical issue concerns the obligation of the elder to recognize and respect the limits that family members may justifiably set on their caregiving responsibilities. This obligation is based on the general obligation that all of us have to avoid harming others without their agreement. This obligation means that none of us has an unlimited claim on the time, attention, energy, or resources of another individual. Elders with long-term care needs are no exception.

These two ethical issues—setting limits by family members and the elder's obligation—need to be negotiated by elders and their family members in the context of the long-term care needs of the elder and the available options for meeting those needs. Setting such limits is a matter of careful reflection and considered judgment; there is no ready formula for identifying precisely where to set limits. A major responsibility of health care and social-service professionals involved with older adults and their family members in long-term care decision-making is to help them negotiate these limits in ways that are acceptable to the involved parties.

A fourth ethical issue arises when the decision is made to change either the elder's place of living or support services—but especially the former. Any such change means a loss of autonomy. This loss can involve major "either-or" matters, such as whether to leave one's home of many years and move to a nursing home. These have

been called *nodal* decisions. This loss can also involve smaller, more everyday decisions such as maintaining one's privacy or having one's favorite possessions ready to hand, which have been called *interstitial* decisions. The nodal decisions of long-term care tend to receive the most attention—with interstitial decisions often neglected—especially when long-term care decisions are urgent, as they can become after a prolonged, unexpected hospitalization. In order to respect the elder's autonomy in its full dimensions, and therefore to maintain the elder's dignity, the long-term care decision-making process should consider relevant interstitial decisions that are implicated in nodal decisions. Thus, if it is agreed that an older adult will move from his or her own home to the home of an adult child, many interstitial decisions remain to be made, such as the time for meals, starting and ending one's day, and respecting the privacy of all members of the family.

A fifth ethical issue concerns the balance to be struck between independence and safety, which can sometimes be understood to be mutually exclusive. Family members and health care professionals can tend to give priority to safety, especially after serious health- or life-threatening events such as wandering out into a busy intersection. Elders, it will come as no surprise, tend to give priority to independence. The conflict between safety and independence is one of the defining ethical features of long-term care decision-making.

Bart Collopy (1995) has suggested a very useful way to respond to the potential for conflict between independence and safety: they should not be seen as mutually exclusive but as the endpoints of a continuum. Safety involves not just physical safety, but also psychological safety. Thus, staying in one's home may risk physical safety but protect, and even enhance, psychological safety. Independence depends to a considerable degree on one's health status, and unnecessary loss of health can and does lead to loss of independence. Both safety and independence have health, psychological, and social components, so it does indeed make conceptual and practical sense to see them in terms of a continuum of ethical concern rather than an "either-or" forced choice in which one of the two will be protected only by sacrificing the other. The response to potential conflict between the two should therefore be, first, to recognize their complex nature and how they often overlap, and, second, to negotiate compromise in which both concerns are protected, though in a balanced fashion. It will be important in some cases for family members to appreciate the importance of sacrificing physical safety in order to protect psychological safety and a sense of independence. It will be as important in other cases for the elder to appreciate the need to preserve physical safety and health as the only way to protect remaining independence from further preventable loss.

Long-term care decision-making, in its ethical aspects, should be understood in terms of a process of mutual decision-making by elders and family members, with the support of health and social-service professionals when they are involved. There is no algorithm into which the ethical issues identified above can be "plugged," with the answer simply "cranked out." The ethical issues involved in long-term care decision-making are matters for negotiation and, often, complex compromises by elders and involved family members. Long-term decisions should, therefore, not be regarded as permanent. Moreover, the health and social factors that shape long-term care decision making can change. The elder's condition can change, either for the worse or the better. The ability or willingness of informal caregivers to continue to provide informal long-term care services can change, and policy constraints can also change. As a consequence, elders, involved family members, and health care and social-service professionals should all appreciate that any long-term care arrangement decided upon involves a trial of a change in where the elder lives and/or the level of support. The durability of such a trial, by its very nature, cannot be known in advance. Thus, as circumstances change, it is sometimes necessary to repeat the long-term care decision-making process in response to changed circumstances. This reality is often a source of frustration and distress for elders and family members alike, calling for sustained support by professionals, especially those involved in provisions of formal long-term care services.

LAURENCE B. MCCULLOUGH

See also AUTONOMY; COMPETENCY; DEMENTIA; FILIAL OBLIGATION; FUNCTIONAL ABILITY; HOME CARE AND HOME SERVICES; LONG-TERM CARE; PARENTAL OBLIGATIONS.

BIBLIOGRAPHY

AGICH, G. J. *Autonomy and Long-Term Care*. New York: Oxford University Press, 1993.

CALLAHAN, D. *Setting Limits: Medical Goals in an Aging Society*. New York: Simon and Schuster, 1987.

COLLOPY, B. "Safety and Independence: Rethinking Some Basic Concepts in Long-Term Care." In *Long-Term Care Decisions: Ethical and Conceptual Dimensions*. Edited by Laurence B. McCullough and Nancy L. Wilson. Baltimore, Md.: Johns Hopkins University Press, 1995. Pages 137–152.

DANIELS, N. *Am I My Parents Keeper?* New York: Oxford University Press, 1988.

DANIELS, N. *Just Health Care*. Cambridge, U.K.: Cambridge University Press, 1986.

KANE, R. A., and CAPLAN, A. L., eds. *Ethical Conflicts in the Management of Home Care: The Case Manager's Dilemma*. New York: Springer Publishing Company, 1993.

KANE, R. A., and CAPLAN, A. L., eds. *Ethical Issues in the Everyday Life of Nursing Home Residents*. New York: Springer Publishing Company, 1990.

KANE, R. A., and KANE, R. L. *Long-Term Care: Principles, Programs, and Policies*. New York: Springer Publishing Company, 1987.

MCCULLOUGH, L. B., and WILSON, N. L., eds. *Long-Term Care Decisions: Ethical and Conceptual Dimensions*. Baltimore, Md.: Johns Hopkins University Press, 1995.

LONG-TERM CARE FINANCING

The financing of long-term care services comes from a patchwork of funds from the federal, state, and local levels, and from private dollars, primarily paid from the consumer's own pocket. According to data from the Centers for Medicare & Medicaid Services (CMS), almost $115 billion dollars were spent on long-term care (not including Medicaid waiver expenditures) in 1997, with the majority (72 percent) covering nursing home care and institutions for people with mental retardation. Public resources (primarily Medicaid and Medicare) accounted for 62 percent of institutional coverage and 56 percent of home care. Other federal programs (funded by the Title 20 of the Social Security Act, Older Americans Act, and the Department of Veterans Affairs) accounted for less than 4 percent of total long-term care spending. Approximately one third of long-term care expenditures were attributable to out-of-pocket expenses, with private insurance covering only 5 percent of nursing home expenditures and perhaps as much as 11 percent of home and community-based expenditures (primarily medically oriented home health care).

Informal care

Estimates of formal spending for long-term care do not place a dollar value on the vast amount of unpaid care, including the value of wages foregone by family caregivers. The major long-term care provider is the family and, to a lesser extent, other unpaid *informal* caregivers. According to data from the 1994 National Long-Term Care Survey, more than seven million Americans—mostly family members—provide 120 million hours of unpaid care to older adults with functional disabilities living in the community. If these caregivers were paid, the cost would be between $45 billion and $94 billion a year.

The overwhelming majority of noninstitutionalized older adults with disabilities (about 95 percent) receive at least some assistance from family and friends. Approximately two-thirds rely solely on unpaid help, primarily from wives or daughters. As disability increases, elderly persons receive more informal care. Eighty-six percent of older adults at greatest risk for nursing home placement live with others and receive almost sixty hours of informal care per week, supplemented by a little over fourteen hours of paid assistance. Although reliable statistics are not available, many family members provide assistance to elderly relatives living in nursing homes, and others engage in long-distance caregiving—arranging for the care of a parent or other relative who lives far away.

Medicaid

Medicaid, the federal/state health insurance program for the poor, is the major public program covering long-term care for older adults. Elderly persons with low incomes and few assets (or those who deplete their assets paying for long-term care) are entitled to nursing home coverage and home health care, and, depending on state program rules, they may have access to home and community-based services. Since the mid-1970s, states have had the option to offer personal care services (assistance with activities of daily living such as bathing, dressing, and eating) under their Medicaid state plans. In 2000, twen-

ty-seven states offered this option to eligible older adults. In 1981, Congress authorized the waiver of certain federal requirements to enable a state to provide home and community-based services (other than room and board) to individuals who would otherwise require nursing home care. This allows states to fund a range of services, including case management, homemaker services, home health aide services, personal care, adult day health care, rehabilitation, and respite care to help keep older adults and younger people with disabilities out of institutions. All states have waiver programs which are subject to approval by CMS, the federal agency that administers Medicaid. In 2000 there were 242 such programs. It is important to note, however, that two-thirds of the 11 billion dollars in waiver services in 1999 were spent on people with mental retardation and developmental disabilities. The remaining third supported services for older adults, younger people with physical disabilities, and other populations.

Despite the public's tremendous interest in, and preference for, care in the home, Medicaid continues to exhibit a strong bias toward institutional care. Out of the 59 billion dollars spent by Medicaid on long-term care in 1997, a little less than one quarter was spent on home and community-based services. Three quarters of the states devoted less than 15 percent of their long-term care resources to noninstitutional services, and in half the states the home and community-based share was less than 8 percent.

The home and community-based care sector, however, has experienced tremendous growth, with spending on these services increasing much faster than spending on nursing home care. Between 1993 and 1994, for example, total Medicaid spending for long-term care increased by just 9 percent, while spending for waivers and the personal care option benefit increased by 26 percent. Much of the growth in these services is due to the implementation and expansion of Medicaid waiver programs. A small but growing number of states are spending at least 20 percent of their long-term care resources on home and community-based services.

Several states, notably Oregon and Washington, have explicitly recognized nursing homes as the setting of last resort, and have intentionally reduced the number of nursing home beds. They have successfully used Medicaid waivers to place many elderly persons with serious disabilities in alternative assisted-living facilities and adult foster homes. Both states also use Medicaid dollars to support extensive care-management programs that help to keep many older adults in their own homes.

State and local funding

In addition to dollars that states use to match federal Medicaid expenditures (approximately 17 percent of all long-term care expenses in 1995), many states augment or create their own programs with state funds. Pennsylvania and New Jersey, for example, have relatively large home and community-based care programs supported mainly by lottery dollars. A number of local communities have also been successful in raising funds for long-term care services. Hamilton County, Ohio (the Cincinnati metropolitan area) supports services for older adults with disabilities through a county levy enacted under the leadership of the local Area Agency on Aging (AAA). In 1997, the AAA's Elderly Services Program spent 17 million dollars in levy funding for homemaker services, personal care, home-delivered meals, care management, adult day care, and transportation. This agency was able to convince both elderly and younger county residents that the levy for long-term care services was necessary, given the continuing cuts in federal funds, and that the dollars would benefit the entire community, not just older adults.

Medicare

Although not considered a major supporter of long-term care services, Medicare, the universal health insurance program for most older adults and a subgroup of younger people with disabilities, pays a substantial part of skilled nursing facility and home health care bills. The Medicare nursing home benefit is limited to one hundred days, post-hospitalization, for individuals who need continued skilled nursing care and/or skilled rehabilitation. Home health visits are limited to persons who need skilled nursing care on a part-time or intermittent basis. In 1998, 10 percent of total Medicare spending was attributed to nursing facility and home health care. Between 1990 and 1998, Medicare spending for care in skilled nursing facilities increased more than 500 percent and spending for home health care increased 250 percent.

In the mid-1990s, Congress began to express concern about the growth in spending on home

health care and about evidence that, due to liberal interpretations of definition and scope of service, Medicare was providing more long-term, nonskilled personal care than the program was intended to provide. There was also anecdotal and case-study evidence that providers participating in Medicaid home care programs were being encouraged by states to help their clients become eligible for Medicare home health benefits in order to reduce state costs for long-term care. Congress responded to these concerns by enacting provisions in the Balanced Budget Act of 1997 that significantly reduced payments to home health agencies, that cracked down on fraud and abuse, and that attempted to return the program to its post-acute care roots. Several studies indicate that this legislation has been successful in reducing the number of visits and the duration of the home care episode, but the impact on elderly consumers' access to care and on quality outcomes is uncertain.

Private long-term care insurance

Private long-term care insurance pays only a small part of the bill—1995, such insurance covered less than 6 percent of all long-term care costs. The market grew during the 1990s, however, and the total number of policies increased from 800,000 in 1987 to almost 5 million in 1996. A 1997 survey conducted by the Health Insurance Association of America (HIAA) indicated that the number of policies purchased increased by more than 600,000 in 1996 alone, the largest number of policies ever sold in one year. The estimated total of 5 million, however, is cumulative; the number currently in force is a fraction of those ever sold, and could be even smaller given the high lapse rate (i.e., insured individuals dropping policies) seen in this industry.

In 1996, approximately 80 percent of the 5 million policies were individual policies. The remaining 20 percent were policies sold either through employer groups or as part of a life insurance package—up from less than 3 percent of the market in 1988. Half of all individual policies had been sold in only nine states. In 1996, the average annual premium for a person at age sixty-five who purchased basic long-term care insurance (covering four years of nursing home care or home health care beginning after the first twenty days of care) was $980. The premium rose to $1,321 with nonforfeiture protection, to $1,829 with 5 percent compounded inflation protection, and to $2,432 with both additional protections.

Controversy has raged around private long-term care insurance since 1990. The private sector has argued that public programs will never meet the demand and that individuals with financial means should not be encouraged to shelter or spend down their assets to become eligible for Medicaid coverage. Consumers and regulators have expressed concern about the lack of affordability and fraudulent marketing practices. A 1997 *Consumer Reports* article suggested that only 10 to 20 percent of the elderly can afford long-term care insurance, noting that premiums for two adequate policies bought at age sixty-five cost $3,500 per year, or 13 percent of the median annual income of elderly married couples. Whether this figure reflects a high or low proportion of a couple's annual expenditure depends on how much money (primarily assets) the couple has and what else they must buy.

Many observers have suggested that private long-term care insurance might play a more significant role in financing these services if an employer-based group market develops. Premiums for long-term care insurance sold through employers are lower than those sold as individual products because: (1) employers can market to younger people, (2) costs of administration are lower and there are no agent commissions, and (3) employers might use bargaining power to reduce insurers' profit percentages. Employer-based products also offer less stringent health screening criteria or eliminate medical underwriting entirely. A group market, furthermore, offers increased ease and comfort of purchase due to the fewer coverage decisions required. According to the 1997 HIAA survey, 1,532 employers were offering long-term care insurance to their employees and retirees by the end of 1996; up from seven in 1988 and 1,260 in 1995.

Financing trends

A number of initiatives at the federal, state, and provider levels seek to use public funds creatively to provide an array of services to older adults with chronic disabilities. One major trend is the integration of acute and long-term care funding streams to allow for better management of care across the service spectrum. The most ubiquitous example of this activity is the Program of All-Inclusive Care for the Elderly (PACE), a managed care approach to providing

long-term care for disabled older adults who are eligible for Medicaid and are nursing home certifiable. Participating providers receive a lump-sum payment for each elderly beneficiary that integrates Medicare and Medicaid reimbursement to allow maximum flexibility in meeting the primary care and long-term care needs of the consumer. Additional distinguishing features of this program include: (1) provider assumption of financial risk in caring for the older adult within the monthly capitation payment; (2) integrated service delivery, with adult day care as the focal point; (3) care management through the use of interdisciplinary care teams, from physicians to the van driver; and (4) a vigorous attempt to keep individuals in community care and out of nursing homes. The Balanced Budget Act of 1997 made PACE a permanent Medicare category, and there are ongoing efforts by providers and some states to expand the number of sites across the country. The potential for this model, however, to address the financial as well as the delivery concerns of millions of older adults who need long-term care will remain limited unless policymakers and providers figure out how to expand the scale and scope of the program in an efficient manner.

Motivated by escalating Medicaid budgets and growing numbers of elderly and younger disabled enrollees, many states have expressed interest in the integration of acute and long-term care. They are particularly concerned about their *dual eligible* population—individuals eligible for both Medicaid and Medicare—who account for about 17 percent of the states' Medicaid enrollees and 35 percent of program expenditures. By the late 1990s, nineteen states, most notably Arizona, Maine, Minnesota, Texas, and Wisconsin, had some type of integration initiative. The Robert Wood Johnson Foundation and the Centers for Medicare & Medicaid Services are sponsoring evaluations of these programs and demonstrations in other states, but results will not be available for some time. Meanwhile, the rhetoric of integration will continue, as policymakers, providers, and researchers struggle to implement the details.

Consumer direction in home and community-based care is another trend that is slowly emerging as a financing option for older adults. This concept originated in the independent living movement of younger people with physical disabilities and the self-determination movement of people with mental retardation and developmental disabilities. Both of these movements opposed institutionalization and demanded more consumer control over services. Consumer direction emphasizes privacy, autonomy, and the right to manage one's own risk. Aside from leveling the playing field between institutional and home and community-based care, a growing number of policymakers see it as a potential way to save money through more efficient allocation of resources and through flexibility in how, where, and by whom care is delivered. Policy options range from consumer involvement in planning and decision-making to the ultimate in consumer direction—providing cash benefits to beneficiaries and/or their families and letting them purchase their own services and supports.

Most of the consumer direction programs have been implemented at the state level, through Medicaid waiver authority and state-funded personal-assistance service programs. The Cash and Counseling Demonstration and Evaluation, a five-year program jointly funded by the U.S. Department of Health and Human Services and the Robert Wood Johnson Foundation in 1997, is testing the efficacy of *cashing out* the Medicaid home and community-based waiver benefit in Arkansas, Florida, and New Jersey. A randomly-assigned group of beneficiaries is receiving a cash benefit that is a slightly discounted monetary equivalent of a package of personal care services provided by an agency to a control group of beneficiaries. A rigorous evaluation is under way to assess the impact on elderly and younger consumers and on state coffers. Special attention is focused on how individuals spend the dollars and the extent to which this option might compromise quality.

U.S. policymakers have been comfortable with cash benefits for certain subpopulations, such as veterans and workers with disabilities. Over the past five years, several federal legislators and the current and previous presidents have included within large tax bills which were never passed a three thousand dollar, nonrefundable tax credit for people needing long-term care or for family members caring for them. This proposal would provide consumer-directed benefits, that is, a cash refund. Policymakers have been less supportive of direct payments to allegedly "undeserving" individuals who receive public benefits due to their financially disadvantaged status. Concerns about misuse of dollars as well as potential liability for unforeseen mishaps, such as abuse of elderly clients by privately hired

workers or deaths of older adults because of insufficient or inappropriate service delivery, have impeded the growth of this trend in the United States.

The future of long-term care financing

Based on data from the Long-Term Care Financing Model and the National Long-Term Care Survey, the Congressional Budget Office (CBO) estimates that inflation-adjusted expenditures for long-term care for older adults will grow by 2.6 percent annually between 2000 and 2040. Expenditures are expected to reach 207 billion dollars in 2020 and 346 billion dollars in 2040. Projections beyond the next twenty years, however, should be viewed with caution because of uncertainties about demand, as well as about the scope and costs of services in the future. These estimates, for example, assume an average decline of 1.5 percent per year in the rate of disability. If the prevalence of disability among older adults remains constant, total expenditures in 2040 will be about 40 percent higher than the CBO estimate.

After thirty years of debate about financing, it is almost certain that the United States will maintain its patchwork approach by experimenting with different ways to balance public and private funding. Medicaid will continue to be the primary source of public funding, and the federal and state governments will rely increasingly on the tax code to achieve incremental reform, including tax credits for caregivers and care recipients and tax breaks to encourage the development of a private insurance market. Although tomorrow's elderly population, on average, will be wealthier than today's, there will be much variation within each generation of older adults. It is important to note that, because of the connection between low income and disability, those most likely to need long-term care in the future will also be the least likely to be able to pay for services out-of-pocket. A wealthier and more educated population will probably want more choices, and financing strategies that offer flexibility in how resources are used should appeal to more elderly Americans and their families.

ROBYN I. STONE

See also AREA AGENCY ON AGING; CAREGIVING, INFORMAL; CONSUMER DIRECTED CARE; FINANCIAL PLANNING FOR LONG-TERM CARE; HEALTH AND LONG-TERM CARE PROGRAM INTEGRATION; HOME CARE AND HOME SERVICES; LONG-TERM CARE INSURANCE; MEDICAID; MEDICARE; NURSING HOME.

BIBLIOGRAPHY

BENJAMIN, A. E. "Consumer Directed Services at Home: A New Model for Persons with Disabilities." *Health Affairs* 20 (2001): 80–95.

BOYD, B. L., ed. *Long-Term Care: Knowing the Risk, Paying the Price*. Washington D.C.: Health Insurance Association of America, 1997.

COHEN, M. A. "Emerging Trends in the Finance and Delivery of Long-Term Care: Public and Private Opportunities and Challenges." *The Gerontologist* 38 (1998): 80–89.

KANE, R. L.; KANE, R. A.; and LADD, R. *The Heart of Long-Term Care*. New York: Oxford University Press, 1998.

MANTON, K. G.; CORDER, L.; and STALLARD, E. "Chronic Disability Trends in Elderly United States Populations: 1982–1994." *Proceedings of the National Academy of Sciences of the U.S.A.* 94 (1997): 2593–2598.

NEWCOMER, R. J.; WILKINSON, A. M.; and LAWTON, P., eds. *Annual Review of Gerontology and Geriatrics,* Volume 16. New York: Springer Publishing, 1997.

STONE, R. I. *Long-Term Care for the Elderly With Disabilities: Current Policy, Emerging Trends, and Implications for the Twenty-First Century*. New York: Milbank Memorial Fund, 2000.

STONE, R. I. "Integration of Home and Community-Based Services: Issues for the 1990s." In *Home-Based Care for a New Century*. Edited by Daniel M. Fox and Carol Raphael. Malden, Mass.: Blackwell, 1997. Pages 71–98.

U.S. Department of Health and Human Services—Office of the Assistant Secretary for Planning and Evaluation, and the Administration on Aging. *Informal Caregiving: Compassion in Action*. Washington, D.C.: Government Printing Office, 1998.

WIENER, J. M.; ILLSTON, L. H.; and HANLEY, R. J. *Sharing the Burden: Strategies for Public and Private Long-Term Care Insurance*. Washington, D.C.: The Brookings Institution, 1994.

LONG-TERM CARE INSURANCE

The feasibility of private long-term care insurance is central to the public policy debate over financing long-term care. The failure of the private market, even with public subsidies, to insure

a substantial portion of the population has a bearing on the public sector's role in financing long-term care. The larger the share of the population with adequate private insurance, the less likely that public resources will be needed to provide long-term care to those in need. But very little about any private market is purely private. Public resources are often used to support or improve the private market, regulate the market, and ultimately help consumers. This is true for private long-term care insurance as well. The market for private long-term care insurance has been expanding at a rapid rate, but not as fast as the population is aging, and hence a growing proportion of the population is getting older without pooling their financial risks of needing long-term care.

Why long-term care is an insurable event

Saving for an event whose occurrence and costs are predictable is very efficient. Preparing for an event involving known financial consequences, however, is not the same as preparing for an unpredictable event with unknown costs. Either too much or too little is likely to be saved. Those who set aside the most that they might need are quite likely to save too much and therefore deprive their families of other goods and services needed over their lifetimes. More than likely, most people would underestimate the costs, thereby depriving themselves of other opportunities, and still not have sufficient resources when care is needed.

Since the future need for long-term care is not known, and since, if needed, its cost is not predictable, self-funding for this contingency is inefficient. Sharing the financial risk through insurance—either public or private—is more efficient. This is the basic function of insurance where large groups of people pool the financial risks of the group. No one person in the group bears the full cost of care and everyone in the group shares in financing the care for those who end up needing it. Despite the existence of long-term care insurance in local markets since the 1960s, relatively few people have purchased long-term care insurance to pool the financial risk of needing long-term care. Since Medicare does not cover most long-term care needs, this leaves most people purchasing their own long-term care and then turning to the state Medicaid program for assistance if impoverished.

What is long-term care insurance?

Long-term care insurance is conceptually more like whole life insurance than health insurance. Health insurance is for a fixed term (usually the month in which the insurance is purchased) and it covers necessary medical care during that time as well as any ongoing expenses related to that episode in which care is needed. Long-term care insurance, on the other hand, provides for a fixed payment toward long-term care services once long-term care is needed. There are specific triggers, which are often tied to measures of activities of daily living or ADLS. But the amount of the benefit is most often tied to the site of care and not the level of functional disability. Moreover, the amount of benefit is predetermined by the consumer, for example, $100/day for a nursing home stay and $50/day for care at home. Most policies offer consumers the option to allow the benefit amount to increase with inflation, but often the inflation index is either a fixed percentage (for example, 5 percent) or tied to general inflation and not necessarily the increase in the cost of long-term care.

The price of the policy depends on the options chosen and the age at which the policy is initially purchased. This age at which the policy was first purchased determines the price of the policy for as long as the policy is held. Assuming a 5 percent compounded inflation benefit and a nonforfiture benefit, a policy purchased at age forty, for example, might cost $770 a year; while the same policy initially purchased at age sixty-five would cost $2,305 a year (Chart III-13 in *Congressional Research Services Long-Term Care Chartbook*, 2000). If bought at age forty, the premium will be one-third of what it will cost if the individual waits until age sixty-five to begin buying the policy with the same benefits. This significant price difference arises because the forty year old has a significantly lower risk of needing long-term care in the short-run and because of the longer period in which premium payments on the part of the forty year old will grow.

For example, let's assume a forty-year-old and a sixty-five-year-old buy the same long-term care policy. Further assume that they maintain the policy and that they both need nursing home care at age eighty-five. This will be twenty years for the sixty-five year old and forty-five years for the forty year old. Over the course of the forty-five years the forty year old will have paid $26,950 in long-term care insurance premiums.

Over the course of the twenty years, the sixty-five year old will have paid $46,100 in long-term care insurance premiums, for the same benefit.

Although the forty year old will have paid less, the value of the premiums to the insurance company will be worth more. Take for example the first year's premium. The forty year old paid $770 and the sixty-five year old paid $2,305. When the forty year old is eight-five, that initial premium will have grown in tax-free investments held by the insurance company—assuming an 8 percent rate of return—to be worth $27,845, while the first year premium paid by the sixty-five year old will only be worth $11,356 to the insurance company.

Employer-provided or employer-organized group purchases

In a voluntary private insurance market, employer-provided or even employer-sponsored benefits offer a very natural and efficient way to pool risk, achieve marketing and administrative savings, and effectively negotiate better terms and plan designs. Employers devote tremendous resources choosing and negotiating plan arrangements. Generally, larger employers have been able to obtain more comprehensive benefits for a lower "premium" than smaller employers, and virtually all employment-based groupings offer more coverage for the same "premium" as do individual policies. Such efforts are, of course, voluntary, although encouraged by the labor market and tax policy.

Long-term care insurance has not been sold as a "term" product but as a "whole life" type product, meaning that its price is contingent on the age at which the policy was initially purchased and not the current age of the policyholder. For this reason, long-term care insurance is substantially less expensive when purchased at a younger age. Unfortunately, to maintain this premium, one must retain the policy until it is needed, perhaps thirty years after the initial purchase. Maintaining the value of any employee benefit when moving from one employer to another is a substantial hurdle, but is particularly problematic with a product like long-term care insurance.

For most insurance products, such as health care, disability, and even life insurance, the insurance protection is often limited to a relatively short period of time such as the month in which the premium is paid. The vested rights of pension benefits might be transferable, but the value remains at what it was the day the employee left the firm. Only the cash-value of defined contribution plans are relatively easy to move, but here too there are complications when much of that value is in company-held equity, particularly when the company is privately held.

Individual market

Voluntary, even tax-subsidized, individual markets for insurance require substantially more marketing and information gathering by both the consumer and the insurer. For insurers these costs are either added to the premium or taken from the benefit. As a result, some individuals might not be eligible and the premium may be prohibitive. Further, adverse selection and moral hazard are much more substantial issues for the insurer in the individual market and hence they design both the application process and the product with these concerns in mind. Other limitations of private long-term care insurance include denial, misunderstanding of coverage, underwriting as well as the competing demands for savings that families face (i.e., housing, education, and retirement). People who need long-term care and people with medical conditions that could eventually require some assistance have usually been denied coverage.

In a survey of buyers and people initially interested in long-term care insurance who ultimately decided not to buy it, it is clear that the reasons for buying and for not buying are quite complex. Among buyers, the most important reason was to protect assets, but less than one-third identified this as an important reason. About 19 percent indicated a desire to avoid dependence on others, but nearly one-quarter had other reasons. On the other hand, of those who had investigated purchasing a long-term care insurance policy but chose not to, more than one-half (54 percent) indicated that the cost was a very important reason and another 30 percent indicated that the cost was an important reason in their decision not to buy (Health Insurance Association of America, October 2000). Other reasons cited by the non-buyers were suspicions about insurance companies, a lack of understanding about the risk of needing long-term care, confusion about what the government does and does not now cover, and general lack of knowledge about the policies.

It has been difficult, at best, to sell long-term care insurance to older people. It is even more difficult to sell it to younger people. This is particularly unfortunate, since this is when premiums are the least expensive. Moreover, while the probabilities of needing long-term care increase with age, nearly half of the long-term care population is under the age of sixty-five.

Growth of the long-term care insurance market

Since the mid-1990s, the number of long-term care insurance policies sold has nearly doubled. The vast majority of policies sold (80 percent) are sold in the individual market rather than in the employer-group market. This reflects the relatively easier sell of long-term care insurance to older people than to younger, working-age people.

In 1984, sixteen insurance companies had sold 125,000 long-term care insurance policies in select states (Friedland). By 30 June 1998, 119 insurance companies were selling long-term care insurance policies nationally and over 5.8 million policies had been sold (Health Insurance Association of America, March 2000). Employers have been relatively slow to either provide or help organize the provision of long-term care insurance to their employees. Prior to June 1987, no employers offered long-term care insurance to their employees, and as of 30 June 1998, there were over 2,100 employers offering long-term care insurance to their employees, retirees, and often to the parents and in-laws of their employees.

Policies sold and policies in force are not, however, the same. People stop paying their premiums and hence the policy ceases to provide coverage. Not much is known about lapse rates, but clearly some people are opting for a new policy and, given the older ages at which these polices are purchased, some people have died. One analyst has estimated that the number of policies in force is about half the policies sold (Cohen). Even if everyone held all of the policies ever sold to those age sixty-five and older, then one could imply that about 18 percent of the elderly have some form of long-term care insurance protection. Of course the reality is far fewer have such insurance. Moreover, about 45 percent of the long-term care population is under the age of sixty-five (CRS and The Urban Institute). Therefore, if one narrows the population at risk to everyone age forty-five and older, then long-term care insurance has covered less than 7 percent of the most relevant market.

It is quite likely that the employer-sponsored market will change dramatically in the first decade of the twenty-first century. The largest employer, the federal government, is in the process of organizing the availability of long-term care insurance to their employees and their retirees, as well as dependents of employees, and even the parents of employees. There are an estimated 6.5 million federal employees and retirees. Adding spouses and parents suggests a potential market of 13 million people, not only learning more about long-term care insurance but also having the opportunity to purchase long-term care insurance on a group basis.

Private insurance and long-term care

So far, private long-term care insurance has had virtually no impact on the organization or delivery of long-term care. This is because most of the financing for long-term care is either through Medicaid, Medicare, or directly from those needing long-term care. In 1998, Medicaid, the largest public payer of long-term care services, accounted for 45 percent of all long-term care expenditures. Medicare financed 16 percent overall. Families directly financed 27 percent and private insurance, from all types of private insurance, financed less than 7 percent of long-term care. Most private insurance payments, however, are not yet from long-term care insurance. Analogous to Medicare, the financing of long-term care is from the acute health insurance plans (and Medicare HMOs) using long-term care services, often as an alternative to inpatient hospital care.

Public sector support and influences on the private market

Insurance is licensed and regulated by each state. The federal government has had regulatory authority when the insurance is provided through most employer-provided benefit plans. Tax-favored employee benefits are regulated by the federal government, but this regulation has been primarily focused on ensuring that employee benefits are not provided in a way that favors one class of employees over another.

Until 1996 the federal tax code did not recognize long-term care as a tax-exempt employee benefit. This has resulted in a great deal of am-

biguity concerning the tax treatment of premiums paid, the tax treatment of benefits received by policyholders, and the treatment of the reserves accumulating to pay future long-term care benefits (especially prior to 1989). Much of the ambiguity stemmed from the fact that the preferential tax treatment of health insurance was derived from a 1954 definition of medical care, which was so explicit to leave lawyers wondering if assistance to function on a daily basis or to remain independent despite chronic conditions would be included. That is, so much of the definition was related to the diagnosis and treatment of a disease to render serious questions about nonmedical services even when they were necessary because of a medical condition.

If it had been clear that long-term care is covered by the medical definition, then long-term care insurance could be treated like health insurance. Health benefits in a health insurance plan are not treated as either federal or state taxable income, and if the premiums are paid by an employer the premiums are not treated as taxable income either. Long-term care insurance relies on prefunding, much like whole life insurance, but clearly long-term care insurance pays benefits prior to death. In the case of whole life insurance, the insurers intend to invest the premiums in a reserve fund that is used to pay benefits. The earnings on those reserves are not taxed at the federal level and often not at the state level and hence premiums are lower than they otherwise would be.

The Health Insurance Portability and Accountability Act (HIPPA) of 1996 made long-term care insurance explicit in the federal tax code (Tapay and Feder). In so doing, the federal government defined long-term care insurance in ways in which states had not. This actually created two kinds of long-term care insurance. That which is only state approved and that which is both state approved and qualified for preferential tax treatment by the federal standard. While each state has its own standards to define long-term care, no state had established standards like those in HIPPA. For example, to be federally qualified, the long-term care insurance policy must pay benefits if the policyholder has limits in two or more activities of daily living. Most states that have such a standard use a criterion of limitations in three or more activities of daily living.

While HIPPA added clarity for the tax treatment of long-term care insurance policies that meet federal standards, it may have inadvertently left even more uncertainty for state-licensed policies that do not meet the federal standards. Furthermore, tax preferences not only lower the cost of the policy, they imply an implicit signal from the government that suggests an endorsement of long-term care insurance. This is seen as critical for selling insurance by insurance industry experts who have acknowledged just how difficult it has been to sell long-term care insurance policies, especially to people under the age of sixty-five.

Potential for the future

Relatively few people have purchased long-term care insurance polices. While the market potential is enormous, public policies may be necessary to further encourage this market. A long-term care financing system that depends on some proportion of the population purchasing insurance may want to focus on public policies that also inform and protect consumers from making inappropriate purchases. This may include public information, tax incentives, or even direct subsidies for the purchase of private insurance.

The real potential for long-term care insurance lies in educating people about the risk of long-term care and their options to pool this risk. In order for the private market to be effective at pooling this risk, large portions of people in their forties and fifties need to purchase policies and continue to make annual premium payments until they are in their eighties. Given what we know about individual purchases of other insurance, including health insurance, this is not likely to happen unless substantial numbers of employers are able to encourage most of their workers to obtain insurance through their workplace. Only then will private long-term care insurance begin to have a significant impact on the financing and delivery of long-term care. However, even if more people started buying long-term care insurance today, it will take another twenty years before these purchases begin to affect the financing and delivery of long-term care.

As our population ages, long-term care expenditures are expected to increase dramatically. Estimates by the Congressional Budget Office suggest that for just the elderly, long-term care expenditures are expected to increase from $123 billion in 2000 to $346 billion in 2040 (in 2000 dollars) (Hagen). The Congressional Budget Of-

fice estimates that regardless of how much private long-term care insurance expands between now and 2020, Medicaid spending will still increase substantially. Assuming an increase in private long-term care insurance spending, Medicaid spending would have to increase from $43 billion today to $75 billion in 2020 (in 2000 dollars) to maintain current levels of service to low and middle-income elderly people. If there is no appreciable expansion in private insurance spending, Medicaid long-term care expenditures for the elderly is estimated to increase to $88 billion by 2020 (Hagen).

For individuals, however, private long-term care insurance is the only option for pooling the financial risks of long-term care. Unfortunately, this is a limited and biased option. The benefit that is purchased is usually cash to be used to pay for care and not access to care itself, and the value of this benefit is greater when the policy is initially purchased and less when it is likely to be needed. That is, despite the "inflation" protections that can be purchased, the benefit value is not likely to increase with the risk-adjusted cost. This is because the "inflation" factor is independent of the real costs of care and the inflation benefit is financed in the premium. Moreover, not everyone purchases the inflation benefit for his or her policy. Nevertheless, these policies do pool some of the risks and this is more effective than saving for the contingency of long-term care, which most people are not doing anyway.

ROBERT B. FRIEDLAND

See also FINANCIAL PLANNING FOR LONG-TERM CARE; LONG-TERM CARE; RISK MANAGEMENT AND INSURANCE.

BIBLIOGRAPHY

Congressional Research Services Long-Term Care Chartbook. 2000.

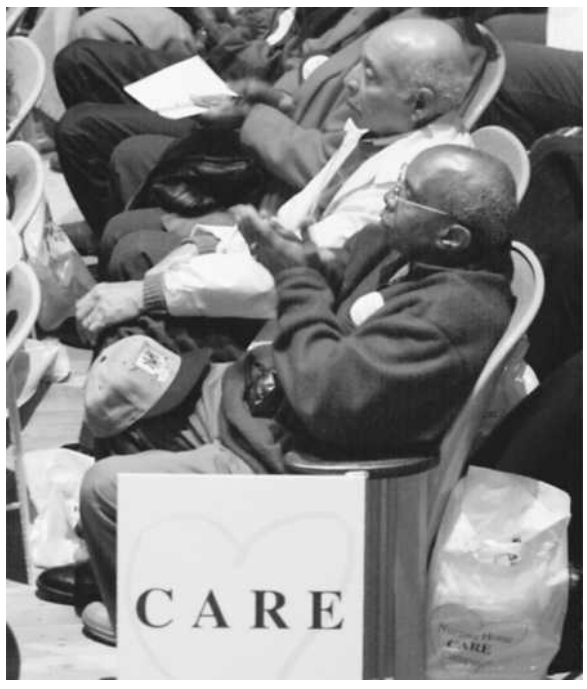
COHEN, M. *Life-Plans, Inc*. Congressional Research Service presentation. 9 May 2000.

CRS and The Urban Institute. *Long-Term Care Chart Book: Persons Served, Payers, and Spending,* 2000.

FRIEDLAND, R. B. *Facing the Costs of Long-Term Care*. Washington, D.C.: Employee Benefit Research Institute, 1990.

HAGEN, S. *Projections of Expenditures for Long-Term Care*. Washington, D.C.: Congressional Budget Office, March 1999.

Health Insurance Association of America. *Long-Term Care Insurance in 1997–1998*. March 2000.



On April 24, 2001, senior citizens across Tennessee gathered at War Memorial Plaza in Nashville to rally for improvements in the quality of long-term care systems and nursing homes. (AP photo by Mark Humphrey.)

Health Insurance Association of America. *Who Buys Long-term Insurance in 2000*. October 2000.

TAPAY, N., and FEDER, J. "Federal Standards for Private Long-Term Care Insurance: Implementing Protections Through the Federal Tax Code." Institute for Health Care Research and Policy, IWP 99–105. March 1999, Georgetown University.

LONG-TERM CARE, QUALITY OF

Quality in long-term care requires three steps: (1) defining *quality of care*; (2) assessing care and services to determine whether quality standards are being met; and (3) correcting quality problems when they are identified. Quality questions in long-term care go beyond the traditional safety and protection issues that have historically dominated the field of tong-term care; policymakers and regulators are concerned with determining if public monies are paying for effective services that result in better health or improved functioning for the consumer.

Nursing homes

Concerns about the quality of nursing home care and ineffective government regulation of facilities dates back to at least 1970. (Medicare and Medicaid were enacted in 1965 and soon after, there was an expansion of nursing homes and increasing concerns about quality.) A 1987 law known as the Omnibus Budget Reconciliation Act (OBRA 1987) raised quality-of-care standards for nursing homes participating in Medicare and Medicaid and strengthened federal and state oversight. Following the law's implementation, several studies found evidence of improvements in nursing home care, including a decline in the use of physical and chemical restraints, reduced prevalence of dehydration and pressure ulcers, and less frequent use of catheters. Pressure ulcers are a standard measure of nursing home quality, simply because avoiding these skin wounds requires coordinated care efforts to turn and take care of bedridden residents.

Despite these improvements, studies indicate that many nursing homes continue to provide inadequate care. The U.S. General Accounting Office (GAO) in 1999 found that one-fourth of nursing facilities have serious deficiencies that have caused actual harm to residents or placed their health and safety at risk (see Scalon 2001). According to the Institute of Medicine, many of these homes have had repeated serious deficiencies, and even when problems have been identified, state and federal enforcement policies are often effective in ensuring that they are corrected and remain corrected.

There is a growing awareness among nursing-home administrators, state and federal regulators, consumer advocates, and others that staff shortages and insufficient staff training are part of the problem. High turnover in nursing-home staff (currently at 40 to 75 percent nationally, and as high as 500 percent in certain facilities) makes it difficult to recruit and retain a high quality workforce. Staff turnover among certified nursing assistants (CNAs), who are at the front lines of nursing-home care, is particularly detrimental to overall quality of care. Instability in the CNA workforce means that residents are constantly receiving care from new people who often lack experience and a knowledge of individual residents. In such an environment, continuity of care is compromised. In addition, the cost of training new staff drains resources from resident care.

Improvements in the basic elements of nursing-home care, such as fire safety, inappropriate use of physical or chemical restraints, and a lack of available social programs, have been recorded. Nursing-home quality now needs to broaden its focus to address both issues of quality of care and quality of life. The emphasis on health and safety, which has been dominant in the U.S. regulatory system, needs to be expanded to emphasize the critical aspects of life, such as choice and control of the services received, if nursing homes are to be quality settings.

Assisted living

Assisted living is usually defined as a residential-care setting for persons who can no longer live independently and who require some supervision or help with activities of daily living (ADLs), but who may not need the level of skilled care provided in a nursing home. National definitions and regulations of assisted living do not exist, thus assisted living varies considerably from state to state. Most definitions specify that assisted living provide personal care and supportive services twenty-four hours a day; including some health care, meals, and housing in a congregate residential setting serving primarily an older population. The intensity of services, the range of disabilities for which services are provided, the type of living arrangements, and many other aspects of assisted living vary a great deal, often within, as well as between, states.

The ability of residents to age in place as their health declines or their needs change is determined largely by admission and discharge criteria. There is considerable variation across the states in these criteria, some of which comes from state regulations, some from the facilities' choice of whom to serve, and some from the particular services an assisted-living facility chooses to provide or make available.

Frequently identified quality problems in assisted living include facilities providing inadequate or insufficient care to residents; insufficient, unqualified, and untrained staff; and not providing residents appropriate medications—or storing medications improperly. In addition, state regulations on assisted living generally focus on three main areas: requirements for the living unit, admission and retention criteria, and the types and levels of services that may be provided.

Regulations that ensure the safety and quality of care in assisted living are limited. Regula-

tions in most states set the parameters for assisted living, but owners and operators define the practice. A 1999 GAO report also found that assisted-living facilities have quality problems related to incorrect, incomplete, and misleading information provision; inadequate care; insufficient staffing; and medication errors.

In 1996, several organizations representing consumers and providers formed the Assisted Living Quality Coalition (ALQC) to address issues of quality improvement in assisted living. The goal was to develop an assisted-living quality framework by promoting the highest possible quality of life for older adults and those with disabilities by advocating for an assisted-living philosophy of independence, privacy, dignity, and autonomy.

During its deliberations, the ALQC sought the counsel and advice of numerous individuals and organizations representing consumers, providers, state regulators, ombudsmen, third-party payers, and investors. The coalition also examined a variety of approaches to promoting quality, including traditional state regulation, accreditation, contracts, and quality indicators. The coalition's report, published in 1998, includes guidelines for states developing standards. As of 2001, however, there had been no federal action on the coalition recommendations.

Home care

There are two major categories of home care. *Home health care* is skilled care that is provided to individuals and families in their place of residence for the purpose of promoting, maintaining, or restoring health, or for maximizing the level of independence while minimizing the effects of disabilities and illness. This care is primarily funded through the Medicare program and to a lesser extent, by Medicaid. *Home and community-based services* (HCBS) include a range of services that help with the tasks of daily living, such as personal care, homemaking, cooking, and laundry. These services are typically provided under the Medicaid program through HCBS waivers or the personal care option, through the Older Americans Act. or through the Social Service Block Grant. All fifty states and the District of Columbia now provide HCBS waivers for long-term care services, including personal-care services, care management, adult day care, home-delivered meals, emergency response systems, transportation programs, respite programs, caregiver support programs, and home modification programs.

Quality home-care services involve the provision of appropriate and competent medical and personal-care services, incorporating those values of significance to consumers: independence, choice, control, dignity, and privacy. A 1997 GAO report found that very poor care was provided by a number of home health agencies. Several examples were cited showing quality problems in home care, including agency administrators with no health care experience and agencies serving ineligible patients and falsifying records and staff credentials. Moreover, the report stated that only 3 percent of all certified home health agencies have been cited by the Centers for Medicare and Medicaid Services (CMS, formerly HCFA) for being out of compliance with one or more conditions.

Regulation and research help guide the process of assuring the quality of home care. The research on home health care points to a mixed experience in developing good strategies for ensuring the quality of care. The majority of the research in home care has examined structural and process measures, rather than outcomes of care. Medicare-funded home health care generally appears to be of adequate quality in terms of the transactions between caregivers and consumers. However, the program has suffered from problems of overuse and inappropriate use, leading to new constraints on payments that may adversely affect the quality of services for those consumers with the most severe needs. Access to home and community-based services, especially personal attendant services for people with disabilities, is not uniformly available across states and the need for these services appears to be largely unmet. Research shows that access to services and choice of appropriate services are essential to the quality of home care.

More research is needed towards developing an appropriate array of community-based long-term care services to meet the needs of consumers and assess the quality of the services and outcomes. Furthermore, consumers should ultimately define quality of care. As Kane, Kane, and Ladd point out, "Only the person receiving the care and help can judge how it enhances or interferes with their happiness, productivity, and social lives" (p. 193). Home-care programs are beginning to develop approaches to assessing consumer satisfaction with services and outcomes of importance.

An additional mechanism for assuring quality in the nursing home and home care settings is through the nursing home ombudsman program. Funded through the Older Americans Act legislation, this program establishes an advocacy and complaint system in each state. Typically administered by the state unit and regional area agency on aging, the ombudsman function involves the investigation of complaints received by consumers, advocates, or employees surrounding the quality of care received. Complaints can be received via a 1-800 hot line or through the mail. Ombudsman can either report problems to the legal or inspection system or negotiate a resolution to the problem with the provider and consumer. Although originally designed for nursing homes, the ombudsman function has been expanded to other long-term care settings in recent years.

Assuring the quality of long-term care is a complex undertaking. For instance, although researchers have developed or identified a variety of approaches for determining the quality of home-care services, no method has yet been judged entirely adequate. Problems with the quality of care being provided across all types of long-term care settings remain, and better mechanisms are needed to adequately assess quality in these settings. More attention should be given to issues such as consumer choice, safety, and broadening consumer participation in decision making.

Traditionally, long-term care has focused heavily on structure and process strategies to ensure quality of care. Recent experiences indicate that consumers can provide important input into the quality assessment process. Efforts to educate consumers directly, inform them of their rights, and inform them of reasonable costs for services all are elements of a strategy to promote quality.

Future approaches

Total quality management (TQM) represents a major new approach to managing long-term care. TQM is the integration of a customer-focused, continuous-improvement philosophy, analytical skills, people skills, and a structure and organization within an internal and external culture (organizational or corporate culture which represents the values and beliefs of the organization) driven by leadership. The uniqueness and power of TQM is the integration and balance of the different components, not in the use of its individual parts. Moreover, TQM is grounded in a philosophy of meeting and exceeding customer-defined requirements and working for continuous improvement.

Recent work on quality has identified five principles that are applicable to quality efforts in long-term care:

1. *Providers must know their customers.* Quality improvement suggests that organizations have a range of customers. It is essential for agencies to recognize the many different customer groups that they serve. In long-term care, important customer groups such as home-health or nursing-home aides are often ignored.
2. *Providers must listen to consumers.* Quality improvement indicates knowing what consumers want and how they feel about the long-term care service delivered is an essential ingredient in achieving quality.
3. *Information is essential for good decision making.* For many agencies, basic information about the service recipients, costs, and outcomes of care are simply not available. Quality improvement suggests that agencies must be able to use systematic information to make decisions.
4. *The group is smarter than the individual.* This principle states that, in the problem solving and improvement process, a group, in this case, a group of individuals involved in the delivery of service, will make better decisions than an individual, and therefore must be involved in changing the way care is delivered.
5. *Suboptimization is a key challenge facing organizations.* Suboptimization occurs when one unit maximizes its efficiency at the expense of other units within the organization. Rather than having individual department or unit goals, agencies need to have a common goal—quality long-term care service.

Implementing total quality principles requires a clear commitment to continuously improving the quality of services delivered. Such programs are not easy to develop, but without a solid approach to involving consumers in the quality process, it is difficult to achieve the quality goals desired by providers and consumers.

SHAWN DAVIS
ROBERT A. APPLEBAUM

See also AGING IN PLACE; ASSISTED LIVING; HOME CARE AND HOME SERVICES; LONG-TERM CARE; NURSING HOMES.

BIBLIOGRAPHY

APPLEBAUM, R., and DAVIS, S. "Long-Term Care Off to the Races: But Does Anyone Know Where the Finish Line Is?" *The Gerontologist* 40 (2000): 377–379.

APPLEBAUM, R.; STRAKER, J.; and GERON, S. *Assessing Satisfaction in Health and Long-Term Care; Practical Approaches to Hearing the Voices of Consumers*. New York: Springer, 2000.

Assisted Living Quality Coalition. *Assisted Living Quality Initiative: Building a Structure that Promotes Quality*. Washington, D.C.: ALQC, 1998.

CRAMER, B.; HARMUTH, S.; and GAMBLE, E. *Comparing State Efforts to Address the Recruitment and Retention of Nurse Aide and Other Paraprofessional Aide Workers*. Raleigh, N.C.: North Carolina Division of Facility Services, 1999.

EUSTIS, N.; KANE, R.; and FISCHER, L. "Home Care Quality and Home Care Workers: Beyond Quality Assurance as Usual." *The Gerontologist* 33 (1993): 47–54.

HARRINGTON, C.; CARRILLO, S.; THOLLAUG, P.; and SUMMERS, R. "Nursing Facilities, Staffing, Residents, and Facility Deficiencies, 1991 through 1997." Washington, D.C.: Health Care Financing Administration. www.hcfa.gov/medicaid

HAWES, C.; ROSE, M.; and PHILLIPS, C. *A National Study on Assisted Living for the Frail Elderly: Results of a National Survey of Facilities*. Beachwood, Ohio: Myers Research Institute, Menorah Park Center on Aging, 1999.]

Institute on Medicine. *Best at Home: Assuring Quality Long-Term Care in Home and Community-Based Settings*. Washington, D.C.: National Academy Press, 1996.

Institute on Medicine, Committee on Improving Quality in Long-Term Care. *Improving the Quality of Long-Term Care*. Washington, D.C.: National Academy Press, 2001.

Institute on Medicine, Committee on Nursing Home Regulation. *Improving the Quality of Care in Nursing Homes*. Washington, D.C.: National Academy Press, 1986.

KANE, R.; KANE, R.; and LADD, R. *The Heart of Long-Term Care*. New York: Oxford University Press, 1998.

MOLLICA, R., and SNOW, K. *State Assisted Living Policy: 1996*. Portland, Maine: National Academy for State Health Policy, 1996.

PHILLIPS, C. "Measuring and Assuring Quality Care in Nursing Homes." In *Linking Quality of Long-Term Care and Quality of Life*. Edited by L. Noekler and Z. Harel. New York: Springer, 2001.

PHILLIPS, C.; MORRIS, J.; HAWES, C.; FRIES, B.; MOR, V.; NENNSTIEL, M.; and IANNACCHIONE, V. "Association of the Resident Assessment Instrument (RAI) with Changes in Function, Cognition, and Psychosocial Status." *Journal of the American Geriatrics Society* 45, no. 8 (1997): 986–993.

SCANLON, WILLIAM. *Nursing Workforce: Recruitment and Retention of Nurses and Nurse Aides Is a Growing Concern*. GAO-01-750T. Washington, D.C.: United States Governmental Printing Office, 2001.

U.S. General Accounting Office. *Assisted Living: Quality of Care and Consumer Protection Issues in Four States*. Washington, D.C.: U.S. Governmental Printing Office, 1999.

U.S. General Accounting Office. *Medicare Home Health Agencies: Certification Process Ineffective in Excluding Problem Agencies*. Washington, D.C.: U.S. Governmental Printing Office, 1997.

U.S. General Accounting Office. *Nursing Homes: Additional Steps Needed to Strengthen Enforcement of Federal Standards*. Washington, D.C.: U.S. Governmental Printing Office, 1999.

LUNG, AGING

The main function of the respiratory system is to secure gas exchange: oxygen, which fuels metabolism, is transported from the ambient air (which contains 21 percent oxygen) to the pulmonary capillaries, and carbon dioxide is transported from the pulmonary capillaries to the external atmosphere. The oxygen-enriched blood reaches (via the pulmonary veins) the left side of the heart and the peripheral arterial network, which distributes it to the various organs, according to their metabolic needs. Carbon dioxide, which is the end-product of the mitochondrial tissue metabolism, is brought to the lung through the systemic veins, then to the right side of the heart, and then to the pulmonary arteries.

In the blood, oxygen molecules are bound to the hemoglobin contained in the red blood cells, with only 3 percent being dissolved in plasma (100 millileters (ml) of normal blood are able to transport 20 ml of oxygen). The oxygen dissolved in arterial blood yields a partial pressure (PaO_2) of around 100 mm of mercury (Hg) in a young adult; in the mixed venous blood, the oxygen partial pressure is 40 mm Hg. At these pressures, the hemoglobin oxygen saturation is, respectively, 97 percent and 70 percent. At rest,

one quarter of the oxygen arterial content is consumed by the tissues, so that 100 ml of mixed venous blood transports 15 ml of oxygen, and the arterio-venous difference between the arterial content in oxygen and the venous content in oxygen content is 5 volume percent (5 ml oxygen per 100 ml blood).

The carbon dioxide produced by tissue metabolism is collected by the peripheral veins, with 7 percent being dissolved in the plasma, and the rest being absorbed by the red blood cells. Seventy percent of the red-cell carbon dioxide content is transformed in bicarbonate and hydrogen ions through the action of the enzyme, *carbonic anhydrase*. In these conditions, 100 ml of blood can transport around 50 ml of carbon dioxide.

At rest, 250 ml of oxygen are absorbed by the lung per minute, eliminating 200 ml of carbon dioxide. The ratio between carbon dioxide excretion and oxygen absorption, called the *respiratory quotient,* is therefore equal to 0.8.

Gas transport from the mouth to the alveoli, and vice-versa, is only possible because of the inflation and deflation capability of the rib cage. At rest, the active phenomenon is called *inspiration,* which needs the coordinated contraction of three groups of muscles: the diaphragm muscle, the parasternals, and the scalenes. The rib cage distension results in an increased depression in the pleural space (the virtual space between the visceral and the parietal pleurae), which is followed by distension of the lung and transport of gas molecules from the mouth along the bronchial tree to the alveoli. When contraction of the inspiratory muscles ceases, the elastic energy stocked in the lung and chest wall is restored, and the volume of the respiratory system decreases, allowing expiration.

The volume of gas contained in the lungs at the end of an unforced, relaxed expiration is called the *functional residual capacity* (FRC). The volume of air that is inspired and expired during each respiratory movement is called the *tidal volume* (V_T), which is about 500 ml, at rest in a adult. There are around sixteen respiratory movments per minute, so that the per-minute ventilation is eight liters. The level of ventilation is adjusted to maintain PaO_2 and $PaCO_2$ in the normal range ($PaCO_2$ = 40 mm Hg) through a complex control system involving peripheral and central chemoreceptors situated in the carotid bodies and the medulla, respectively. During exercise, for example, the per-minute ventilation increases proportionally to the increase in oxygen consumption and carbon dioxide excretion. There is also an increase in the tidal volume and the respiratory frequency, and the expiration becomes active with the involvment of the expiratory thoracic (triangularis sterni) and abdominal (transverse abdominis) muscles. The same phenomenon is observed during forced expiratory maneuvers like sneezing or coughing.

The volume of gas contained in the lungs at the end of a maximal inspiration is called the *total lung capacity* (TLC), whereas the volume remaining in the lungs at the end of a maximal expiration is called the *residual volume* (RV). The volume mobilised between the TLC and RV levels is the *vital capacity* (VC). Together with the FRC, these three volumes determine the size of the lung. Taller people have proportionally larger lungs; women have smaller lungs than men (about 80 percent smaller); and there are also some differences linked to ethnic factors.

It is also of interest to look at the speed at which the vital capacity can be mobilized; the simplest way to determine this is to measure the volume of gas that can be expelled during the first second of a forced expiratory maneuver, starting at the TLC level (this is known as the *one-second forced expiratory volume,* or FEV_1). In a healthy middle-aged subject the FEV_1/VC ratio is about 75 percent. Another commonly measured index during a forced expiratory maneuver is the maximal instantaneous flow that can be attained after the onset of the maneuver; this is called the *peak expiratory flow rate* (PEFR).

In general, lung function declinces with age. Recent studies have also made clear that changes in function due to aging can be distinguished from those due to disease and environmental factors such as smoking. With age, structural changes occur in the respiratory system. The thoracic cage changes its form, becoming rounder, the intercostal cartilages become calcified, and there is some arthritis of the costovertebral joints. The large bronchi increase somewhat in size, whereas the caliber of the bronchioles decreases after the age of forty. The periphery of the lung changes consistently, with a progressive increase in the diameter of the respiratory bronchioles and of the alveolar ducts. By contrast, the alveolar sacs become shallower, so that the alveolar surface area decreases by 15 percent by the age of seventy, though the alveolar wall remains intact.

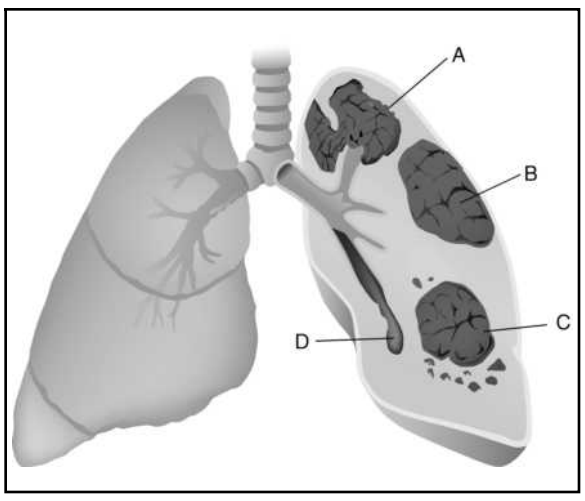
Morphological changes in the lung are associated with a progressive change in lung elasticity, particularly a loss of lung recoil pressure (pressure exerted by a distended lung) and a slight increase in lung distensibility. On the other hand, the chest-wall distensibility decreases, so that there is a slight increase in the functional residual capacity. The performance of the respiratory muscles, both in terms of force generation and endurance, decreases (which is also the case for the other skeletal muscles). The net effect of increased lung distensibility, combined with decreased thoracic compliance and inspiratory muscle force, is that the total lung capacity does not change over time. In contrast, the maximal expiration becomes limited, mainly because smaller peripheral airways in the dependent parts of the lung close, so that alveolar air remains trapped and the residual volume increases.

In older adults, contrasting changes in larger and smaller airways are such that the airway resistance associated with the transport of gas along the bronchial tree remains constant during normal breathing. However, during forced breathing both the maximal expiratory and inspiratory flow rates decrease. Changes in FEV_1 over time have been the most extensively studied. Cross-sectional studies of populations of different ages have conclusively shown a lower FEV_1 in older people (up to the age of eighty-five), the mean decline being 29 ml per year in males and 25 ml per year in females. Longitudinal studies, however, have shown that the decline is not rectilinear, with an acceleration in FEV_1 loss in older subjects.

Whether the loss in FEV_1 is linked to the aging process alone is difficult to know, since the lung is constantly exposed to many environmental stresses, with cigarette smoke being most important. Smokers have a steeper decline in FEV_1 than nonsmokers by a mean of 15 ml. per year, though following smoking cessation, the slope becomes normal again. Other factors that have a negative impact on lung function include occupational exposures to dusts and fumes, exposure to air pollutants, and respiratory infections (mainly during childhood).

In addition to the decreased alveolar surface area associated with aging, there is a limitation in the diffusion of oxygen molecules across the alveolar wall. This has been established through cross-sectional and longitudinal studies in both sexes, and in smokers and nonsmokers. However, this reduced diffusing capacity does not explain the arterial hypoxemia (reduced oxygen in the blood) that occurs with aging, at least up to the age of seventy-five. In older adults, hypoxemia results from a progressive imbalance between the perfusion and the ventilation of the alveoli, so that the difference between oxygen alveolar pressure and the oxygen arterial pressure widens progressively. Arterial carbon dioxide pressure (and its pH), however, does not change consistently.

Figure 1
Four types of chronic lung disease are illustrated in the lung on the right: a) lung cancer; b) pneumonia; c) emphysema; and d) phlegm caused by chronic bronchitis.



SOURCE: Argosy, Inc. for the Gale Group.

The ability to perform physical tasks diminishes with age, with a progressive reduction of the amount of external work that can be performed and, consequently, of maximal oxygen consumption (a simple index of the fitness of an individual), both in men and in women. This reduction is closely linked to a progressive loss of muscle mass (which contrasts with an increase in the fat mass) and to a decrease in maximal cardiac frequency (which is aggravated by an increasing sedentary lifestyle and decreasing fitness). In healthy subjects, however, the ventilatory performance is never the limiting factor during exercise (the subject's cardiovascular and muscular states are), although an elderly person will approach his ventilatory limits during maximal ex-

ercise. This means that, after any slight impairment, the respiratory pump (i.e., the thoracic cagewith the respiratory muscles) may also become a limiting factor to exercise.

The physical ability of any individual can be estimated by a formal exercise test performed on a cycle ergometer or a treadmill, or by measuring the distance walked during a six or twelve-minute period, which decreases with age.

Enough information is now available on the performance of the respiratory system to properly identify common diseases such as asthma or chronic obstructive pulmonary disease, and to separate their effects from the physiological changes of aging and deconditioning that can also contribute to the occurrence of shortness of breath in up to half of an elderly population. Identifying specific diseases allows an efficient therapy, which has a major effect on a patient's quality of life and improves rates of survival.

JEAN-CLAUDE YERNAULT

See also PNEUMONIA; SMOKING.

BIBLIOGRAPHY

ANTHONISEN, N. R.; CONNETT, J.; KILEY, J.; et al. "Effects of Smoking Intervention and the Use of An Inhaled Anticholinergic Bronchodilator on the Rate of Decline of FEV_1: The Lung Health Study." *Journal of the American Medical Association* 272 (1994): 1497–1505.

CERVERI, I.; ZOIA, MC; FANGULLA, F.; et al. "Reference Values of Arterial Oxygen Tension in the Middle-Aged and Elderly." *American Journal of Respiratory Critical Medicine* 152 (1995): 934–941.

CHAN, E. D., and WELSH, H. "Geriatric Respiratory Medicine." *Chest* 114 (1998): 1704–1733.

COTES, N. L.; CHINN, D. J.; QUANJER, P. H.; ROCA, J.; and YERNAULT, J. C. "Standardization of the Measurement of the Transfer Factor (Diffusing Capacity)." *European Respiratory Journal* 16, suppl. 16 (1993): 41–52.

DE TROYER, A., and YERNAULT, J. C. "Inspiratory Muscle Force in Normal Subjects and Patients with Interstitial Lung Disease." *Thorax* 35 (1980): 92–100.

ENRIGHT, P. L.; KRONMAL, R. A.; HIGGINS, M.; SCHENKER, M.; and HAPSONIK, E. F. "Spirometry Reference Values for Women and Men 65 to 85 Years of Age." *American Journal of Respiratory Critical Care Medicine* 147 (1993): 125–133.

ENRIGHT, P. L., and SHERRILL, D. L. "Reference Equations for the Six-Minute Walk in Healthy Adults." *American Journal of Respiratory Critical Care Medicine* 158 (1998): 1384–1387.

ESTENNE, M.; YERNAULT, J. C.; and DE TROYER, A. "Rib Cage and Diaphragm-Abdomen Compliance in Humans: Effect of Age and Posture." *Journal of Applied Physiology* 59 (1985): 1842–1848.

GILLOOLY, M., and LAMB, D. "Airspace Size in Lungs of Lifelong Non-Smokers: Effect of Age and Sex." *Thorax* 48 (1993): 39–43.

HANKINSON, J. L.; ODENCRANTZ, J. R.; and FEDAN, K. B. "Spirometric Reference Values from a Sample of the General U.S. Population." *American Journal of Respiratory Critical Care Medicine* 159 (1999): 179–187.

HUTCHINSON, J. "On the Capacity of the Lungs and On the Respiratory Functions, with a View of Establishing a Precise and Easy Method of Detecting Disease by the Spirometer." Med Chir Trans (London) 29 (1846): 137–252.

JONES, N. L., and KILLIAN, K. J. "Exercise Limitation in Health and Disease." *New England Journal of Medicine* 343 (2000): 632–641.

KEESTJENS, H. A. M.; RIJCKEN, B.; SCHOUTEN, J. P.; and POSTMA, D. S. "Decline in FEV_1 by Age and Smoking Status: Facts, Figures, and Fallacies." *Thorax* 52 (1997): 820–827.

LEBLANC, P.; RUFF, F.; and MILIC-EMILI, J. "Effects of Age and Body Position on Airway Closure in Man." *Journal of Applied Physiology* 28 (1970): 448–451.

NOSEDA, A.; VAN MUYLEM, A.; ESTENNE, M.; and YERNAULT, J. C. "Inspiratory and Expiratory Lung Pressure-Volume Curves in Healthy Males and Females." *Bull Eur Physiopathol Respir* 20 (1984): 245–249.

QUANJER, P. H.; TAMMELING, G. J.; COTES, J. E.; PEDERSEN, O. F.; PESLIN, R.; and YERNAULT, J. C. "Lung Volumes and Forced Ventilatory Flows." *European Respiratory Journal* 6, suppl. 16 (1993): 5–40.

VERBEKEN, E. K.; CAUBERGHS, M.; MERTENS, I.; CLEMENT, J.; LAUWERYNS, J. M.; and VAN DE WOESTIJNE, K. P. "The Senile Lung. Comparison with Normal and Emphysematous Lungs. I: Structural Aspects." *Chest* 101 (1992): 793–799.

VIEGI, G.; SHERRIL, D. L.; CARROZZI, L.; DI PEDE, F.; BALDACCI, S.; PISTELLI, F.; and ENRIGHT, P. "An 8-Year Follow-up of Carbon Monoxide Diffusing Capacity in a General Population Sample of Northern Italy." *Chest* 120 (2001): 74–80.

WEST, J. B. *Pulmonary Physiology and Pathophysiology*. Philadelphia: Lippincott Williams & Wilkins, 2001.

YERNAULT, J. C. "Dyspnoea in the Elderly. A Clinical Approach to Diagnosis." *Drugs Aging* 16 (2001): 177–187.

M

MALNUTRITION

Good nutritional status is essential to the maintenance of health and quality of life among older people. Normal changes associated with aging, along with physical illness and cognitive or emotional problems, can lead to dietary changes and contribute to undernutrition. Consequently, any deterioration in nutritional status can be considered a major determinant of morbidity and mortality in persons, especially those living in institutions or nursing homes.

Numerous changes in body composition occur after the age of seventy. Decreased bone mass, changes in the size of body organs, decreases in skeletal muscle and body water, and changes in body fat content contribute to losses in lean and fat body mass. Age-related decline in height is common, but its physiological or clinical importance to health is unknown. However, weight losses after age fifty are generally associated with deterioration in nutritional and overall health and mobility (Losonczy et al.)

Food and nutrient needs

Although food intake tends to decrease with age as a function of social, psychological, and physiological changes, distinct requirements exist for a range of nutrients to compensate for age-related changes in absorption, utilization, and excretion (ADA). For example, even though energy needs decline with age because of decreased basal metabolism, reduction in lean body mass, and a more sedentary lifestyle (Ausman and Russell), it becomes difficult to ensure adequate diet quality (Blumberg) when daily energy intake is too low (less than 1,500 calories or 6.3 megajoules). Furthermore, protein requirements exceed those of younger adults (1.0 to 1.25 gram/kilogram versus 0.8 gram/kilogram body weight, respectively) (Garry and Vellas), which argues for continued consumption of sufficient intakes of high-quality protein food. Finally, even though vitamin A requirements lessen with age, other nutrient needs may increase.

In addition to appropriate intakes of energy and high-quality protein, and sufficient complex carbohydrates and fats (especially the mono- and polyunsaturated fats), older people require specific levels of micronutrients (vitamins and minerals) to ensure metabolic function and overall health. Also, since degenerative changes of aging are believed to result, in part, from the oxidative destruction of cells and tissues, much recent study has centered on the risk-lowering properties of antioxidant nutrients that may protect against such damage at the cellular level (Masaki et al.). Emerging research thus is now targeting nutrients found in a group of common foods, many of which have antioxidant properties. These so-called functional foods are ordinary foods eaten in usual quantities.

Micronutrient requirements, published as the dietary reference intakes, or DRIs (NAS), were revised in 2001 for all age groups (see Table 1), and new evidence is emerging on the potential protective nature of adequate intake levels of specific vitamins and minerals in aging individuals. Nutrients such as folic acid, riboflavin, and vitamins B_6, B_{12}, and C may prevent some age-related decline in memory loss (Rosenberg and Miller), and reduce risk for vascular disease. Adequate calcium is needed to prevent osteoporosis, and vitamin D can have favorable effects on mus-

cle strength, bone mineral, and fracture risk (Heaney). Vitamins A and C and zinc are essential for competent immune system response and wound healing (Chandra). The antioxidants alpha-tocopherol (vitamin E), beta-carotene, and vitamin C may have consequences for aging and longevity (Hallfrisch et al.). These nutrients may also protect against cataract formation and age-related macular degeneration (Jacques), and the carotenoids lutein and zeaxanthin may protect the retina (Blumberg). Vitamin E in foods or supplements helps lessen risk of developing disorders such as Alzheimer's dementia and Parkinson's disease (Perkins et al.) as well as atherosclerosis (Kromhout). Vitamin K helps maintain bone density and lowers risk of reduced bone mass (Ferland). Sufficient dietary fiber is essential for prevention and/or treatment of constipation, hemorrhoids, diverticulosis, hiatal hernia, varicose veins, diabetes, elevated blood lipids, and obesity, and adequate fiber intake has also been related to decreased rates of heart disease and cancer (Ausman and Russell). Finally, adequate fluid intake is essential to prevent dehydration, which results in constipation, fecal impaction, cognitive impairment, functional decline, and, in extreme cases, death.

A varied diet can provide nutrient balance and adequate quantities of healthful foods. Physical activity, wise food selection, and greater intakes of enriched foods help increase total intake, nutrient density, and micronutrient levels. The modified Food Guide Pyramid was developed in the United States for people over the age of seventy to help them select appropriate foods (Russell et al.). This guide emphasizes nutrient-dense foods, dietary fiber, sufficient fluid intake, and the role of dietary supplements in maintaining adequate nutrient intakes. Recommendations include eating whole-grain cereals and breads; dark green, orange, and yellow fruits and vegetables to favor those with high levels of antioxidants; and using low-fat dairy products. The narrower base of the modified pyramid reflects the decreased needs for energy (calories) among older people.

Table 1
Dietary Reference Intakes (DRIs) for persons age 70-plus (NAS, 2000)

	DRIs	
NUTRIENT	**MALES**	**FEMALES**
Energy (kcal)	2000[1]	1700
Protein (g)	57	47
Calcium (mg)	1200[2]	1200
Phosphorus (mg)	580	580
Iron (mg)	6	5
Vitamin A (RE)	625[3]	500
Thiamin (mg)	1	0.9
Riboflavin (mg)	1.1	0.9
Niacin (EN)	12	11
Vitamin C (mg)	75	60
Folate (mcg)	320	320
Zinc (mg)	9.4	6.8
Vitamin B6 (mg)	1.4	1.3
Magnesium (mg)	350	265
Vitamin B12 (mcg)	2	2
Pantothenic acid (mg)	5.0[2]	5

[1] Recommended energy intakes for moderate activity levels
[2] Adequate intake (Estimated average requirement (EAR) not available)
[3] Based on revision of provitamin A activity; intakes could be overestimated

SOURCE: Author

Causes of malnutrition

In community-dwelling older people, dietary and nutritional adequacy depend on the ability to purchase and prepare food, and to eat independently. Among those living in institutions, the availability of dietary assistance when needed and appropriate meal presentation are additional nutrition considerations. The presence of disease or chronic conditions such as mobility problems, depression, or dementia, or medications with an effect on appetite can lead to a worsening nutritional situation. Aging adults, particularly those dependent on others, have been recognized as a group at nutritional risk (Sullivan and Walls). In sum, inadequate food intake and/or increased nutritional requirements can lead to malnutrition, and poor nutritional status is considered a key determinant of morbidity and mortality in elderly individuals (Sullivan and Walls).

In older people, most malnutrition is the consequence of decreased or inappropriate food intake. Common causes are loss of appetite, dysphagia, oral health problems such as poor dentition or dryness of the mouth, depression, polymedication, inappropriate use of restricted

or modified diets, physical and cognitive impairments, dementia, slowness in eating, inability to feed oneself, inadequate assistance in eating, suboptimal dining environment, and limited menu choices (Keller; Sullivan et al.). In addition, sensory problems, such as olfactory or taste dysfunction, may affect desire for and appreciation of food, thereby diminishing intake and increasing risk of chronic diseases. Finally, it has been shown that people with adequate dental status (especially those with natural teeth) have better dietary patterns than those with ill-fitting dentures or who are toothless, and this contributes to higher protein, vitamin, and mineral levels, and lower fat and cholesterol intakes. On the other hand, obesity in elderly people may be related to dietary imbalances, such as insufficient fruit and vegetable intakes and excessive meat intakes, or consumption of easily prepared, easy-to-chew, empty-calorie foods, which may contribute to or exacerbate health problems.

Weight loss, which signals an imbalance between energy intake and expenditure, is a well-known marker of nutritional status in older people. It leads to decline in functional abilities, increased risk of hip fracture, and early institutionalization and mortality, independent of coexisting disease states. Furthermore, this phenomenon has been observed in studies of widely different groups of elderly persons, ranging from those in good health (Harris et al.) to hospital patients (Franzoni et al.) and to individuals who require home care in order to continue living in the community (Payette et al.).

Loss of skeletal muscle mass, or sarcopenia (Rosenberg) is observed with aging even in well elderly people at a stable, healthy weight and the obese (Melton et al.). Sarcopenia is associated with decreased functional abilities and increased risk of falls among very old people (Rosenberg). This lowers energy needs (Poehlman et al.) and increases the likelihood of mobility problems and fractures resulting from osteoporosis (Melton et al.). In addition, it appears that older people with both sarcopenia and obesity are more likely than their nonobese sarcopenic or nonsarcopenic counterparts to suffer from physical disabilities and problems with balance and gait, and to experience falls (Baumgartner).

It now appears that many diseases associated with aging, including heart disease, diabetes, and infectious diseases, are associated with weight loss and wasting, or cachexia (Roubenoff and Harris). Intensive nutritional intervention has the potential to halt and reverse weight loss, and may even contribute to weight gain (Franzoni et al.), which could delay mortality in elderly chronic care patients (Keller). Indeed, it has been shown that women who maintain a consistent body weight after menopause are less likely to suffer fractures than those who systematically lose weight (Cummings et al.).

Prevalence of malnutrition

Estimates of nutrition risk in older persons vary by setting. For example, while it has been reported that some 15 percent of community-dwelling elders are undernourished, the prevalence of protein-energy malnutrition (PEM) among those living in nursing homes or institutions may range from 30 to 60 percent (Omran and Morely), depending on the component measured.

Risk of PEM increases with loss of appetite, decrease in usual weight, increased percentage of weight change in the previous year, and low body mass index (BMI) (White et al.). It has been suggested that loss of more than 4 percent of body weight in a one-year period predicts an increased risk of mortality. Indeed, weight loss alone usually heralds increased morbidity and mortality in elderly people (Losonczy et al.). Furthermore, unintentional weight loss is generally associated with advanced age, lower educational level, and poor health status. In the long-term care setting, malnourished residents are older and more dependent on others, and require more eating assistance than those with adequate nutrition status. Among participants in the Canadian Study of Health and Aging, low BMI, poor appetite, weight loss, and low levels of albumin (a protein that reflects nutrition status in older people) were highly intercorrelated and characterized nutritional risk, which was a significant independent predictor of mortality (Keller and Ostbye).

Weight loss and undernutrition in dementia

"Dementia" is a generic term covering degenerative diseases of the brain leading to problems with memory and other cognitive functions. Decreased food intake, eating behavior disturbances, and loss of body weight are significant problems among patients with Alzheimer's de-

mentia (AD) (White et al.). Indeed, it is typically observed that AD patients are at greater risk of weight loss and a worsening in their nutritional status than individuals without cognitive problems. Data collected over time suggest that weight loss precedes the onset or diagnosis of dementia (Barrett-Connor et al.) or occurs in the early stages of the disease (White et al.). While weight loss and undernutrition in this group are believed to have multiple origins, it also appears that resting metabolic rate is no higher in those with AD than in older persons with no cognitive problems (Donaldson et al.). Finally, although a poor dietary environment can have a negative effect on food intake, adequate nutritional status can be maintained even among institutionalized older people as long as patients have a favorable eating environment and appropriate dietary assistance (Shatenstein and Ferland).

Consequences of undernutrition

In elderly people, weight loss and undernutrition affect functional and cognitive abilities, and the immune response (Chandra). This may result in serious complications including difficulty in swallowing, dehydration, and pressure ulcers. Poor nutritional status also leads to decreased lean body mass, and lessened muscular strength and aerobic capacity. These changes contribute to a state of chronic fatigue, as well as alterations in gait and balance, which increase the probability of falls and fractures. For many older people, this sequence of events leads to a deterioration in their overall quality of life, causing the affected individual to become increasingly dependent on others. The ultimate cost to the individual and society is great.

BRYNA SHATENSTEIN

See also CONGREGATE AND HOME DELIVERED MEALS; DEMENTIA; DENTAL CARE; NUTRITION; SARCOPENIA; TASTE AND SMELL; VITAMINS.

BIBLIOGRAPHY

American Dietetic Association. "Position of the American Dietetic Association: Nutrition, Aging, and the Continuum of Care." *Journal of the American Dietetic Association*. 100 (2000): 580–595.

AUSMAN, L. M., and RUSSELL, R. M. "Nutrition in the Elderly." In *Modern Nutrition in Health and Disease,* 9th ed. Edited by M. E. Shils, J. A. Olson, M. Shike, and A. C. Ross. Baltimore: Williams & Wilkins, 1999. Pages 869–881.

BARRETT-CONNOR, E.; EDELSTEIN, S.; COREY-BLOOM, J.; and WIEDERHOLT, W. "Weight Loss Precedes Dementia in Community-Dwelling Older Adults." *Journal of American Geriatrics Society* 44 (1996): 1147–1152.

BLUMBERG, J. "Nutritional Needs of Seniors." *Journal of the American College of Nutrition* 16 (1997): 517–523.

CHANDRA, R. K. "Effect of Vitamin and Trace Element Supplementation on Immune Response and Infection in Elderly Subjects." *Lancet* 340 (1992): 1124–1127.

CUMMINGS, S. R.; NEVITT, M. C.; BROWNER, W. S.; STONE, K.; FOX, K. M.; ENSRUD, K. E.; CAULEY, J.; BLACK, D.; and VOGT, T. M. "Risk Factors for Hip Fracture in White Women. Study of Osteoporotic Fractures Research Group." *New England Journal of Medicine* 332, no. 12 (1995): 767–773.

DONALDSON, K. E.; CARPENTER, W. H.; TOTH, M. J.; GORAN, M. I.; NEWHOUSE, P.; and POEHLMAN, E. T. "No Evidence for a Higher Resting Metabolic Rate in Noninstitutionalized Alzheimer's Disease Patients." *Journal of American Geriatrics Society* 44, no. 10 (1996): 1232–1234.

FERLAND, G. "The Vitamin K-Dependent Proteins: An Update." *Nutrition Reviews* 56, no. 8 (1998): 223–230.

FRANZONI, S.; FRISONI, G. B.; BOFFELLI, S.; ROZZINI, R.; and TRABUCCHI, M. "Good Nutritional Oral Intake is Associated with Equal Survival in Demented and Nondemented Very Old Patients." *Journal of the American Geriatrics Society* 44 (1996): 1366–1370.

GARRY, P. J., and VELLAS, B. J. "Aging and Nutrition." In *Present Knowledge in Nutrition,* 7th ed. Edited by E. E. Ziegler and L. J. Filer, Jr. Washington, D.C.: ILSI Press, 1996. Pages 414–419.

HALLFRISCH, J.; MULLER, D. C.; and SINGH, V. N. "Vitamin A and E Intakes and Plasma Concentrations of Retinol, Beta-Carotene, and Alpha-Tocopherol in Men and Women of the Baltimore Longitudinal Study of Aging." *American Journal of Clinical Nutrition* 60 (1994): 176–182.

HARRIS, T. B.; LOOKER, A. C.; MADANS, J.; and BACON, E. C. "Weight Loss and Risk of Hip Fracture in Postmenopausal White Women Aged 60–74. The NHANES-1 Epidemiologic Follow Up Study." *Journal of American Geriatrics Society* 40 (1992): SA5.

HEANEY, R. P. "Age Considerations in Nutrient Needs for Bone Health: Older Adults." *Jour-*

nal of the American College of Nutrition 15 (1996): 575–578.

JACQUES, P. F. "The Potential Preventive Effects of Vitamins for Cataract and Age-Related Macular Degeneration." *International Journal of Vitamin and Nutrition Research* 69 (1999): 198–205.

KELLER, H. H. "Weight Gain Impacts Morbidity and Mortality in Institutionalized Older Persons." *Journal of American Geriatrics Society* 43, no. 2 (1995): 165–169.

KELLER, H. H., and OSTBYE, T. "Do Nutrition Indicators Predict Death in Elderly Canadians with Cognitive Impairment?" *Canadian Journal of Public Health* 91, no. 3 (2000): 220–224.

KROMHOUT, D. "Fatty Acids, Antioxidants, and Coronary Heart Disease from an Epidemiological Perspective." *Lipids* 34, supp. (1999): S27–S31.

LOSONCZY, K. G.; HARRIS, T. B.; CORNONI-HUNTLEY, J.; SIMONSICK, E. M.; WALLACE, R. B.; COOK, N. R.; OSTFELD, A. M.; and BLAZER, D. G. "Does Weight Loss from Middle Age to Old Age Explain the Inverse Weight Mortality Relation in Old Age?" *American Journal of Epidemiology* 141, no. 4 (1995): 312–321.

MASAKI, K. H.; LOSONCZY, K. G.; IZMIRLIAN, G.; FOLEY, D. J.; ROSS, G. W.; PETROVITCH, H.; HAVLIK, R.; and WHITE, L. R. "Association of Vitamin E and C Supplement Use with Cognitive Function and Dementia in Elderly Men." *Neurology* 54 (2000): 1265–1272.

MELTON, L. J.; KHOSLA, S.; CROWSON, C. S.; O'CONNOR, M. K.; O'FALLON, W. M.; and RIGGS, B. L. "Epidemiology of Sarcopenia." *Journal of the American Geriatrics Society* 48 (2000): 625–630.

National Academy of Sciences (NAS). "Dietary Reference Intakes: Applications in Dietary Assessment," 2000. www.nap.edu

OMRAN, M. L., and MORELY, J. E. "Assessment of Protein Energy Malnutrition in Older Persons, Part 1: History, Examination, Body Composition, and Screening Tools." *Nutrition* 16 (2000): 50–63.

PAYETTE, H.; COULOMBE, C.; BOUTIER, V.; and GRAY-DONALD, K. "Weight Loss and Mortality Among the Free-Living Frail Elderly: A Prospective Study." *Journal of Gerontology: Medical Sciences* 54A (1999): M440–M445.

PERKINS, A. J.; HENDRIE, H. C.; CALLAHAN, C. M.; GAO, S.; UNVERZAGT, F. W.; XU, Y.; HALL, K. S.; and HUI, S. L. "Association of Antioxidants with Memory in the Multiethnic Elderly Sample Using the Third National Health and Nutrition Examination Survey." *American Journal of Epidemiology* 150 (1999): 37–44.

POEHLMAN, E. T. "Energy Expenditure and Requirements in Aging Humans." *Journal of Nutrition* 122 (1992): 2057–2065.

ROSENBERG, I. H. "Sarcopenia: Origins and Clinical Relevance." *Journal of Nutrition* 127 (1997): 990S–991S.

ROSENBERG, I. H., and MILLER, J. W. "Nutritional Factors in Physical and Cognitive Functions of Elderly People." *American Journal of Clinical Nutrition* 55 supp. (1992): 1237S–1243S.

ROUBENOFF, R., and HARRIS, T. B. "Failure to Thrive, Sarcopenia, and Functional Decline in the Elderly." *Clinical Geriatric Medicine* 13 (1997): 613–621.

RUSSELL, R. M.; RASMUSSEN, H.; and LICHTENSTEIN, A. H. "Modified Food Guide Pyramid for People Over Seventy Years of Age." *Journal of Nutrition* 129, no. 3 (1999): 751–753.

SHATENSTEIN, B., and FERLAND, G. "Absence of Nutritional or Clinical Consequences of Decentralized Bulk Food Portioning in Elderly Nursing Home Residents with Dementia in Montreal." *Journal of the American Diet Association* 100, no. 11 (2000): 1354–1360.

SULLIVAN, D. H., and WALLS, R. C. "Impact of Nutritional Status on Morbidity in a Population of Geriatric Rehabilitation Patients." *Journal of the American Geriatrics Society* 42 (1994): 471–477.

WHITE, H.; PIEPER, C.; SCHMADER, K.; and FILLENBAUM, G. "Weight Change in Alzheimer's Disease." *Journal of the American Geriatrics Society* 44, no. 3 (1996): 265–272.

MANAGED CARE

See MEDICARE

MARITAL RELATIONSHIPS

A stable and satisfying marriage can provide an important source of emotional and instrumental support throughout adulthood, and is associated with increased economic well-being, mental health, and physical health. Some of these apparent benefits of marriage may result from improved health behaviors among married people, care and monitoring provided by a spouse, or by selection of the healthiest, happiest, and most economically secure men and women into stable marriages in the first place. Although the exact nature of processes producing these positive outcomes is not well understood, marriage is associated with important benefits for older Americans.

Gender differences in marriage

The experience of marriage in later life differs substantially by gender. Indeed, a larger proportion of older men than women are married, reflecting the tendency for women to marry men somewhat older than themselves, gender differences in rates of remarriage after divorce or widowhood, as well as gender differences in longevity. While approximately 77 percent of men age sixty-five to seventy-four were living with a spouse in 1999, the same was true for only 53 percent of similarly aged women (Smith and Tillipman). In addition to gender differences in the level of marriage, research points to important differences in the character of marital relationships in later life. For example, some research suggests that older husbands are more likely to name their spouse as a primary confidant, and less likely to name someone other than their spouse as a confidant, than are older wives. These results suggest that men may be relatively more dependent on marriage for interpersonal involvement and intimacy in later life than are women (Tower and Kasl). Older women, however, tend to be more economically dependent on the marital relationship than are their husbands. This gender difference in economic dependency is likely to decline for subsequent cohorts of elderly women due to improvements over time in women's participation and position in the labor market.

Changes in marital relationships over the life course

Marital quality is among the most heavily studied aspects of marital relationships, which is not surprising given its strong association with the stability of marital unions. Measures of marital quality are most often based on reports of the level of happiness or satisfaction with one's marriage. Social scientists once generally believed that marital quality followed a U-shaped pattern over the life course, declining in the early years of marriage and then rising again at midlife. This pattern was thought to result from a reduction in the compatibility of spouses over time or from changes in the marital relationship associated with the shifting demands of child rearing and other social roles over the life course. The evidence for such a pattern, however, was based largely on cross-sectional samples, which infer rather than demonstrate change over the course of individual marriages. Analyses of longitudinal data conducted in the 1990s support the notion that marital quality declines early in marriage, but do not suggest that marital quality recovers again in midlife (Glenn; Vaillant and Vaillant). Instead, these studies suggest that marital quality remains relatively stable during the later years of marriage.

Despite this apparent lack of improvement in marital quality beyond midlife, and evidence of a general decline in the level of marital happiness in the United States during the latter half of the twentieth century, the majority of people still in their marriages in later life report these relationships as being happy or very happy. Of course, it is likely that many unhappily married couples end their unions through divorce earlier in life. Studies of long-lasting marriages suggest that commitment to one's spouse and to the institution of marriage, viewing one's spouse as a best friend, and sharing similar life goals and a sense of humor characterize these durable relationships (Lauer, Lauer, and Kerr). Although more research has been conducted on the content of marital interaction among young couples than among relatively older couples, there is some evidence that the interactions of older couples are less emotional but more affectionate than the interactions of middle-aged couples (Cartensen, Gottman, and Levenson). Older couples have also been found to display lower levels of anger, disgust, belligerence, and whining in their interactions than middle-aged couples.

Factors affecting marital relationships in later life

Several factors are associated with variation in subjective assessments of marital quality in later life. For example, men are more likely to report high satisfaction with their marriages in later life than are women, highlighting the fact that assessments of marital quality may vary depending on which spouse is asked. Some research further suggests that marital quality tends to be higher for better educated individuals and for people who attend religious services frequently, but lower for people who report less satisfaction with their division of household labor (Karney and Bradbury; Suitor). Perceptions of the fairness in the division of household labor, however, more strongly affect assessments of marital satisfaction among wives than among husbands.

Much attention has been paid to the impact of retirement on marital relationships in later

Married on January 18, 1918, Paul and Mary Onesi posed for this photo on their eightieth wedding anniversary, which made them the longest-married couple in the United States at the time. Paul, 101, and Mary, 93, credited their longevity to always talking through their problems. (AP photo by Bill Sikes.)

life. Demographic trends such as increasing numbers of women in the workforce and longer life expectancy suggest that retirement is increasingly becoming a couple event, meaning that both husband and wife tend to retire together and adapt simultaneously to each other's retirement (Szinovacz and Ekerdt). Retirement may reduce role conflicts and time constraints experienced by men and women, increase the amount of time couples spend with one another, and offer the potential for a reshuffling of domestic roles. Despite this potential for major change in the context of marital relationships in later life, much research suggests that retirement has little effect on overall levels of marital satisfaction among older couples. Indeed, many studies show that retired couples who are currently happy with their marriages also tended to have been happy with their marriages before they retired. Yet, the context in which retirement occurs is important. For example, marital satisfaction may deteriorate and marital conflict may increase if husbands retire before their wives, perhaps because wives tend to retain responsibility for the majority of household chores (Lee and Shehan). Although many men do increase their participation in household tasks upon retirement, this effort tends to be directed toward projects such as home remodeling or heavy outdoor work, leading to little reduction in the daily chores performed by women (Vinick and Ekerdt).

Finally, marital relationships can be affected by changes in the health status of spouses that require one spouse to become the primary caregiver for the other. A large proportion of the research on caregiving's impact on the marital relationship has focused on individuals caring for spouses with dementia, although this literature has also examined other forms of mental and physical impairment. Taken together, this body of research suggests that marital quality and intimacy tend to decline under the strain of deteriorating health and caring for an ill spouse (e.g., Kramer and Lambert; Booth and Johnson). A spouse's poor health appears to have larger negative effects on perceptions of marital quality than does the deterioration of one's own health. Although findings vary across studies, some evidence suggests that caregiving wives are more likely to report strain, depression, and negative feelings toward their marriages than caregiving husbands. These gender differences are more pronounced, however, when the spouse in need of care is cognitively impaired, perhaps because the resulting loss of reciprocity in the marital relationship impacts the well-being of women more than men (Hooker et al.). Wives also tend to provide more care than husbands when their spouses become ill or impaired, which may further explain women's relatively higher level of stress in the caregiving role (Allen).

Discussion

Taken together, these findings suggest that couples whose marriages survive into later life can generally look forward to happy and satisfying relationships. More research is needed, however, to better understand how marital relationships in later life may vary across racial, ethnic, and socioeconomic subpopulations. More longitudinal analyses of representative samples are also needed to examine how individual marriages change over time and in response to important life events such as retirement and declines in health.

In conclusion, it is important to place the experiences of older Americans at the beginning of the twenty-first century in historical context, as demographic trends point to change in the context of marital relationships for subsequent cohorts of older adults. For example, changing social norms and improved economic opportunities for women have increased the overall labor force participation of wives. The effect of these changes on gender relations within later life marriages will be more strongly felt in the years to come, as cohorts of women who experienced high rates of labor force participation throughout their lives move into increasingly older age groups. High levels of divorce further suggest that increasing numbers of Americans will be unmarried as they enter old age. To the extent that marriage is associated with benefits in terms of health and well-being in later life, it is important that we better understand the mechanisms underlying these observed relationships, and identify alternative sources of emotional and instrumental support among older adults.

MEGAN M. SWEENEY
ELAINE M. REPLOGLE

See also DIVORCE: TRENDS AND CONSEQUENCES; MARRIAGE AND REMARRIAGE; RETIREMENT, TRANSITION.

BIBLIOGRAPHY

ALLEN, S. M. "Gender Differences in Spousal Caregiving and Unmet Need for Care." *Journal of Gerontology: Social Sciences* 49 (1994): S187–S195.

BOOTH, A., and JOHNSON, D. R. "Declining Health and Marital Quality." *Journal of Marriage and the Family* 56 (1994): 218–223.

CARTENSEN, L. L.; GOTTMAN, J. M.; and LEVENSON, R. W. "Emotional Behavior in Long-Term Marriage." *Psychology and Aging* 10 (1995): 140–149.

GLENN, N. D. "The Course of Marital Success and Failure in Five American 10-Year Marriage Cohorts." *Journal of Marriage and the Family* 60 (1998): 569–576.

GOLDSCHEIDER, F. K. 'The Aging of the Gender Revolution: What Do We Know and What Do We Need to Know?" *Research on Aging* 12 (1990): 531–545.

HOOKER, K.; MANOOGIAN-O'DELL, M.; MONAHAN, D. J.; FRASIER, L. D.; and SHIFREN, K. "Does Type of Disease Matter? Gender Differences Among Alzheimer's and Parkinson's Disease Spouse Caregivers." *The Gerontologist* 40 (2000): 568–573.

KARNEY, B. R., and BRADBURY, T. N. "The Longitudinal Course of Marital Quality and Stability: A Review of Theory, Method, and Research." *Psychological Bulletin* 118 (1995): 3–34.

KRAMER, B. J., and LAMBERT, J. D. "Caregiving as a Life Course Transition Among Older Husbands: A Prospective Study." *The Gerontologist* 39 (1999): 658–667.

LAUER, R. H.; LAUER, J. C.; and KERR, S. T. "The Long-term Marriage: Perceptions of Stability and Satisfaction." *International Journal of Aging and Human Development* 31 (1990):189–195.

LEE, G. R., and SHELAN, C. L. "Retirement and Marital Satisfaction." *Journal of Gerontology* 44 (1989): S226–S230.

SMITH, D., and TILLIPMAN, H. "The Older Population in the United States." *Current Population Reports P20–532*. Washington D.C.: U.S. Government Printing Office, 2000.

SUITOR, J. J. "Marital Quality and Satisfaction with the Division of Household Labor across the Family Life Cycle." *Journal of Marriage and the Family* 53 (1991): 221–230.

SZINOVACZ, M. E., and EKERDT, D. J. "Families and Retirement." In *Handbook of Aging and the Family*. Edited by Rosemary Blieszner and Victoria H. Bedford. Westport, Conn.: Greenwood Press, 1995. Pages 375–400.

TOWER, R. B., and KASL, S. V. "Gender, Marital Closeness, and Depressive Symptoms in Elderly Couples." *Journal of Gerontology: Psychological Sciences* 51B (1996): P115–P129.

VAILLANT, C. O., and VAILLANT, G. E. "Is the U-Curve of Marital Satisfaction an Illusion? A 40-Year Study of Marriage." *Journal of Marriage and the Family* 55 (1993): 230–239.

VINICK, B. H., and EKERDT, D. J. "Retirement: What Happens to Husband-Wife Relationships?" *Journal of Geriatric Psychiatry* 24 (1991): 23–40.

MARRIAGE AND REMARRIAGE

Throughout history, the formation of marriages has been primarily between young adults, and that remains true in the United States and other modern societies. In late twentieth-century America, however, marital union formation became spread through the adult life span to an unprecedented extent, the average age of those marrying around the end of the century being substantially higher than it was fifty years earlier and moderately higher than it was a century earlier.

This increase in the average age of those entering marriage resulted from a rise both in the typical age at first marriage and in the proportion of marriages involving previously married persons. The former change occurred primarily in the 1980s and the latter in the 1970s and early 1980s, so the age distribution of those entering marriage changed rather dramatically in just one decade, from 1980 to 1990. The percentage of men who married who were under age twenty declined from 8.5 to 4.3, and the comparable percentage for women went from 21.1 to 10.6. The percentage of marrying persons who were under age twenty-five dropped from 44.2 to 29.0 for men and from 58.2 to 39.9 for women. In contrast, the percentage who were age thirty-five or older rose from 19.7 to 27.4 for men and from 13.8 to 21.0 for women.

By the early to middle 1980s the proportion of marriages in which at least one of the spouses was remarrying leveled off at about 46 percent, up from 31.4 percent in 1970. (The latest available data are for 1988, but there is little reason to believe that this proportion had changed much by the end of the century.) In 1990, the latest year for which relevant data are available, the median age of those remarrying after divorce was 37.4 for men and 34.2 for women, compared with 25.9 and 24.0, respectively, for men and women marrying for the first time. By the end of the twentieth century it had become common for persons remarrying after divorce to be in their forties and fifties. The median age of persons remarrying after widowhood was of course higher than that for those remarrying after divorce, and that age rose moderately, going from 51.2 to 54.0 for women and from 58.7 to 63.1 for men in the 1970–1990 period. Clearly, entering into marriage was no longer a common experience only for young adults.

The median age of persons entering first marriages went from 22.5 for men and 20.6 for women in 1970 to 26.8 and 25.0, for men and women, respectively, in 1997. This change apparently resulted partly from an increased tendency for couples to live together before marrying; the typical age at which marrying couples started cohabitation rose less than the typical age at which they married, though the exact extent of the difference is not known. Among the likely reasons often given for the increase in the median age at first marriage are (a) an increase in the ability of unmarried young adults to enter into sexual relationships, with or without cohabitation, and (b) a decline in the earnings of young adult males.

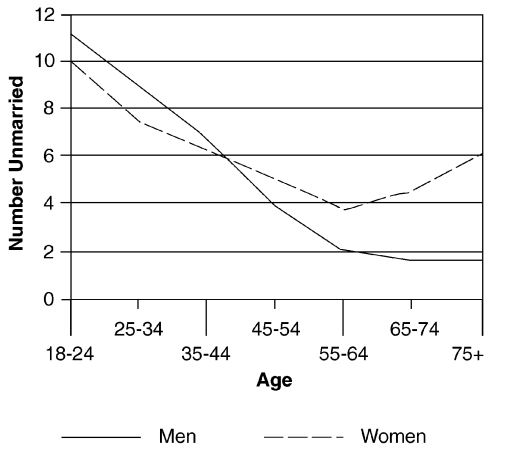
The increase in the typical age of those entering marriages has had important implications for how persons meet and choose their spouses. In the 1950s and 1960s, most people married soon after they completed their formal education, and many if not most of those married someone they met in school or college. By the end of the twentieth century, most people were marrying a few years after completion of their formal education, and the proportion who married someone they met in school or college had almost certainly declined. Work settings typically provide limited opportunities for meeting appropriate prospective spouses, and getting to know a large number and wide variety of eligible persons of the opposite sex is difficult for many single working people. This is especially true of single parents, who usually have very limited time and energy to seek spouses. Furthermore, single parents' search for spouses is complicated by the fact that each parent and his or her child or children are "on the market" as a package, which makes fewer prospective spouses acceptable and attractable.

The search for a spouse is more difficult for middle-aged and elderly women than for similarly aged men, because higher mortality among males produces a scarcity of men beyond early adulthood. More boys than girls are born (about 105.5 boys for every 100 girls), but that ratio declines within a birth cohort (the persons born during the same year or other period) as it grows older, so that in the twenties there are about equal numbers of males and females. In 1998, the number of males per 100 females in the United States was 98.6 at ages twenty-five to forty-four, 93.7 at ages forty-five to sixty-four, and 70.3 among persons age sixty-five and older.

The sex ratio among older persons is even more unbalanced for unmarried than for all persons, as shown by the number of unmarried persons by sex and age in the United States in 1998 (see Figure 1). Beyond about age forty, there were more unmarried women than men—a difference that was greater at the older ages. In the fifty-five to sixty-four age range, there were almost twice as many unmarried women as unmarried men, and in the range of seventy-five and older, more than three quarters of the unmarried persons were women.

The consequences of the decline in the sex ratio in aging birth cohorts on the relative mar-

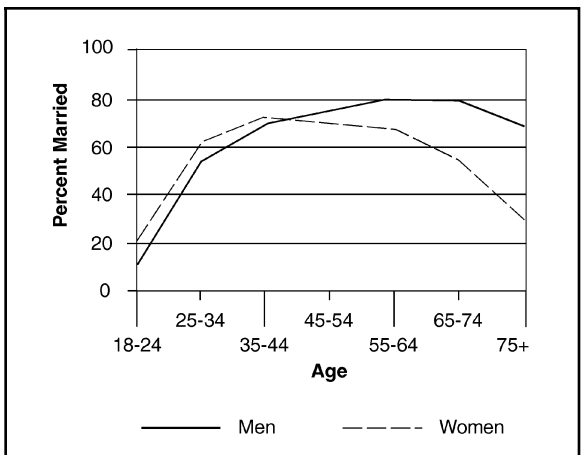
Figure 1
Number of Unmarried Persons (In Millions) by Sex and Age, United States, 1998



Age	Men	Women
18–24	11.2	10.0
25–34	9.0	7.5
35–44	6.8	6.2
45–54	3.9	5.1
55–64	2.1	3.7
65–74	1.7	4.5
75+	1.7	6.1

SOURCE: Author

Figure 2
Percent of Persons Married, by Sex and Age, United States, 1998



Age	Men	Women
18–24	11.3	20.5
25–34	54.1	62.2
35–44	69.1	72.1
45–54	76.3	70.8
55–64	80.2	67.8
65–74	79.2	54.8
75+	69.2	29.5

SOURCE: Author

riage prospects of older men and women are exacerbated by the practice of men marrying women younger than themselves—the typical age difference between husband and wife being greater for those who marry at older ages. Among Americans marrying for the first time in 1990, the median age of the men was 1.9 years greater than that of the women. Among persons remarrying after divorce, the male-female difference in median age was 3.2 years, and among persons remarrying after being widowed it was 9.1 years.

As a result of male-female mortality differences and age disparities between husbands and wives, the remarriage rate of divorced and widowed persons is substantially higher for men than for women. For instance, in 1990 (the last year for which data are available) the number of marriages per 1,000 persons was 105.9 for divorced men but only 76.2 for divorced women, and the rate for widowed persons was 23.8 and 5.2, for men and women, respectively.

It follows that the pattern of marital status by age must differ substantially for men and women (see Figure 2). In the United States in 1998, the proportion of women who were married was highest in the age range of thirty-five to forty-four, in which a little more than 70 percent were married. In contrast, the proportion of men who were married was highest in the age range of fifty-five to seventy-four, in which about 80 percent were married. Among persons age seventy-five and older, the proportion married was more than twice as great for men as for women.

Beyond the basic demographic facts, relatively little is known about late-life marriages. For instance, there is no systematic evidence on how the very favorable marriage-market situation of older men affects the mate selection process or the nature (such as relative husband—wife power) of the marriages formed among older adults. Little is known about how and where middle-aged and older persons meet the persons they marry and about the characteristics they seek in potential spouses. Nor is much

known about how the marital choices, including the decision to marry or not, of older persons are affected by relatives, friends, and acquaintances. The adult offspring of older persons who marry, or who consider marriage, are of course often concerned about how a parent's marriage will affect their inheritance. On the other hand, the remarriage of an elderly person sometimes eases the burden of care on offspring and other relatives. Whether adult offspring typically support or oppose a parent's decision to remarry is not known.

A desire to protect the financial interests of heirs has led many remarrying older persons in recent years to enter into prenuptial agreements with their new spouses to keep their property separate or in some other way to limit the claim of each spouse on the property the other has at the time of marriage. Placing property in trusts for offspring, grandchildren, or other relatives is also a common method used by wealthier persons to protect heirs from adverse financial consequences of remarriage.

A deterrent to the remarriage of many widowed persons is the loss or reduction of pensions, medical insurance, or other survivors' benefits that remarriage can cause. This, along with the value changes that have affected the living arrangements of younger persons, has led to an increase in nonmarital cohabitation among widows and widowers. Some older couples who are opposed on religious grounds to living together without being married have persuaded clergymen to perform marriage ceremonies without licenses or registration with the state so they can feel married "in the eyes of God." The prevalence of such informal marriages is not known, nor is it known how persons in such marriages report their marital status in census and other surveys.

NORVAL D. GLENN

See also MARITAL RELATIONSHIPS.

BIBLIOGRAPHY

ATCHLEY, R. C. *Social Forces and Aging—An Introduction to Social Gerontology,* 9th ed. Belmont, Calif.: Wadsworth Pub. Co., 1999.

BRUBAKER, T. H., ed. *Family Relationships in Later Life*. Newbury Park, Calif.: Sage, 1990.

U.S. Census Bureau. *Statistical Abstract of the United States: 1999,* 119th ed. Washington, D.C.: U.S. Government Printing Office, 1999.

MEAL PROGRAMS

See CONGREGATE AND HOME-DELIVERED MEALS

MEDIA

See IMAGES OF AGING

MEDICAID

Millions of elderly people in the United States have extensive health care needs and expenses, but many have limited incomes or savings to help them cover the cost of care. Virtually all elderly Americans have Medicare, the federal health insurance program for elderly and disabled Americans, to help pay medical bills. However, limits in the scope of benefits, coupled with financial obligations for coverage, can impose a serious financial burden. Elderly persons with low incomes are particularly vulnerable to these burdens because they are more likely to have health problems than higher-income Medicare beneficiaries, yet are less able to afford care. In addition, they are less likely to be able to access or afford the supplemental coverage that many Medicare beneficiaries purchase to help fill in Medicare's gaps.

Medicaid, a means-tested entitlement program that provides health coverage to low-income Americans, serves as an important complement to Medicare by assisting low-income Medicare beneficiaries with Medicare premiums and cost-sharing, and by providing coverage for prescription drugs and long-term care services not available through Medicare. Medicaid's supplemental coverage helps many low-income elderly persons gain access to needed health services and provides financial security from the high cost of care.

The need for medical assistance

In general, elderly persons are less healthy and have greater health care needs than the general population. Nearly a third of people age sixty-five and over report that their health status is poor or fair, compared to 18 percent of people age 55 to 64 and just 6 percent of those age 25 to 44. A significant percent of elderly persons live with serious or disabling health problems, such as arthritis (56 percent), hypertension (53 percent), and heart disease (36 percent), and many live with multiple chronic conditions (69 per-

cent). These are all conditions that require increased contact with the health care system and ongoing care, including frequent visits with a health care provider, prescription medications, and, at times, hospitalization or other inpatient medical services.

Medicare coverage

The Medicare program provides basic health coverage to most persons age 65 and older, regardless of income, assuring them access to the health system and protection from financial catastrophe when illness strikes. Medicare consists of two parts: Hospital Insurance (Part A), which covers inpatient hospital care, limited skilled nursing facility care, and home health and hospice services, and Supplementary Medical Insurance (Part B), which covers physician and outpatient hospital services, as well as some other screening, laboratory, and home health services. However, the program does not cover all medical services that elderly people need (most notably, prescription drugs and nursing home care) and requires beneficiaries to pay monthly premiums and some portion of the cost of services at the point of care. For example, in 2002 the deductible for Part A was $812 and beneficiaries had to pay some portion of the charge for extended hospital stays. Medicare also requires a monthly ($100 in 2002) premium for Part B coverage ($54 in 2002) and 20 percent coinsurance after the Part B deductible ($100 in 2002) is met.

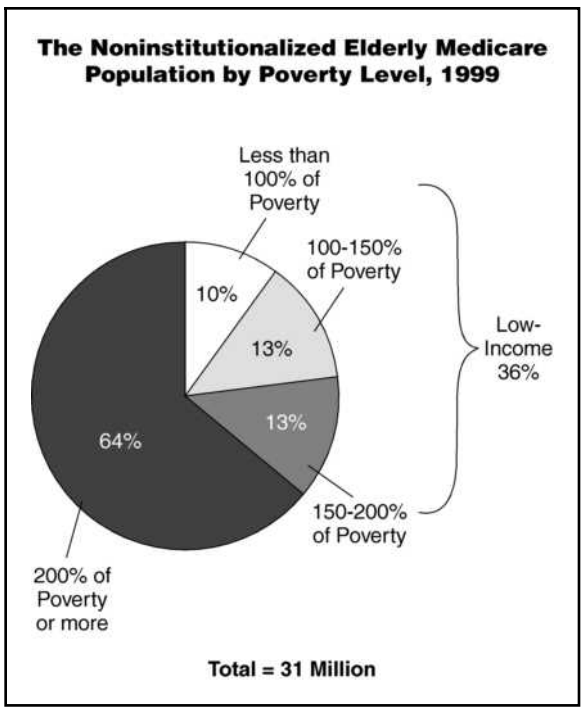
While many Medicare recipients purchase supplemental insurance to help with these cost-sharing obligations, these requirements can impose a substantial financial burden on the more than eleven million elderly Medicare beneficiaries (36 percent) who are poor or near-poor (see Figure 1). Not only do many Medicare beneficiaries live on modest incomes, but most rely on Social Security benefits as their main source of income. Social Security benefits are often quite modest—the average in 2001 was about $800 per month. However, these benefits are the major source of income for nearly two-thirds of beneficiaries. Living on fixed incomes with little potential for additional earnings leaves these beneficiaries with minimal cushion to absorb additional medical costs.

The potential burden of medical costs is particularly important to low-income elderly people because they are more likely to need medical services than higher-income beneficiaries. Poor elderly Medicare beneficiaries are nearly twice as likely as higher-income beneficiaries to report their health status as fair or poor, and they are more likely to live with multiple chronic conditions and functional limitations than elderly people with higher incomes. Poor health status and chronic medical conditions translate into higher costs due to the increased need for medication and physician supervision, as well as the need for nonmedical support services such as transportation and personal care assistance with daily tasks such as bathing and cooking.

To provide assistance in covering the cost of uncovered Medicare services and Medicare cost-sharing, many elderly persons have supplemental coverage in addition to Medicare. There are different types of supplemental coverage, and the cost and scope of benefits vary. Thirty-six percent of Medicare beneficiaries have employer-sponsored retiree coverage. This type of coverage is typically very generous, covering a wide range of benefits and limiting beneficiaries' out-

Figure 1

SOURCE: Urban Institute estimates based on 2000 Current Population Survey. Kaiser Commission on Medicaid and the Uninsured.



NOTE: In 1999, the federal poverty level was $8,240 for individuals, $11,060 for couples.

of-pocket costs. Another source of supplemental coverage is individually purchased *Medigap* policies, which about a quarter of Medicare beneficiaries hold. Beneficiaries pay monthly premiums for Medigap coverage—on average $100 per month, though policies range in cost from about $1,400 to $4,700 per year, depending on where a person lives, the level of coverage they obtain, and their age.

Supplemental coverage of Medicare beneficiaries varies significantly by income (see Figure 2). Higher-income beneficiaries are more likely to have worked in jobs that offer retiree coverage, and higher- and moderate-income beneficiaries are also more likely to purchase Medigap policies. Lower-income beneficiaries, in contrast, are more likely to rely solely on Medicare. This difference in coverage exists because low-income elderly people are less likely to have worked in jobs that offer private supplemental coverage after retirement. In addition, though many purchase Medigap policies, the high cost of such coverage is unaffordable for some.

Ultimately, poor Medicare beneficiaries bear a disproportionate burden in out-of-pocket health care costs, spending more than a third of their income on health care, compared to 10 percent for higher-income beneficiaries. These costs may lead some elderly people into impoverishment or force them to choose between covering their health care costs and paying for other basic necessities.

Medicaid coverage for elderly persons

Medicaid, the nation's major public financing program for providing health and long-term care coverage to low-income people, fills in Medicare's gaps for millions of low-income elderly people. Medicaid is jointly funded by federal and state governments and administered by the states. Enacted as Title XIX of the Social Security Act in 1965, the program has evolved from one that primarily covered people receiving cash assistance to being an essential provider of health and long-term care coverage for over forty million low-income Americans.

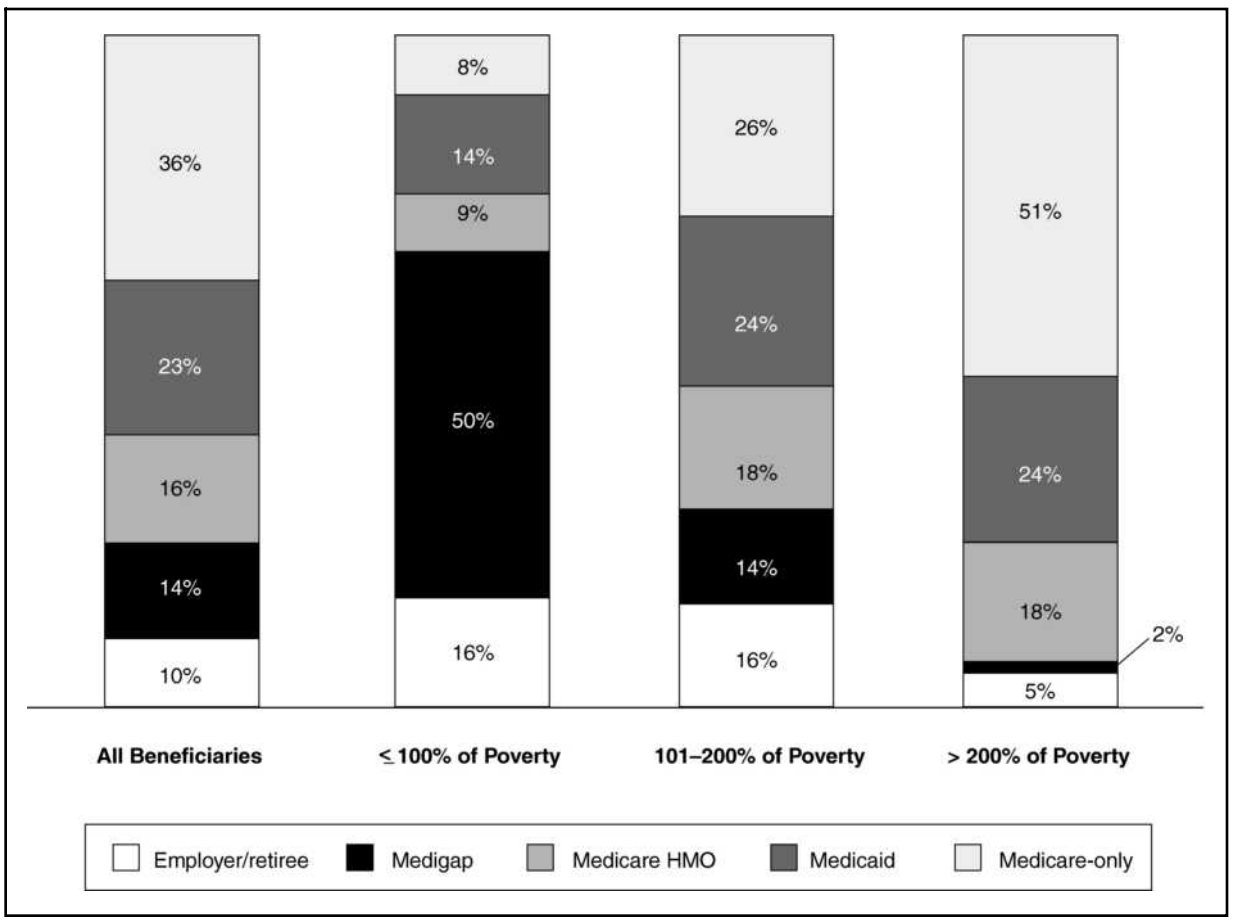
Medicaid coverage is targeted to people who have low incomes, few assets, and who fall into particular categories, such as low-income children, some poor parents, pregnant women, people with disabilities, and elderly persons. In 1998, the program covered over four million elderly people, accounting for about 10 percent of total Medicaid enrollment and about 12 percent of elderly people on Medicare.

There are several pathways through which elderly people can become eligible for Medicaid assistance, and the scope of coverage varies according to which pathway is used (see Table 1). The poorest Medicare beneficiaries—those who are receiving or eligible for cash assistance through the Supplemental Security Income (SSI) program—receive assistance with all of Medicare's financial requirements and are also covered for the full range of Medicaid benefits. These benefits wrap around and supplement Medicare coverage. People who have exhausted their personal resources paying for health and long-term care services to the point that their available incomes fall below cash assistance income standards are also eligible for the same level of benefits. States also have the option to provide this level of coverage to elderly persons with slightly higher incomes or assets.

The majority of elderly people receiving Medicaid assistance fall into one of these groups and receive full Medicaid benefits. Because Medicaid supplements Medicare benefits, these beneficiaries (known as *dual eligibles*) rely on Medicaid primarily for services not covered by Medicare, such as prescription drugs and long-term care, and for coverage of Medicare's premiums and cost-sharing.

Other low-income beneficiaries are eligible to receive assistance primarily limited to Medicare financial requirements (most notably, Part B premiums and cost-sharing), through four related programs, which are often referred to as the *buy-in programs* or "Medicare savings programs." Since the programs' inception in 1965, states have had the option to buy-in the poor to Medicare by paying their Part B premium and cost-sharing. In the late 1980s and the 1990s, the federal government expanded the Medicaid buy-in to assist low-income Medicare beneficiaries with the growing cost of Medicare premiums and cost-sharing. The first initiative was the Qualified Medicare Beneficiary (QMB) program, through which Medicaid pays the Medicare cost-sharing requirements and the Part B premium for beneficiaries with incomes below the federal poverty level (in 2000, the poverty level was $8,350 for an individual and $11,250 for couples) and limited assets. The Specified Low-Income Medicaid Beneficiary (SLMB) program pays the Part B

Figure 2
Health Insurance Coverage of Medicare Beneficiaries, 1998
SOURCE: Urban Institute analysis of 1998 Medicare Current Beneficiary Survey. Kaiser Commission on Medicaid and the Uninsured.



NOTE: Columns may not sum to 100 percent; employer/retiree includes both beneficiaries who have supplemental insurance from a former employer or union and those who are still working and whose current employer is their primary source of insurance.

premium for people with incomes between 100 and 120 percent of the federal poverty level and limited assets. Finally, the Qualified Individual (QI) programs provide a set amount of money to provide some assistance to Medicare beneficiaries with higher incomes (up to 175 percent of poverty) on a first come, first served basis.

Delivering Medicaid services to elderly persons

Because of the more extensive health care needs of elderly Medicaid beneficiaries, the elderly population accounts for a substantial share of spending under Medicaid. Of the $169 billion in total Medicaid expenditures in 1998, $46 billion (27 percent) was spent on services for the 10 percent of beneficiaries who were low-income elderly persons. Nearly three-quarters of Medicaid spending on the elderly population was for long-term care services, primarily nursing-home care; about 7 percent was for prescription drugs; and nearly 6 percent was payments to the Medicare program for premiums or cost-sharing. Largely due to the high cost of long-term care, elderly beneficiaries had the highest per capita expenditures of any Medicaid eligibility group (see Figure 3).

One of the most important roles that Medicaid plays for elderly Americans is financing long-term care. With nursing-home care averaging

Table 1
Medicaid's Protections for Medicare Beneficiaries
SOURCE: Kaiser Commission on Medicaid and the Uninsured

Program	Who's Eligible?	Asset Test	What Does Medicaid Pay?	Entitlement?
Full Medicaid Benefits	≤ 73% of poverty* (SSI eligibility level)	Assets below $2,000 (individual) or $3,000 (couple)	Wrap around benefits, Medicare Part B premium and cost-sharing	Yes
Qualified Medicare Beneficiary (QMB)	≤ 100% of poverty	Assets below $4,000 (individual) or $6,000 (couple)	Medicare part B premium and cost-sharing	Yes
Specified Low-Income Beneficiary (SLMB)	100-120% of poverty	Assets below $4,000 (individual) or $6,000 (couple)	Medicare Part B premium	Yes
Qualifying Individuals 1 (QI1)	Up to 135% of poverty	Assets below $4,000 (individual) or $6,000 (couple)	Medicare Part B premium	No
Qualifying Individuals 2 (QL2)	Up to 175% of poverty	Assets below $4,000 (individual) or $6,000 (couple)	A portion of the Medicare Part B premium	No

*Some states (209b) are permitted to set lower levels; states also have the option to go to 100% of poverty.

NOTE:The first three programs are entitlements; the last two are block grants available on a first-come, first-serve basis.

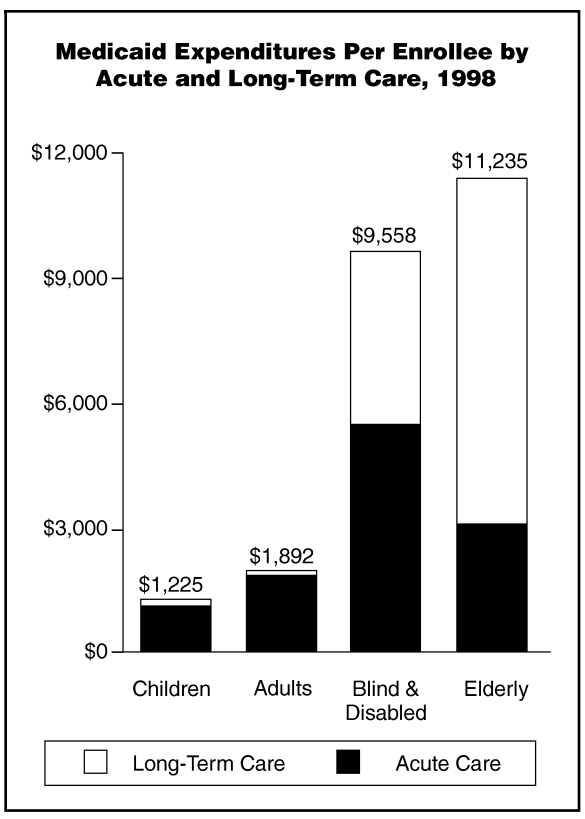
more than $50,000 per year and regular assistance in the community costing more than $10,000 per year in 2001, long-term care can be quite costly and can drain private resources quickly. Medicaid is the major public program that covers nursing-home care; the program finances care for over two-thirds of the nation's nursing-home residents and pays nearly half of all nursing-home costs in the nation. However, because Medicaid coverage is available only to low-income individuals, many people in nursing homes who receive Medicaid assistance must *spend down,* or deplete, their personal resources before Medicaid assistance is available. They must also continue to contribute any available income from Social Security or pensions toward the monthly cost of their care.

In response to the high cost of nursing-home care and people's desire to remain in their community, all states also offer home health and home and community-based services (HCBS) under their Medicaid programs; some states also offer personal care services. These services provide assistance to people in the community and may target a specific mix of noninstitutional long-term care services to a distinct population or geographic area. While community-based services are crucial to enabling many elderly persons with long-term care needs to remain in their homes, they represent less than 10 percent of Medicaid spending and have not been shown to reduce nursing-home utilization. A 1999 Supreme Court decision (*Olmstead v. L.C.*) has helped to promote the broader use of home care as an alternative to institutionalization for people with disabilities, and it may create pressure to increase the amount and share of Medicaid resources devoted to community-based long-term care.

Medicaid's role in covering the cost of prescription drugs to Medicare beneficiaries with low incomes is another key function of the program for elderly persons. Outpatient drug therapy has become an increasingly important part of the therapeutic regimen for millions of elderly Americans. In 1996, eight out of ten Medicare beneficiaries utilized prescription drugs on an ongoing basis as a way of managing chronic conditions, delaying or even preventing the onset of serious illness, or substituting for more invasive methods of care. Prescription drugs come at a substantial cost, however, and, on average, range from $800 to $1,400 per person, per year (as of 2001). People who do not have insurance to help

Figure 3

SOURCE: Urban Institute estimates, 2000, based on HCFA-2082 and HCFA-64 Reports. Kaiser Commission on Medicaid and the Uninsured.



NOTE: Expenditures do not include DSH, adjustments, or administrative costs.

with these costs are less likely to fill prescriptions, and they may pay more for some drugs because they cannot participate in pharmacy discounts negotiated by insurers. All states cover prescription drugs under their Medicaid programs, a benefit that accounted for over 8 percent of total program spending in 1998. One-quarter of Medicaid spending on drugs is on behalf of elderly beneficiaries.

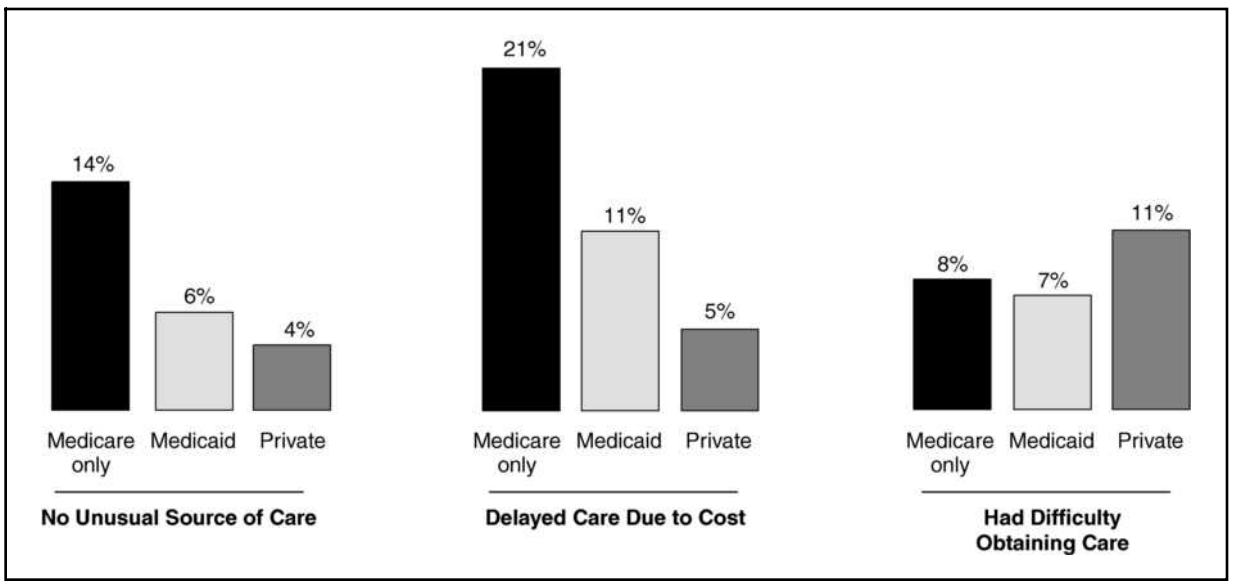
For both long-term and acute care services, elderly persons receiving Medicaid face particular challenges in receiving health services from both Medicare and Medicaid programs. Medicare remains the primary source of insurance for elderly people, while Medicaid covers *wrap-around services*. Depending on how a state's Medicaid program works, dual eligibles may have to see different providers for different services—one for their acute care needs and one for their long-term care needs. This situation creates confusion among beneficiaries, is administratively difficult for providers, and may encourage the programs to try to shift the cost of care to each other. The growing use of managed care, which relies on a restricted network of providers for services, in both Medicare and Medicaid programs for the elderly population, brings yet another layer of complexity to coordination of services. However, without the services in Medicaid to complement Medicare coverage, the four million elderly dual eligibles would have their substantial health needs go unmet. Medicaid functions as a true safety net for Medicare's most vulnerable and sickest beneficiaries.

Medicaid's impact

Medicaid supplemental assistance makes a difference in the lives of the elderly people enrolled in the program. Problems in getting medical care are often tied to financial barriers: If people cannot afford to pay their share for services, they often delay or avoid seeking care, which ultimately compromises their health status and results in greater suffering and mortality. Medicaid coverage helps remove financial barriers to care and substantially improves access to health care for Medicare beneficiaries. Despite their greater health care needs, dual eligibles are much more likely than beneficiaries without any supplemental coverage (Medicare only) to have regular check-ups and to obtain care in a timely manner (see Figure 4). People who receive both Medicare and Medicaid are also more likely to have a usual source of care than are those who have no supplemental coverage, an indicator that Medicaid helps people gain entry into the primary health care system and receive basic health services.

Dual eligibles also have lower out-of-pocket spending than other beneficiaries, spending four to five times less of their income on health care than the average Medicare beneficiary (see Figure 5). While other types of supplemental insurance may also moderate Medicare beneficiaries' out-of-pocket costs, people receiving Medicaid assistance are in the lowest income group, but they also spend far less of their income on medical care.

Figure 4
Access to Care for Medicare Beneficiaries, 1999*
SOURCE: Barents Group of KPMG Consulting analysis of the 1999 Medicare Current Beneficiary Survey.



NOTE: *Community residents only.

Future challenges in Medicaid coverage of elderly persons

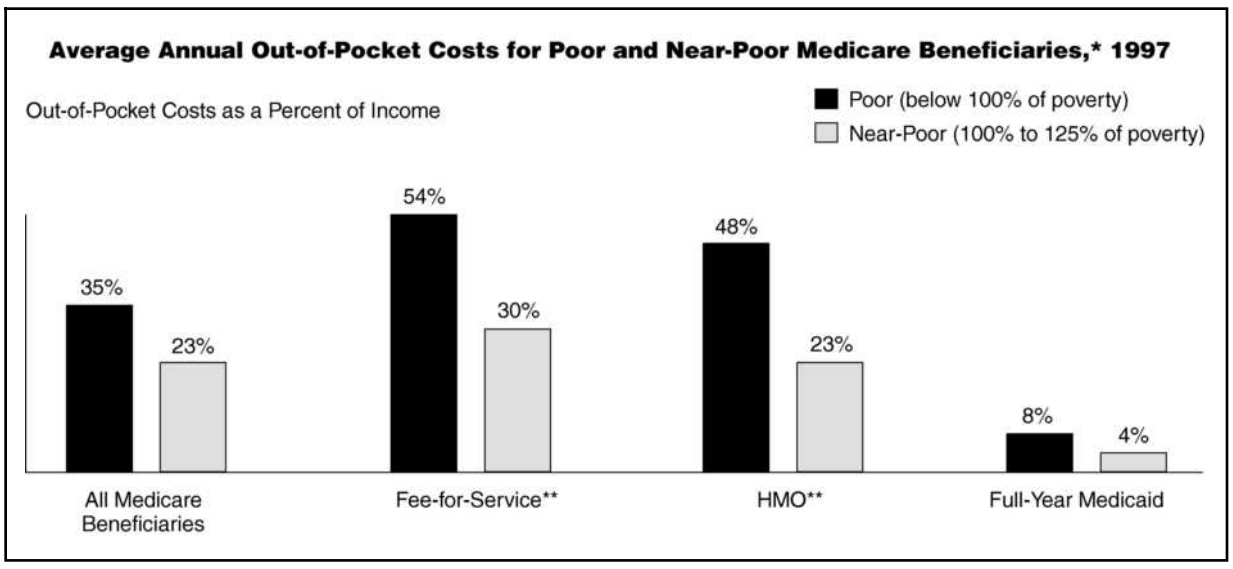
Medicaid has made great strides in assuring access to care and alleviating financial burdens for elderly Americans. The program is a critical source of assistance to four million low-income elderly people. However, despite its importance as a complement to Medicare, Medicaid still faces many challenges in serving current and future beneficiaries.

One of the biggest challenges facing Medicaid is the aging of the general population, which will increase demand for Medicaid services in the future and place a larger financial burden on the program. The elderly population in the United States is expected to double to 70 million people by 2030, and the population over age eighty-five is expected to grow more than fourfold by 2050 to over 18 million people. These demographic changes are not only likely to lead to a greater number of people relying on Medicaid, but also are likely to greatly increase expenditures, as elderly Medicaid beneficiaries are high users of some of the most costly services in the program—long-term care and prescription drugs.

Medicaid's growing role in caring for the poorest elderly Americans and filling in Medicare's gaps occurs at a time when the federal and state governments, with limited resources, are likely to be addressing other, often competing, policy issues. For example, future changes to the Medicare program that add benefits (i.e., prescription drugs) or enact changes to the structure of the program could lead to increased costs for Medicaid and strain state financing. Many state governments operate under very tight budgets and do not have additional resources to cover these costs. Responsibility for financing the care of the growing elderly population remains a major policy challenge.

Future additional burdens on Medicaid coverage of elderly Americans are especially problematic in light of the fact that the existing program still needs several improvements. Currently, Medicaid's coverage of the low-income Medicare population is limited. In 1997, the program reached only half of all poor, and 13 percent of near-poor, Medicare beneficiaries. States have the option to extend full Medicaid benefits to Medicare beneficiaries at higher income levels or use more liberal methods for determining income and assets for eligibility, but levels and allowable assets generally remain low. In addition, many Medicare beneficiaries who are eligible for

Figure 5
SOURCE: American Association of Retired Persons, 1997. Lewin estimates based on 1993 Medicare Current Beneficiary Survey Cost and Use data projected to 1997. Kaiser Commission on Medicaid and the Uninsured



NOTE: *Noninstitutionalized beneficiaries age sixty-five and older. **Not enrolled in Medicaid. The 1997 federal poverty level of people over age sixty-five was $7,698 for individuals and $9.712 for couples.

Medicare premium assistance through the buy-in programs, particularly the SLMB and QI programs, are not enrolled. Lack of significant outreach efforts, complex and burdensome enrollment processes, and limited benefits all contribute to limited enrollment. Simplified or automatic eligibility determination and a meaningful benefit would help expand the scope of Medicaid coverage for low-income elderly persons.

The Medicaid program must also work to assure access to high quality health services for this vulnerable population. With rising prescription drug costs and utilization, states are looking into various methods to control spending in this area, including restricting access to expensive brand-name drugs or limiting the number of prescriptions a beneficiary can fill. Such efforts could lead Medicaid to restrain, rather than expand, its role in providing prescription drug coverage at a time when prescription drugs' importance to maintaining health is growing.

Medicaid can also improve the provision of long-term care to elderly persons. Despite improvements in nursing-home quality following comprehensive nursing-home reforms in the late 1980s, serious problems persist in many facilities. In addition, the supply of community-based services falls far short of demand. Increases in payment levels to levels that allow facilities to properly care for elderly persons and a greater commitment to providing community-based services can enhance the quality of care and the quality of life for elderly Medicaid beneficiaries.

Medicaid is critical to making Medicare work for over four million elderly people in the United States. Despite the importance of Medicare's universal coverage, millions of elderly Americans struggle to gain access to the health care they need. To assure Medicare's adequacy for coverage of elderly persons in future years, it is important to maintain and improve the assistance with financial obligations and additional benefits that Medicaid provides today.

RACHEL GARFIELD
DIANE ROWLAND

See also LONG-TERM CARE; LONG-TERM CARE FINANCING; MEDICARE MEDIGAP; POVERTY.

BIBLIOGRAPHY

Health Care Financing Administration. "Medicare Savings Programs: Medicare/Medicaid

Dual Eligible Home Page." World Wide Web document, 2001. http://www.hcfa.gov/medicaid/dualelig/default.htm.

HOFFMAN, E. D., JR.; KLEES, B. S.; and CURTIS, C. A. "Overview of the Medicare and Medicaid Programs." *Health Care Financing Review* 22 (2000): 175–193.

LAMPHERE, J. A., and ROSENBACH, M. L. "Promises Unfulfilled: Implementation of Expanded Coverage for the Elderly Poor." *HSR: Health Services Research* 35, no. 1, Part II (2000): 207–217.

MOON, M., and MULVEY, J. *Entitlements and the Elderly*. Washington, D.C.: Urban Institute Press, 1995.

MOON, M.; BRENNAN, N.; and SEGAL, M. "Options for Aiding Low-Income Medicare Beneficiaries." *Inquiry* 35 (1998): 346–356.

NEMORE, P. B. *Variations in State Medicaid Buy-In Practices for Low-Income Medicare Beneficiaries, A 1999 Update*. (Publication # 1566.) Washington, D.C.: The Kaiser Family Foundation, 1999.

NIEFIELD, M.; O'BRIEN, E.; and FEDER, J. *Long-Term Care: Medicaid's Role and Challenges*. (Publication #2172.) Washington, D.C.: The Kaiser Commission on Medicaid and the Uninsured, 1999.

United States General Accounting Office. *Low-Income Medicare Beneficiaries: Further Outreach and Administrative Simplification Could Increase Enrollment*. (Publication #GAO/HEHS-99-61.) Washington, D.C.: USGAO, 1999.

WEINER, J. M., and STEVENSON, D. G. "State Policy on Long-Term Care for the Elderly." *Health Affairs* 17, no. 3 (1998): 81–100.

MEDICALIZATION OF AGING

As a discipline and a "worldview," medicine has been one of the most important and powerful forces in the twentieth century. As a paradigm, the biomedical model focuses on individual organic pathology, physiological etiologies, and biomedical interventions.

Turner (1987) delineates the medical model as one in which disease is interpreted regarded as a direct result of malfunctions within the human body. The model "assumes that all human dysfunction might eventually be traced to such specific causal mechanisms within the organism," and it "presupposes a clear mind/body distinction where ultimately the causal agent of illness would be located in the human body" (Turner, p. 9). The sociological model, according to Turner, stands in contrast to the biochemical model of disease by allowing, if not demanding, attention to the cultural specificity of medical science. Brown (1996) and others (Estes and Binney, 1989; P. Fox, 1989) highlight the importance of looking at social causation and the way that the discovery of a disease affects its labeling and treatment. Naming a condition through diagnosis initiates the labeling process and locates the parameters of normality and abnormality. Thus, diagnosis is an integral aspect of the illness experience. Medicine may have emotional, political, and economic impacts.

Medicalization describes a process through which largely social issues may be redefined as medical problems, thus increasing the jurisdiction of medicine. Critics argue that medicalization is a strategy for extending professional dominance and/or institutionalized social control. Some suggest that medical social control ensures social cohesion by focusing on curing and containing diseases that could otherwise disrupt life. Bury (1991) discusses not only the inadequacy of the biomedical model but also of all one-dimensional sociological models of illness and disability labels. Broom and Woodward (1996) cite positive aspects of medicalization for individuals, such as validation, a sense of relief, and support. They explicate the utility of distinguishing between "over-medicalization," which is typically viewed as negative, and "constructive medicalization." A reversal, or process of demedicalization (R. Fox, 1994), can also occur—for example, the redefinition of homosexuality from a mental illness to a lifestyle choice.

In 1951, Talcott Parsons observed that medical diagnosis could legitimize a range of human troubles in cases where behavior could be understood and/or blame removed through a process of medical examination (such as chronic fatigue syndrome). A key goal of medicine, in Parsons's view, is assuring compliance with medical authority. Arguably, power is exerted in medical practice via the dominance and techniques of biomedical science. If medical authority is unstable, or the definition of illness is contested, issues of medical and social control are more likely to surface.

Medicine as an institution achieves social control over potentially deviant populations (e.g., violent offenders) by expanding medical categories. Zola (1972) suggests that medicine has become a form of social control comparable

to religion and law. Medicalization, through disease typifications, medical authority, and the labeling of illness (or behaviors) as deviant from everyday life, has important political consequences: "The medical profession. . .has a virtual monopoly over anything that is defined as illness or a 'medical treatment'" (Conrad and Schneider, 1992, p. 36).

The medical model has assisted in the transformation of health and other human needs into commodities for specific economic markets in ways that have promoted a gargantuan and highly profitable (but not necessarily most efficacious) trillion-dollar medical-industrial complex. For example, the desire for a "silver bullet" to cure health problems reflects the tendency of doctors to medicate and of health care consumers to prefer to be medicated. One example is taking cholesterol medicine rather than changing behavior (e.g., eating less fats or exercising). Both tendencies are consistent with how medicine and society have constructed illness and how to treat it via pharmaceuticals. The result may be an overmedicated population. Clearly, not only are there financial costs to such approaches to health care, but emotional, physical, and social ones as well.

"Biomedicalization" is another term used to describe the medicalization process, through which an increasing number of human problems are classified under the rubric of bioscientific medicine and its corresponding technological interventions. Estes and Binney (1989) note that within aging, two dimensions of biomedicalization are essential: (1) the social construction of aging as a medical problem—that is, thinking of aging itself primarily as a disease and/or medical problem as defined by medical practitioners, and (2) the "praxis," or practice of seeing aging as a medical problem, and the subsequent behaviors and policies that grow out of the biomedical conceptualization of aging.

The biomedical model emphasizes the clinical treatment and management of diseases of older adults as defined and treated by medical practitioners—while giving marginal attention to the social and behavioral processes and problems of aging. Lock (2000) contends that conceptions of "normal" and "abnormal" health are intrinsically tied to cultural and political constructions of "moral order." She explores aging as a way to investigate how morality is articulated through a picture of decline and impairment. Accordingly, it is not possible to try to separate categories of health and illness—and here, aging—from the context in which they are embedded. Renée Fox (1994) also attests the importance of situating conceptions of medicalization in time and place: "What is defined as health and illness, normality and abnormality, sanity and insanity varies from one society, culture, and historical period to another" (p. 403).

As the primary way of viewing the world of aging, or "institutionalized thought structure" (Berger and Luckmann), the medical model influences everything else—research and the development of knowledge in the field, gerontological and geriatric practice, policymaking, public perceptions (Estes and Binney), and subjective experiences. The equation of old age with illness has encouraged society to think about aging as a pathological, abnormal, and undesirable state, a view that in turn shapes the attitudes of members of society toward elderly persons and of older adults toward themselves (Estes). "Sick role expectations" (Parsons, 1951) of appropriate behavior when ill may result in social withdrawal, reduction of activity, increased dependency, and the loss of self-esteem, efficacy, and personal sense of control—each of which increases the social control of elderly persons through medical definition and management (Estes and Binney). The critical perspective purports that "Casting persons in the sick role is regarded as a powerful, latent way for the society to exact conformity and maintain the status quo" (R. Fox, p. 404).

The dominance of the medical model in aging obscures the extent to which illness and other problems of older adults are influenced by potentially modifiable social factors, such as income and education, safe and supportive housing environments that promote healthy behaviors, opportunities for meaningful human connections, the lack of public policy emphasis on (or financing for) rehabilitation, and a better understanding of subjective experiences and quality of life. Biomedical thinking diverts attention, and subsequently solutions, away from research to understand sociological "root causes" of health, including social, economic, and environmental elements (Estes et al.).

Despite the reality that the greatest burden of disease in old age now stems from chronic, rather than acute, conditions, public policy regarding medical care for seniors clings to a medical-engineering model, which constructs health

and illness on the basis of a rational system of causes within the context of the body's cellular and biochemical systems. This model implies a reliance on an "expert" to fix problems (typically after they occur), while also supporting society's growing investment in medical care and technology as the primary determinant of good health, in spite of the expanding body of research that substantiates the significant effect on health in old age of behavior, environment, social inequalities, and myriad other factors.

Clarke and colleagues (2000) depict "a new biomedicalization" within health and illness, which involves a shift from the past medicalization of deviant behavior to a contemporary biomedicalization of normalcy. Medicalization occurs not only on conceptual, organizational, and interactional levels that characterize the past, but also on the new social, cultural, economic, and institutional forms of biomedicine. All of this transpires within the increasingly corporatized, privatized, and multinational context of early twenty-first-century society.

With illness viewed as "deviance" under medicaliztion (Parsons, 1951; Zola, 1972; Conrad and Schneider, 1992), Clarke et al. critique dominant conceptions that equate health with what is defined as "normal" or normatively acceptable (the "gold standard" within biomedicine). Conrad and Schneider observe that the process of biomedicalization transfers definitions of badness to sickness. With medicalization there is a parallel unification of health (defined as free from "disease") and rectitude in contemporary society.

Viewing old age and the life course through a lens of disease and its surrounding rhetoric only accentuates the increasing trend toward seeing the process of aging as something to be fended off and controlled. Such tendencies create a conundrum for gerontologists, policymakers for health and aging matters, society overall, and all persons as individuals. This serves to reinforce the already pervasive stigma of aging and of older adults. A biomedical model of aging precludes an understanding of relevant social and biological dynamics that profoundly shape old age and aging both as experienced by individuals and as "treated" by society through social policy (Estes and Binney).

The biomedicalization of specific conditions, such as dementia, is also debated—for example, whether senility is the site of pathology or an acceleration of essentially normal aging. Gubrium (1986) critically reviews of evidence for the "discovery" of AD as a disease category, suggesting it is not possible to differentiate dementing illness from normal aging. Therefore, attempts to do so are mechanisms to create order in the complex world of dementia.

Patrick Fox (1989; P. Fox et al., 1999) discusses the historical shift in the biomedical conceptualization of AD. Labeling AD as a specific disease category reversed the notion of cognitive decline as an inevitable part of old age and brought aging into the purview of medicine. Specifically, the definition of AD as the primary cause of senile dementia reflects biomedical claims to the diagnosis and management of old age. Cutler (1986) also analyzes the politics of AD as a process whereby those who have interest in creating new disease categories construct "facts." This has greatly increased the number of cases of what we now call Alzheimer's disease and has led to its being perceived as a significant social and health problem.

Patrick Fox et al. purport that conceptions of the relationship between health and aging permeate social, cultural, and political images of old age. Identification of AD indicates that cognitive changes associated with aging result from specific disease processes that can be classified, understood, and, ideally, prevented. Therefore, the biomedicalization of senility is implicit in the designation of "Alzheimer's disease" as a health and societal problem that insinuates social, economic, and biomedical imperatives to avoid disability in old age.

Thus, both contemporary and historical contestation over the definition of conditions like AD is both inevitable and chronic in times of medical dominance. The primacy of directing attention to the disease rather than to the person is done in the interest of a profession to enforce the necessity, if not the urgency, of the power granted to scientific medicine.

Although dementing illnesses involve a disease process for which biomedical research may hold the key to an eventual cure, the reliance on a biomedical model to explain experiences of dementing illness overlooks the social construction of dementia and the impact of treatment and care contexts on disease progression (Lyman), as well as firsthand accounts of subjective experiences. Lyman observes: "[The] biomedical view of dementia is narrow, limited, and sometimes

distorted in its ignorance of social forces that affect the definition, production, and progression of dementia" (p. 600). Few examples highlight the biomedicalization of aging more concretely than AD.

The power of the medical model has suppressed resources that might be applied to pursue promising alternative social, behavioral, and environmental approaches while instead encouraging the "magic-bullet" mentality of Americans seeking the "nirvana" of a happy and eternal life, according to Estes et al. Although biomedicine merits a respected place for its contributions to aging, its extension to and control over all aspects of life diminish its effectiveness, diverting priority away from essential and critical research needed to understand the complex social and environmental factors that significantly shape and structure, and may modify, old age and aging.

Lock warns that notions of normality imply a dichotomy and suggest a need, and potential, for correcting the "mistakes" of natural development (p. 273). The dangers, as well as the benefits, of the current medical model need continual reevaluation. The flourishing medical ideology both poses dilemmas and offers alternatives. Neither is without consequence.

RENÉE L. BEARD
CARROLL L. ESTES

See also CRITICAL GERONTOLOGY; HEALTH, SOCIAL FACTORS.

BIBLIOGRAPHY

BERGER, P. L., and LUCKMANN, T. *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*. Garden City, N.Y.: Doubleday, 1966.

BROOM, D. H., and WOODWARD, R. V. "Medicalization Reconsidered: Toward a Collaborative Approach to Care." *Sociology of Health and Illness* 18 (1996): 357–378.

BROWN, P. "Naming and Framing: The Social Construction of Diagnosis and Illness." In *Perspectives in Medical Sociology,* 2d ed. Edited by P. Brown. Prospect Heights, IL: Waveland Press, 1996. Pages 92–122.

BURY, M. "The Sociology of Chronic Illness: A Review of Research and Prospects." *Sociology of Health and Illness* 13, no. 4 (1991): 451–468.

CLARKE, A. E.; MAMO, L.; SHIM, J. K.; FISHMAN, J. R.; and FOSKET, J. R. "Technoscience and the New Biomedicalization: Western Roots, Global Rhizomes." *Sciences sociales et santé* 18, no. 2 (2000): 11–42.

CONRAD, P., and SCHNEIDER, J. W. *Deviance and Medicalization: From Badness to Sickness,* 2d ed. Philadelphia: Temple University Press, 1992.

CUTLER, N. "Public Response : The National Politics of Alzheimer's Disease." In *The Dementias: Policy and Management*. Edited by M. L. M. Gilhooly, S. H. Zarit, and J. C. Birren. Englewood Cliffs, N.J.: Prentice Hall, 1986. Pages 161–189.

ESTES, C. L. *The Aging Enterprise*. San Francisco: Jossey-Bass Publishers, 1979.

ESTES, C. L., and BINNEY, E. A. "The Biomedicalization of Aging—Dangers and Dilemmas." *The Gerontologist* 29, no. 5 (1989): 587–596.

ESTES, C. L.; WALLACE, S.; LINKINS, K. W.; and BINNEY, E. A. "The Medicalization and Commodification of Aging and the Privatization and Rationalization of Old Age Policy." In *Social Policy and Aging: A Critical Perspective*. Edited by C. L. Estes and Associates. Newbury Park, Calif.: Sage, 2001. Pages 45–59.

FOX, P. J. "From Senility to Alzheimer's Disease: The Rise of the Alzheimer's Disease Movement." *The Millbank Quarterly* 67, no. 1 (1989): 58–102.

FOX, P. J.; KELLEY, S. E.; and TOBIN, S. L. "Defining Dementia: Social and Historical Background of Alzheimer's Disease." *Genetic Testing* 3, no. 1 (1999): 13–19.

FOX, R. C. "The Medicalization and Demedicalization of American Society." In *The Sociology of Health and Illness*. Edited by P. Conrad and R. Kern. New York: St. Martin's Press, 1994. Pages 403–407.

GUBRIUM, J. F. *Oldtimers and Alzheimer's: The Descriptive Organization of Senility*. Greenwich, Conn.: JAI Press, 1986.

LOCK, M. "Accounting for Disease and Distress: Morals of the Normal and Abnormal." In *Handbook of Social Studies in Health & Medicine*. Edited by G. L. Albrecht, R. Fitzpatrick, and S. C. Scrimshaw. Thousand Oaks, Calif.: Sage, 2000. Pages 259–276.

LYMAN, K. A. "Bringing the Social Back In: A Critique of the Biomedicalization of Dementia." *The Gerontologist* 29, no. 5 (1989): 597–605.

PARSONS, T. *The Social System*. Glencoe, Ill.: Free Press, 1951.

TURNER, B. *Medical Power and Social Knowledge*. London: Sage, 1987.

ZOLA, I. K. "Medicine as an Institution of Social Control." *Sociological Review* 20 (November 1972): 487–504.

MEDICARE

When Medicare was established in 1965, many of its supporters believed that insuring persons age sixty-five and over was a precursor to a national system of health insurance. The Medicare program was thought to be just the first piece of legislation towards this end. But instead, Medicare has become the largest public program of health insurance, and universal health insurance is a reality only for older adults and some persons with disabilities.

Although in many ways Medicare has been one of the most successful public programs of the federal government, it has also faced criticism as a result of its rapid expansion. At $222 billion in spending in 2000, it represents about 12 percent of the federal budget. Since the 1980s, it has been a frequent target of efforts to reduce federal spending. Major legislation enacted in 1997 as part of the Balanced Budget Act set in motion the most recent set of changes aimed at slowing the growth of the program. (Legislation enacted in 1998 and 1999 mitigated some of these changes, however.) The implications of an aging society, moreover, are that Medicare will continue to come under scrutiny, and perhaps face major changes in the future.

A brief history and overview

The issue of national health insurance was debated periodically in the United States after World War II. Gradually, the focus shifted to a strategy to begin with older persons. President John F. Kennedy made this one of his major campaign issues in 1960. But it was not until 1965, during a period of considerable social activism, that the legislation was finally passed. Persons over the age of sixty-five were singled out because they had higher rates of poverty and lower rates of insurance than other groups. As a social insurance program, the goals of Medicare have been to provide equal access to care for those who are eligible, supported by taxpayers (who will later become beneficiaries). By most accounts, it has been extremely successful.

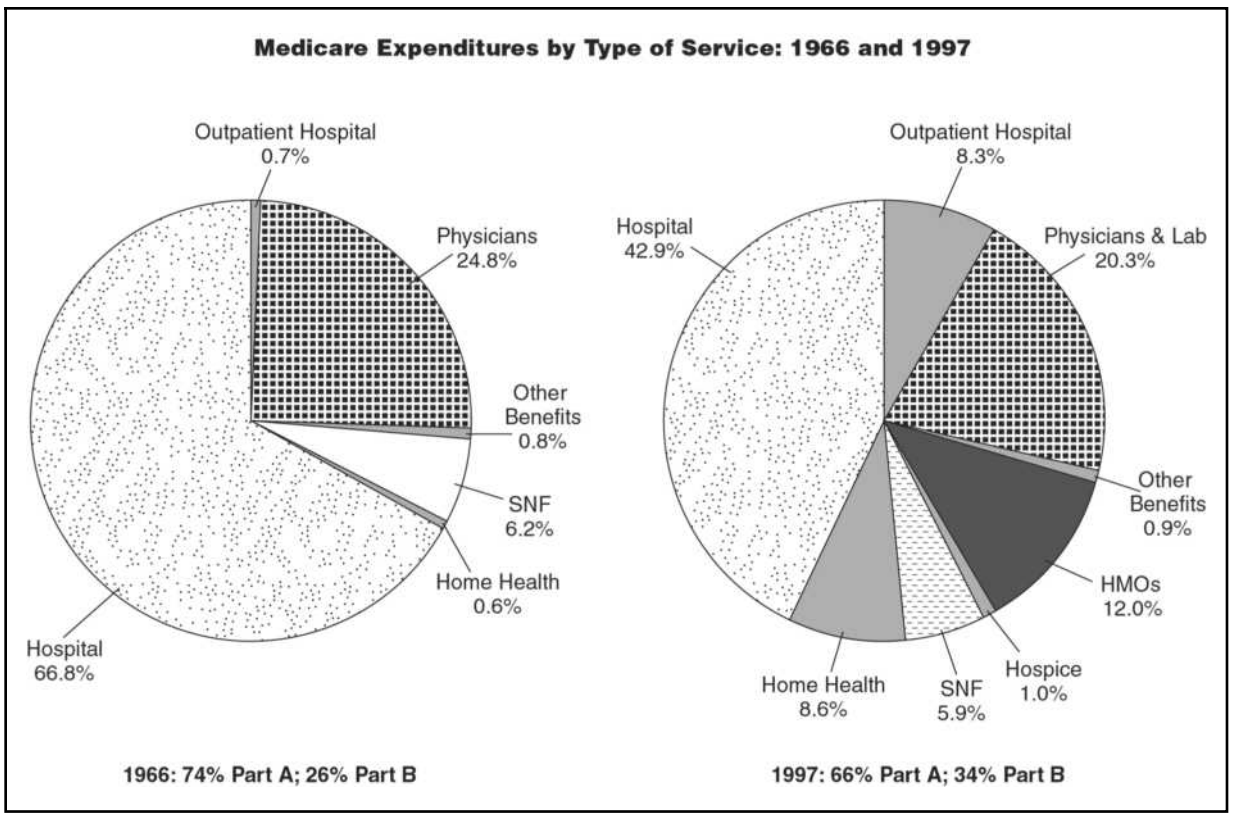
Initially, everyone over the age of sixty-five in 1965 was eligible to participate in Medicare when it began in July of 1966. After that, eligibility was limited to persons over the age of sixty-five who qualified for some type of Social Security benefit, usually as a worker or dependent. This still captures about 98 percent of all persons age sixty-five and older. In 1972, the program's scope was expanded to include persons who receive Social Security Disability Insurance, following a two-year waiting period. In addition, persons with end-stage renal disease—who face costly kidney dialysis treatments— were also added to the program. Over 39 million persons, nearly one in every eight Americans, were enrolled in Medicare in 2000, up from 19 million in 1966.

The benefits covered by Medicare have been altered little since 1965, although changes in the way care is delivered in the United States have affected the size of the various components of the benefit package. Part A of Medicare, also called Hospital Insurance, covers inpatient hospital services, up to one hundred days of care in a skilled nursing facility following a hospital stay, and hospice care. Part B of Medicare, referred to as Supplementary Medical Insurance, covers physician services, outpatient hospital care, laboratory testing, and ambulatory services. Home health care services—skilled care such as rehabilitation services provided to persons who are homebound—have been subject to a number of changes in recent years; presently these services are divided between the two parts of the program.

Part A of Medicare is financed by a payroll tax of 1.45 percent of all wages assessed on both employers and employees (when the program began, that tax rate was 0.35 percent, and has gradually increased over time). The rate of the tax has not changed since 1986, although the amount subject to tax has risen. In 1993, the upper limit on the tax was eliminated so that all wages are subject to the Medicare payroll tax. Part B is voluntary and financed by premiums on beneficiaries and by general revenues sufficient to make up the level of spending required. The premium initially paid 50 percent of the costs of Part B, but legislation reduced this share beginning in 1972 because Medicare's costs were growing substantially faster than incomes of beneficiaries. It was set at 25 percent of the costs of a beneficiary's benefits on a temporary basis starting in 1982, and it became a permanent requirement in 1997.

When Medicare began, it was dominated by inpatient hospital care, which accounted for about two-thirds of all spending. Indeed, most of the focus of debate before Medicare's passage was on Part A of the program. But as care has moved out of the inpatient setting, Part B has be-

Figure 1



SOURCE: Health Care Financing Association, Office of the Actuary 1997

come a much larger share of the program. Care in hospital outpatient departments and in physicians' offices now replaces many surgeries and treatments formerly done only in inpatient settings. In addition, skilled nursing facility care and home health—referred to as post-acute care—have also increased in importance over time. When individuals leave a hospital after only a few days, post-acute care is often needed as a transition. But these benefits have also come under increased scrutiny for moving Medicare into the domain of long-term care services.

Another original principle of the program was that it would not interfere with the practice of medicine. Payments were designed to be as much like the standard insurance policies then in place as possible. But costs for the program rose rapidly almost from the beginning, and in the mid-1970s it became clear that the government needed to slow spending growth. This was done largely through application of new payment policies. Traditional Medicare has remained a fee-for-service program in which beneficiaries are free to see any hospitals or doctors they wish.

Changes in payment policies

Medicare is first and foremost an insurer for elderly and disabled persons, setting rates of payment and contracting with private firms to process and pay claims. Originally, Medicare approved payments with little oversight of charges that providers of care submitted. However, restrictions soon began to be added, and by the mid-1980s, most of the payment systems for various Medicare-covered services had been modified. The most recent broad changes were contained in the 1997 Balanced Budget Act (BBA), which placed a particular emphasis on the post-acute care area. New ways of paying for care, as well as lower rates of payment were legislated, although implementation has taken considerably longer than expected.

These changes were built on similar reforms that date to the 1980s, when new payment sys-

tems for hospitals and physicians were developed. Medicare served as a leader with these reforms, fundamentally changing the way that hospitals and doctors are paid. The hospital payment system for Medicare now pays a flat rate to a hospital, based on the patient's diagnosis. While hospitals with varying characteristics may be paid somewhat different rates, this was a major move away from a system in which the costs reported by the hospital were simply reimbursed by Medicare. This new system has encouraged hospitals to be more efficient, although it has also resulted in some premature discharges. Over time, however, this payment system has been judged to be relatively successful. It has helped to encourage movement away from long inpatient stays and to more care being delivered outside of hospitals. Medicare has been credited with contributing to an array of changes that affect the health care system in general.

Physician payment changes in Medicare sought to rebalance the level of payments between primary-care physicians and specialists. Payments for procedures by specialists have been reduced relative to office visits to primary-care physicians, for example, in order to elevate the importance of basic care. Again, this has been relatively successful, although the level of payments is often criticized by physicians. Many other health care insurers now use Medicare's resource-based relative value scale (RBRUS). Both hospital and physician payments require periodic updating, and Medicare is sometimes criticized for falling behind in making adjustments in response to new procedures, but the program has been a major player affecting the delivery of care.

It remains to be seen whether the payment changes in post-acute care and hospital outpatient services will be as successful. Again, the goal has been to move away from a cost-based system and toward one that will provide incentives for "appropriate" levels of care. It has taken much longer than anticipated to develop these new payment systems, however, because there is much less consensus about the amount of care needed in particular circumstances. Not surprisingly, efforts to implement these new systems have been controversial.

Consider the case of home health care—how many home health visits should someone who has had hip replacement surgery need? Little careful research has been done to help address such issues, and without standards or norms of care it is difficult to devise a fair system. However, spending on Medicare's home-health benefit grew from $3.3 billion in 1990 to $19.6 billion in 1997, so it is not surprising that it became a target for change. This included an effort to introduce a new payment system in stages and to demand greater accountability from agencies to reduce fraud and abuse. As a consequence, home health care spending actually declined in the late 1990s. Unfortunately, just as policy in 1997 was not developed with a full understanding of its ultimate consequences, changes in the new payment system are also likely to be undertaken with little guidance.

Other Medicare policies affecting health care delivery

In addition to the influence of Medicare's payment systems, the program has had other important effects on the delivery of health care. One of the most significant of these was the requirement that hospitals treating Medicare patients must treat all those eligible, leading to the desegregation in the 1960s of many hospitals that had formerly excluded black Americans. Medicare has also been a leader in the development of data systems that have allowed research into various issues, such as how care is delivered in different parts of the country, and the creation of various quality measurements. Medicare decisions about coverage of certain procedures are often used by private insurers for their decision-making processes as well. Finally, included in Medicare's payments to hospitals are subsidies for hospitals that provide medical education and for those that treat a disproportionate share of low-income individuals. Unlike many other payers of health care, Medicare contributes not just to the costs for its own beneficiaries, but for other activities that benefit all Americans.

Private plans serving Medicare beneficiaries

Beneficiaries have another option under the Medicare program: they can choose to enroll in a participating private plan and agree to get all of their Medicare-covered services from that plan. This plan—usually a health maintenance organization (HMO)—agrees to provide care to Medicare beneficiaries in a given geographical area for a fixed monthly payment. When this HMO option was established in 1983, it was intended to save money for Medicare by paying

plans at a rate of 95 percent of the costs of average enrollees. The new Part C of Medicare, called Medicare+Choice, established by the BBA renamed and modified the managed-care option. The intent of this change was to move Medicare further away from its traditional role as insurer and expand its role as a purchaser of private insurance. Additional types of plans, such as private fee-for-service plans and physician- or hospital-led insurance, are now also allowed to participate in Medicare+Choice, although so far only a few such plans have been offered to Medicare beneficiaries.

Initially, when the HMO option began, private plans attracted only a very small share of Medicare beneficiaries, because HMOs require beneficiaries to use only plan-approved doctors and hospitals as a condition of coverage. Medicare has lagged behind the rest of the health care system in part because beneficiaries can choose to remain in traditional fee-for-service Medicare and use services at will with no penalties attached. To be more competitive with fee-for-service, many HMOs offer beneficiaries services in addition to those covered by Medicare, such as prescription drug coverage—a strategy that became more successful as the cost of supplemental insurance elsewhere in the system rose rapidly. Many of the HMOs offering further benefits do so in those parts of the country where Medicare's monthly contribution to HMOs is high. Plans are able to offer more benefits in part because beneficiaries agree to abide by a stricter set of rules for participation, such as using only doctors, hospitals, and other health care providers who are on a prescribed list. In exchange, beneficiaries usually face lower cost-sharing requirements, and they sometimes have access to benefits such as prescription drug coverage or dental care.

Most studies of the private-plan option have suggested that payments are more generous than what it actually costs to provide services, so that Medicare's monthly payments to plans effectively subsidize additional benefits for those in private plans—and the option therefore fails to save money for the government. Changes made under the BBA were intended to reduce these overpayments, but these changes have been controversial and have contributed to a number of plans withdrawing from the Medicare+Choice system. BBA clearly did not accelerate the move to more private coverage of Medicare beneficiaries. Some of the BBA changes were modified in 1999, but HMOs remain critical of the severity of the BBA cutbacks. Although plans may still be overpaid, both HMOs and their enrollees argue that they should not be subject to slower rates of growth in payments over time, as this restricts their ability to continue offering extra benefits. On the other hand, beneficiaries in fee-for-service Medicare do not receive subsidies for extra benefits, and higher payments to HMOs may increase the gap in funding levels between these two sources.

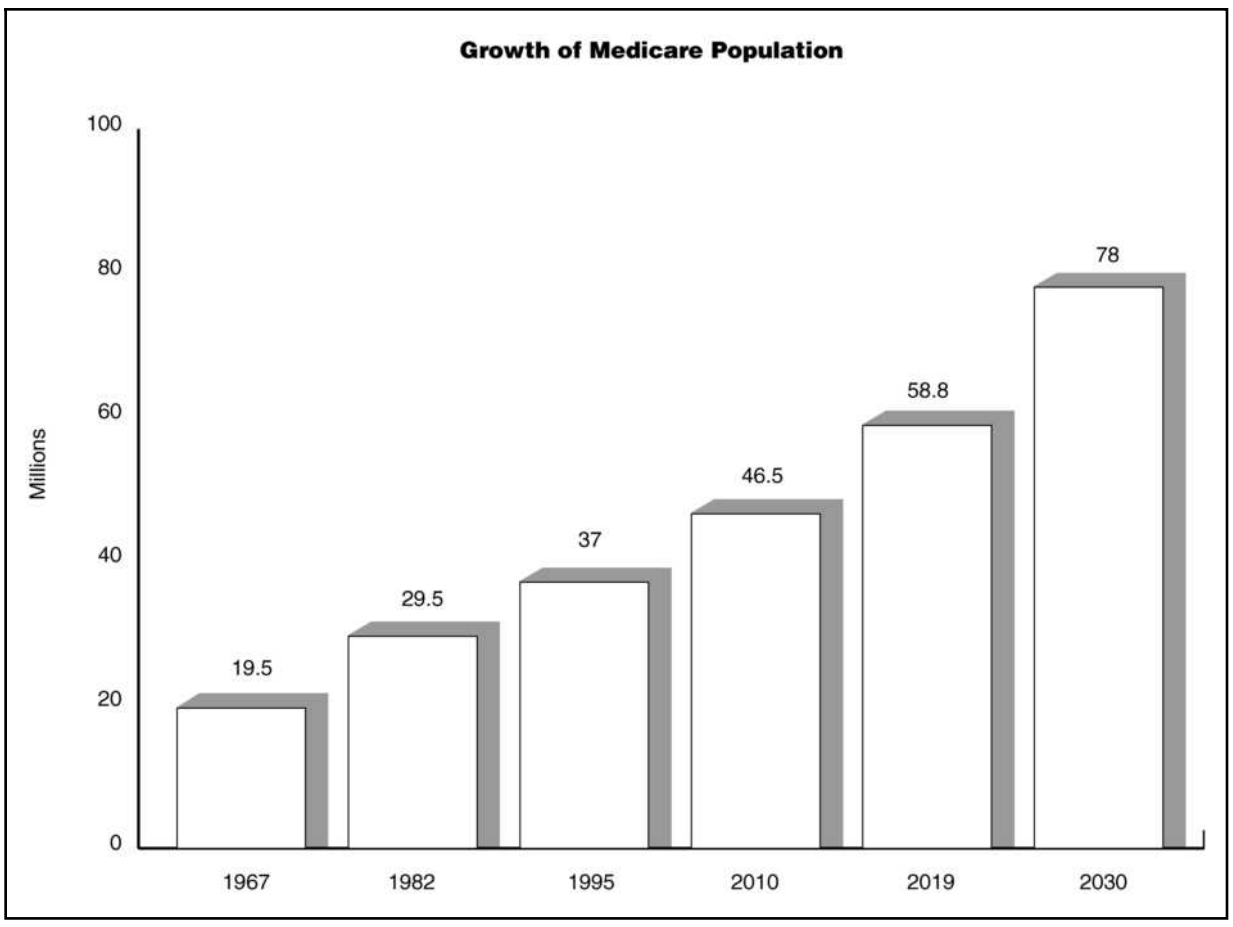
In early 2001, about 5.6 million beneficiaries participated in Medicare+Choice plans. While still representing only about 14 percent of all beneficiaries, this portion of Medicare has grown rapidly since the early 1990s, though growth slowed between 1998 and 2001. The viability of the Medicare+Choice plan remains one of the most important problems facing Medicare, and also raises concerns about some of the broader reform options now under consideration.

Costs to beneficiaries

Although Part B of Medicare is voluntary, because the premium required represents only 25 percent of the costs of the benefit, most who are eligible choose to enroll. In addition to the Part B premium, Medicare beneficiaries are required to pay an array of cost-sharing charges. That is, beneficiaries must pay for a share of much of the care they receive, either in up-front costs (deductibles) or each time they visit physicians (coinsurance). Both Parts A and B have a deductible, and most of the services are subject to some type of co-insurance. The Part A deductible ($776 in 2000) is particularly high. This requires cost-sharing, and the required exclusion of some benefits (such as prescription drugs) from coverage have resulted in a less comprehensive benefit package than what is available to many younger families. Consequently, a market for supplemental insurance has arisen, either supported by employers as part of a retirement package or purchased specifically by beneficiaries (and referred to as Medigap).

Persons covered by employer-subsidized retiree benefits have the best coverage. The extra coverage is usually quite comprehensive, and any premiums that retirees must pay are usually subsidized. This coverage usually fills in most of Medicare's required cost-sharing, as well as benefits such as prescription drugs. In contrast, Medigap plans are expensive and carry high administrative costs. Those who enroll in these

Figure 2



SOURCE: Health Care Financing Administration

plans get some protection from unusually high expenses, but also face substantially higher financial burdens from the premiums. Regulations on the Medigap market place controls on what can be offered but not on the costs of plans. These costs tend to be very high for the oldest beneficiaries and often are not available to beneficiaries under age sixty-five.

As noted above, beneficiaries also can obtain additional benefits to supplement Medicare's basic package by enrolling in Medicare+Choice. Cost sharing is lower, and some additional benefits are usually offered for less than the price of a Medigap plan. But these plans have also become more expensive and less comprehensive over time.

Gaps in coverage for low-income beneficiaries are made up through Medicaid, a joint federal/state program to which most Medicare beneficiaries can qualify if their financial resources are low enough. In addition, legislation enacted in 1988 established the Qualified Medicare Beneficiary Program, which allows Medicaid to further fill in the gaps. Later additions include the Specified Low-Income Medicare Beneficiary Program and the Qualified Individual Program. These programs help to fill in Medicare's cost-sharing or premium requirements for low-income persons who do not qualify for full Medicaid benefits, and each is targeted to a different income group. However, participation rates remain a problem, reducing the effectiveness of these programs. As a consequence, the comprehensiveness of coverage for older Americans and eligible disabled persons varies considerably via this complicated environment of patchwork supplemental benefits.

One important result of the absence of a comprehensive Medicare benefit is the financial burden that beneficiaries face in paying for their own care. When the premiums that they pay for Part B and supplemental insurance are added to the direct expenses for care not covered by any insurance, older Americans devote over 20 percent of their incomes to health care on average. This does not include the costs of long-term care for persons in institutions. Those enrolled in the Medicare+Choice program face smaller but not insignificant burdens. In 1965, when Medicare was instituted, the share of income that individuals paid for their care was about 19 percent. Medicare reduced that share, but it has gradually risen over time as the costs of health care have gone up faster than the incomes of older Americans. Even without further requirements on beneficiaries to pay more for their care, that share will likely rise over time as health costs continue to outpace retirement incomes.

The future of Medicare

The future of Medicare has become a controversial political issue, mainly because it is a large and popular public program that faces projections of rapid growth in the future. As a government program, either new revenues will have to be added to support Medicare, or its growth will have to be curtailed. Much of the problem is driven by the expected increase in the number of persons eligible for Medicare—from 39 million in 2000 to 78 million in 2030—as the baby-boom generation becomes eligible for benefits. While the numbers covered by Medicare have already doubled since 1966, this is likely to be a more significant change because the share of the population eligible for Medicare will also grow from one in every eight Americans to more than one in every five.

One option for savings often discussed is an increase in the age of eligibility, although this would have only a small impact on the numbers eligible if the age were to rise from sixty-five to sixty-seven, for example. About 5 percent of beneficiaries are in this age range, but they are considerably less costly to insure than the average Medicare beneficiary. Nonetheless, this option is likely to be seriously debated as one means for reducing Medicare's costs. Another approach is to limit eligibility to persons with low or moderate incomes, changing dramatically the nature of a program that has always been very inclusive. As yet there seems to be little political support for this latter option, although proposals to ask higher income beneficiaries to bear a greater share of Medicare's costs (e.g., through an income-related premium) is more often discussed. One of Medicare's strengths is its universality and resulting broad-based taxpayer acceptance, and making high-income persons ineligible could undermine that support.

Most of the political discussion in the late 1990s and early in this century continues to focus on ways to make the program more efficient, but there is little agreement on how to do this. The two major strains of debate center on whether extensive restructuring (relying on the private sector to achieve efficiencies) is necessary, or whether more incremental changes within the current program would be sufficient. The Medicare+Choice program, for example, was enacted in an effort to rely more upon the private sector to find ways to hold down the rate of spending growth. Supporters of using the private sector to foster competition among plans serving the Medicare population would put private plans center stage, with the traditional program offered as just one of many options. This approach has been termed *premium support* and would require that beneficiaries wishing to stay in the traditional plan or choose expensive options pay higher premiums to do so. An even more dramatic restructuring proposal would simply give those who are eligible the resources to buy private plans with very little oversight. Supporters of these approaches promote the likelihood of greater efficiency from relying on private plans as compared to the government. Thus, savings would likely come both from charging some beneficiaries more and from any benefits of competition.

On the other hand, a substantial slowdown in growth in 1998 and 1999 was achieved for Medicare using traditional methods of limiting payments and reforming the payment structure for benefits, lending support to those who would prefer to retain the current structure with its emphasis on a public program. Reforms would still be needed, but might instead concentrate on improving the Medicare+Choice payment mechanism and adding more active management to the fee-for-service piece of Medicare. Key issues in the debate between these approaches center on which will retain the highest quality of care and the greatest protections for the beneficiaries of the program.

Regardless of whether structural or incremental approaches to change are adopted, it is unlikely that the program can be maintained in its current form without more revenues. A further complicating policy issue arises over the comprehensiveness of the benefit package. It is difficult to imagine achieving greater efficiency in the delivery of health care if major pieces of that care, such as prescription drugs, are not included in the basic benefit package. Both sides of the debate generally agree that improvements in the benefit package should be made, but this adds to the complexity of any solution because new benefits inevitably mean higher costs, putting further pressure on the need for new revenues and/or reforms in the current system. The contentious debate on the prescription drug issue in 2000 and 2001 is illustrative of the difficulty in finding common ground for reforms.

Finally, another issue that may add to the costs of the Medicare program over time is reform of the protections for low-income beneficiaries. Low participation and state reluctance to improve upon these protections suggest that they might better be moved out of Medicaid and into Medicare, but again this would raise costs for the Medicare program.

The future of Medicare will inevitably bring changes: some will come from explicit policy and legislative initiatives, but others will reflect the rapidly changing nature of the health care system as a whole. Medicare cannot be understood or administered without an appreciation for its interrelationships with the American health care system, and an aging society will inevitably put pressures on the program that will require new approaches and new funding.

MARILYN MOON

See also HEALTH INSURANCE, NATIONAL APPROACHES; MEDICAID; MEDICATION COSTS AND REIMBURSEMENTS; MEDIGAP.

BIBLIOGRAPHY

AARON, H. J., and REISCHAUER, R. D. "The Medicare Reform Debate: What is the Next Step?" *Health Affairs* 14 (1995) 8–30.

Centers for Medicare and Medical Services. *Medicare & You 2001*. Washington, D.C.: USGPO, 2001.

FEDER, J., and MOON, M. "Can Medicare Survive its Saviors?" *American Prospect* (May-June 1999): 56–60.

FUCHS, V. "Health Care for the Elderly: How Much? Who Will Pay for It?" *Health Affairs* 18 (1999): 11–21.

HUSKAMP, H.; ROSENTHAL, M.; FRANK, R.; and NEWHOUSE, J. "The Medicare Prescription Drug Benefit: How Will the Game Be Played?" *Health Affairs* 19 (2000): 8–23.

MOON, M. *Medicare Now and in the Future,* 2d ed. Washington, D.C.: The Urban Institute Press, 1996.

MOON, M. "Will the Care Be There? Vulnerable Beneficiaries and Medicare Reform. *Health Affairs* 18 (1999): 107–117.

POISAL, J., and CHULIS, G. "Medicare Beneficiaries and Drug Coverage." *Health Affairs* 19 (2000): 248–256.

VLADECK, B. "The Political Economy of Medicare." *Health Affairs* 18 (1999): 22–36.

WILENSKY, G., and NEWHOUSE, J. "Medicare: What's Right? What's Wrong? What's Next?" *Health Affairs* 18 (1999): 92–106.

MEDICATION COSTS AND REIMBURSEMENTS

Prescription drugs are an important part of medical care. Their proper use can lower hospital and nursing home stays and lead to an overall decline in health care expenditures. However, many older individuals lack insurance coverage for such medications. This has led to a national discussion of adding a prescription benefit to Medicare for senior citizens.

Prescription drug expenditures

According to the Centers for Medicare and Medicaid Services, national spending on prescription drugs in the United States totaled $85.2 billion in 1998, more than double the level of total spending in 1990. Spending for pharmaceuticals is expected to continue rising, by some estimates more than 10 percent annually until at least 2010.

This dramatic increase in prescription drug spending, much larger than that seen in other areas of medical care spending, has several causes. First, there has been a rapid increase in the number of new drugs entering the marketplace. From the early 1960s to the early 1990s, the annual number of new molecular entities (NMEs) receiving approval from the Food and Drug Administration (FDA) nearly doubled, from an average of fourteen in the 1960s to twen-

ty-six in the early 1990s. By 1999, the annual number of NMEs approved had increased to thirty-nine. While some of these NMEs represent new treatments, many are intended as replacement drugs, possibly with fewer side effects. These new drugs are often more expensive than those they are intended to replace.

A second reason for the increase in prescription drug expenditures is the large amount of direct-to-consumer advertising for prescription drugs that has appeared since the FDA lifted its ban on such advertising in 1985. In response, pharmaceutical firm expenditures for direct-to-consumer advertisements rose significantly, from $55 million in 1991 to $1.8 billion in 1999 (National Institute for Health Care Management). This increase in advertising affects prescription drug expenditures in two ways. First, these advertisements lead to an increase in the demand for many name-brand prescription drugs. Second, the advertising expense increases the costs faced by pharmaceutical firms, which are in part passed on to consumers in the form of higher prescription drug prices.

Finally, the aging of the U.S. population is contributing to increased spending on pharmaceutical products. The number of individuals over age sixty-five has grown for the past several decades, and is expected to double between 2000 and 2050. This increases the number of individuals at risk for chronic and disabling conditions that often require prescription medications. For example, according to a study by the Department of Health and Human Services, in 1998, individuals age sixty-five and older accounted for forty-two cents of every dollar spent on prescription drugs even though they accounted for only approximately 13 percent of the population.

Each year, 87 percent of Medicare beneficiaries need to fill at least one prescription. The majority of Medicare beneficiaries (56 percent) use prescription drugs that cost more than $500 per year, and 38 percent use drugs that cost $1000 or more (Department of Health and Human Services). A 2000 study by John Poisal and George Chulis that examined prescription drug expenditures and insurance coverage of Medicare beneficiaries found that, in 1996, the average beneficiary spent $673 on prescription drugs.

Insurance coverage

Approximately one-third of all Medicare beneficiaries have no prescription drug coverage. This lack of coverage disproportionately affects Medicare beneficiaries near the poverty level, those in rural areas, and those age eighty-five and older. While some may receive assistance through state pharmacy programs, out-of-pocket expenditures for beneficiaries without coverage for prescriptions are significantly higher than for those with coverage. For example, Poisals' and Chulis's study found that in 1996, annual out-of-pocket expenditures averaged $463 for Medicare beneficiaries without prescription drug coverage, compared with $253 for those with coverage. These out-of-pocket differences existed even though beneficiaries without coverage filled five fewer prescriptions per year, on average, than those with prescription drug coverage.

Medicare beneficiaries with prescription drug coverage receive such coverage from a variety of sources. Poisal and Chulis report that the majority of Medicare beneficiaries receive supplemental drug coverage from private sources, either from an employer (31 percent) or from a purchased Medigap policy (10 percent). The remaining beneficiaries with drug coverage receive such coverage from Medicaid (11 percent) or through a Medicare HMO (8 percent).

Employer-provided coverage. Like many health insurance benefits from employment, drug benefits from former employers tend to be fairly generous. However, due to changes in accounting standards and rising health care costs, the proportion of firms offering health insurance coverage to retirees has been declining. Even firms that continue to provide such insurance have been reducing or eliminating prescription drug coverage. A 2000 study by Hewitt Associates indicated that 36 percent of large employers planned to reduce prescription drug coverage for retirees age sixty-five and over during the next three to five years.

Medigap policies. Individual Medicare beneficiaries purchase Medigap policies to cover some or all of the deductibles and copayments for Part A or Part B services, as well as some uncovered services, such as prescription drugs. Of the ten standard Medigap policies available, only three include prescription drug coverage. These policies have fairly large copayments and deductibles, and also include an annual limit on drug expenditures. For example, one standard policy has a $250 deductible and provides 50 percent coverage up to a limit of $1,250 per year. Anoth-

er standard policy has the same deductible and coinsurance, but a coverage limit of $3,000 per year.

Medigap policies with drug coverage are generally much more expensive, and have experienced larger increases in monthly premiums than those that do not include drug coverage. A 2001 study by Weiss Ratings found that average premiums for Medigap plans covering prescription drugs increased by 37.2 percent from 1998 to 2000, while premiums for Medigap policies that have no drug coverage rose by only 15.5 percent during the same period.

Medicaid. Medicaid provides access to prescription drugs for the poorest Medicare beneficiaries. Medicare beneficiaries who, because of low income, qualify for Supplemental Security Income, or who are deemed to be medically needy because of their extensive medical costs, can qualify for full Medicaid benefits. These individuals pay neither the Medicare Part B premium nor any of Medicare's deductibles and copayments. In addition, they are eligible for all benefits provided by their state Medicaid program, including coverage for prescription drugs. Half of Medicare beneficiaries with incomes below the poverty threshold are covered by Medicaid.

Medicare HMOs. In 2000, 17 percent of Medicare beneficiaries were enrolled in Medicare HMOs. Of these beneficiaries, 80 percent are enrolled in HMO plans that include a prescription drug benefit (Health Care Financing Administration, 2000). There is, however, considerable variation in the scope and generosity of benefits across plans, and Medicare HMOs are not available in all geographic areas. Many plans use cost-containment measures in their prescription drug coverage, such as copayments and low spending limits (often as low as $1,000 annually). Studies show that Medicare beneficiaries often drop out of their HMO plans once they have exhausted their drug benefits. This has led to new restrictions on the ability of beneficiaries to switch plans during the year.

Prescription drug coverage in Canada

There is a national system of health insurance in Canada. This program, however, does not include coverage for prescription drugs. Instead, Canadian citizens may obtain supplemental coverage through an employer or by purchasing a policy in the private market. In addition, for certain segments of the population, such as senior citizens, each Canadian province provides public coverage for other health services that are excluded from the national health insurance. Prescription drugs are covered in these programs, but the exact level of benefits varies across income levels and across provinces.

Proposals to increase prescription drug coverage

Because of rising drug costs and the large number of Medicare beneficiaries without prescription drug coverage, there has been a growing debate in the United States concerning a national drug benefit for senior citizens. For such a benefit to become a reality, however, many decisions must be made. For example, who will be covered? Will the benefit be available to all Medicare beneficiaries or to only those below some specific income threshold? A 1999 study by the National Academy of Social Insurance (Gluck) indicated that providing a drug benefit for all Medicare recipients would increase the costs of the Medicare program by 7 to 13 percent over the next ten years. Other considerations include whether the plan would be voluntary, how the program would be administered, and which methods of cost containment should be used.

There have been four basic programs proposed with these factors in mind. These proposals vary in both scope and the level of federal involvement. Two of them involve changes in the current Medicare program.

Comprehensive Medicare reform. Since the late 1980s, analysts and policy makers have become increasingly concerned about the financial health of the Medicare program. Increasing health care costs and an aging population have led to dire predictions concerning the viability of this important government program. Many analysts have therefore called for a complete overhaul of the Medicare program. Such a reform would include an analysis of what types of coverage should be provided and how it should be financed. Important choices would have to be made concerning the level of benefits received by senior citizens, and cost-control methods would have to be adopted or expanded. It is possible that a prescription drug benefit could then be added to the program, but this would likely occur only in tandem with a reduction in other benefits or an increase in taxes and monthly premiums.

Addition of drug benefit to current Medicare. Instead of reforming the entire Medicare program, some analysts have suggested that the government simply add a new prescription drug benefit to the current program. This would be a voluntary program that would be financed through monthly premiums and general tax revenues (in much the same way that Part B of Medicare is financed). The federal government could make the benefit more affordable for low-income senior citizens by providing them with a subsidy.

Federal subsidies for private insurance. A third suggestion is for the federal government to provide subsidies to senior citizens so that they can purchase prescription drug coverage in the private market. This policy increases access and affordability of drugs to seniors with limited government involvement.

State programs. Last, the federal government could establish state grant programs targeted to provide drug coverage to low-income senior citizens. At the beginning of 2001, twenty-six states had some type of prescription drug program in place to assist senior citizens and disabled individuals. Many of these programs require senior citizens to pay part of the cost of the drugs, but the levels of these copayments vary widely from state to state.

Each of these proposed reforms has merit, yet they also generate concerns. It is possible that a prescription drug benefit could be added to the Medicare program, but this would likely occur only if other benefits are reduced or taxes and monthly premiums are increased. Accurately predicting future prescription drug costs will be difficult, and thus could lead to shortfalls in revenues for the program. This would result in more difficulty for the financially troubled Medicare program. If the prescription drug program through Medicare is voluntary and monthly premiums are sizable, there could be a great deal of adverse selection. Only Medicare beneficiaries requiring numerous prescriptions each year would join the program. This would make predicting the costs of the program much more complex. A federal subsidy to help senior citizens purchase drug coverage through private markets lowers government involvement, but will it be possible for the private market to provide prescription drug coverage that is affordable? Last, state government leaders may be reluctant to participate in a federal grant program if they are concerned that the federal government will eventually shift the cost of the program to the states as costs rise.

LINDA S. GHENT

See also MEDICAID; MEDICARE; MEDIGAP.

BIBLIOGRAPHY

GLUCK, M. E. "A Medicare Prescription Drug Benefit." *National Academy of Social Insurance Medicare Brief* no. 1 (1999).

Health Canada. *Canada's Health Care System*. Ottawa, Ontario: Health Canada, 1999.

Health Care Financing Administration. *Medicare 2000: 35 Years of Improving Americans' Health and Security*. Washington, D.C.: U.S. Government Printing Office, 2000.

Health Care Financing Administration. *National Health Care Expenditures Projections*. www.hcfa.gov/stats 2001.

Hewitt Associates. *Implications of Medicare Prescription Drug Proposals for Employers and Retirees*. Menlo Park, Calif.: Henry J. Kaiser Family Foundation, 2000.

National Institute for Health Care Management. *Prescription Drugs and Mass Media Advertising*. Washington, D.C.: Government Printing Office, 2000.

POISAL, J. A., and CHULIS, G. S. "Medicare Beneficiaries and Drug Coverage." *Health Affairs* 19 (2000): 248–256.

U.S. Department of Health and Human Services. *Prescription Drug Coverage, Spending, Utilization, and Prices*. Washington, D.C.: U.S. Government Printing Office, 2000.

U.S. Food and Drug Administration, Center for Drug Evaluation and Research. *CDER 1997 Report to the Nation: Improving Public Health through Human Drugs*. Washington, D.C.: U.S. Government Printing Office, 1997.

U.S. Food and Drug Administration, Center for Drug Evaluation and Research. *CDER 1999 Report to the Nation: Improving Public Health through Human Drugs*. Washington, D.C.: U.S. Government Printing Office, 1999.

Weiss Ratings, Inc. *Prescription Drug Costs Boost Medigap Premiums Dramatically: First in a Series on the History of Medigap Pricing*. Palm Beach Gardens, Fla.: Weiss Ratings, 2001.

MEDIGAP

Since the enactment of Medicare in 1965, there has been a market for supplemental insur-

ance designed to fill the gaps in the program's coverage. The possession of supplemental insurance is essential for most Medicare beneficiaries because there are a number of gaps in Medicare coverage, some of which can result in catastrophically high out-of-pocket costs. Under Part A (Hospital Insurance), patients face very high daily co-payments ($792 in 2001) in the unlikely event that they experience a hospitalization lasting over sixty days, and no coverage whatsoever if a hospital stay exceeds 150 days. Under Part B (Supplemental Medical Insurance), there is no cap on out-of-pocket payments for the 20 percent co-payment that is applied to the costs of physician and other professional services. There is also no coverage provided for other potentially costly goods and services used by beneficiaries, particularly prescription drugs and long-term nursing home stays. Consequently, most beneficiaries feel the need to acquire additional health coverage.

Supplemental insurance is the norm, therefore, and not the exception. An estimated 91 percent of Medicare beneficiaries have such coverage, with only 9 percent having Medicare as their sole protection. Of the 91 percent, 17 percent are enrolled in Medicare managed care programs, 27 percent have individually purchased (or ''Medigap'') coverage, 36 percent have coverage from an employer or former employer, and 11 percent are covered by Medicaid. Each of these sources of coverage are discussed below.

Medigap insurance

Although all supplemental insurance is sometimes referred to as ''Medigap,'' true Medigap means something more specific: individually-purchased coverage that ''wraps around'' the benefits included in the traditional, fee-for-service Medicare program. Medigap policies always provide coverage for some or all of the co-payments required of beneficiaries under Medicare, and often provide additional benefits that are not covered at all by Medicare.

More so than almost any other type of insurance, Medigap policies have been subject to a great deal of federal regulation. In 1980, Congress passed the Baucus amendments, which established voluntary certification standards subsequently adopted by nearly all states. This legislation specified that Medigap policies contain certain minimum benefits, meet minimum loss ratios (defined as the percentage of premiums collected that are spent on providing covered health care benefits), and provide various information to prospective purchasers.

Under the law, a Supplemental Health Insurance Panel, composed of the secretary of health and human services and four state insurance commissioners, determined whether the regulations in an applicant state met or exceeded the model standards established by the National Association of Insurance Commissioners. In states meeting these standards, Medigap policies issued in that state were considered to be in compliance with the legislation, and companies were allowed to use this information in their marketing. In cases where a state did not conform, insurance companies could ask the secretary to review their policies individually. If a policy was deemed to be conforming, then it would be viewed as receiving certification, just like in states that were in full compliance. All but a few states adopted these standards; those that did not established requirements of their own, which were often far from stringent.

Although the Baucus amendments were deemed a success in reducing marketing abuses and ensuring that policies provide decent benefits with reasonable payouts, the problem that remained was that with so many different configurations of benefits available, it was almost impossible for consumers to engage in effective comparison shopping. This problem was dealt with through the passage of the Omnibus Budget Reconciliation Act of 1990 (OBRA-90), which stipulated that all Medigap policies conform to one of ten particular sets of standardized benefits.

The ten different types of Medigap coverage are shown in Table 1. Each carrier selling Medigap coverage must cover policy type A, which includes several ''core benefits'' contained in all ten benefit packages: the inpatient daily hospital co-payments for stays lasting more than 60 days; the 20 percent Part B co-insurance; and a deductible for the first three pints of blood used. Benefits that are contained in some of the other nine packages include coverage for:

- The skilled nursing facility (SNF) daily co-payment
- The Part A hospital deductible
- The $100 Part B deductible

Table 1
Standardized benefits covered by Medigap policies under OBRA-90.

	Policies									
Benefits	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Core benefits[a]	•	•	•	•	•	•	•	•	•	•
SNF coinsurance[b]			•	•	•	•	•	•	•	•
Part A deductible		•	•	•	•	•	•	•	•	•
Part B deductible			•			•				•
Part B excess charges						High[c]	Low[c]		High[c]	High[c]
Foreign travel			•	•	•	•	•	•	•	•
At-home recovery				•			•		•	•
Prescription drugs								Low[d]	Low[d]	High[d]
Preventive medical care					•					•

[a] Core benefits include coverage of all Part A (hospital) coinsurance for stays longer than 60 days, the 20% Part B coinsurance, and the Parts A and B blood deductible.
[b] SNF is skilled nursing facility.
[c] Low excess charge coverage pays 80% difference between the physician's charge and the Medicare-allowable rate; high coverage pays 100% of the difference.
[d] Low prescription drug coverage has a $250 annual deductible, 50% coinsurance, and a maximum annual benefit of $1,250; high coverage is similar, but it has a $3,000 maximum annual benefit.

SOURCE: National Association of Insurance Commissioners, Medicare Supplement Insurance Minimum Standards Model Act 6 (July 30, 1991).

- Either 80 percent or 100 percent of nonassigned physician charges in excess of Medicare's reasonable charge
- Medical emergencies while traveling outside of the United States
- At-home visits when recovering from an acute illness when patients need help performing activities of daily living, with a limit of 40 visits per year and $40 per visit
- Fifty percent of prescription drug costs after a $250 annual deductible is met, with a maximum annual limit of $1,250 or $3,000 in benefits
- Coverage for preventive medical care visits with an annual limit of $120

Most analysts have considered Medigap policy standardization under OBRA-90 to have been successful, particularly because it has vastly simplified consumer understanding of, and shopping for, coverage. There are, nevertheless, a number of problems remaining in the Medigap market. First, the possession of Medigap policies results in higher utilization and, therefore, higher health care costs. Furthermore, because Medigap is tied to the fee-for-service system, there is a financial incentive for providers to deliver more services.

Although other types of insurance also encourage the use of more services, there is one peculiarity about Medigap: most of the extra costs are borne not by policy owners, but by the Medicare program as a whole. This is because ownership of such policies does indeed result in higher costs, but these extra costs are covered, and therefore mainly paid for, by Medicare. To illustrate, Medicare pays 80 percent of the costs of physician services. If owning a Medigap policy stimulates a person to use an extra service, Medicare pays for most of the associated costs. This allows Medigap insurers to sell policies more cheaply than they could otherwise. Thus, the Medicare program is essentially subsidizing the purchase of Medigap policies, which would be more expensive (and presumably less appealing) were it not for these cross-subsidies.

Another problem with Medigap concerns the benefit structure. Some of the benefits are not terribly useful, and there are some notable gaps

in coverage as well. Some Medigap benefits being purchased do not provide real insurance coverage (e.g., under half of beneficiaries do not have coverage for the $100 annual Part B annual deductible) or do not seem worth the cost. For example, about 45 percent of Medigap owners have coverage for nonassigned physician services, often at a substantial cost. This covers physician billing above the amount Medicare deems to be "reasonable," but this is a very uncommon practice now, and there are strict limits on how much extra physicians can bill.

The benefits are also limited; the main limit being the lack of effective coverage for long-term care. In addition, beneficiaries cannot choose a "catastrophic coverage" option, where they are allowed to choose to pay a high annual deductible for lower premiums.

Medigap policies are very expensive, and, therefore, not evenly distributed among seniors. The most popular policy, Plan F, costs over $1,000 annually (in 1996) for a sixty-five-year old, and can cost much more for older beneficiaries. On average, Plan F premiums constituted about 8 percent of a 75-year old's total income in 1996. The plans with prescription drug coverage are particularly expensive, not only because they cover drugs, but because beneficiaries with higher overall utilization tend to join. For example, the additional premiums associated with the Medigap plans providing a maximum of $1,250 annually in prescription drug benefits average about $600 annually for a sixty-five-year old, $1,000 for a seventy-five-year old, and $1,300 for an eighty-five-year old.

Partly because of these costs, those who are better off are more likely to have Medigap coverage. In 1999, 12 percent of poor and near-poor seniors had no supplemental insurance of any kind, compared to 8 percent of middle-income seniors and 6 percent of high-income seniors.

Medicare managed-care plans

In recent years, many beneficiaries have chosen to receive their supplemental benefits through Medicare managed-care plans. These plans, which, unlike Medigap policies, do not have standardized benefits, usually provide benefits in addition to those provided by Medicare. In 2000, for example, two-thirds offered coverage for pharmaceuticals. Although plans are allowed to charge a premium in addition to the Medicare Part B premium, many (42 percent in 2000) do not, and those that do tend to charge much less than for Medigap policies.

Growth in such plans was rapid through 1998—from 1.3 to 6.3 million beneficiaries between 1990 and 1998. Enrollment fell by about 10 percent between 1998 and 2001, mainly because many plans pulled out of the market due to reduced payments from the federal government. Between 1998 and 2000, the number of Medicare managed care plans fell by almost 30 percent.

A second concern involves selection bias. Prior to 2001, healthier beneficiaries tended to join Medicare managed-care plans, leaving those who are in poorer health in the fee-for-service program. The main reason for this is that seniors who are in poor health are more likely to have a relationship with a doctor that they want to preserve. To many of them, the great advantage of the traditional Medicare program is that it offers complete freedom of provider choice. A second reason for selection bias is that healthier beneficiaries are likely to be better informed than others, and thus more likely to avail themselves of managed-care options. Finally, although Medicare HMOs are required to accept all applicants, they have a strong incentive to aim their marketing to those who are younger and healthier.

Selection bias is a problem for two reasons. First, it means that those who are sicker and who could most benefit from the coordinated care provided by HMOs are less likely to avail themselves of it. Second, it drives up premiums for those who remain in fee-for-service, making Medigap coverage increasingly unaffordable.

Employer-sponsored policies

Although they have received almost no attention from policymakers, even more common than individually purchased Medigap policies is coverage provided by employers and former employers. Typically, retirees with this coverage enjoy the same benefits as active workers in a firm, and they pay less in premiums and cost-sharing requirements than do owners of Medigap policies. For example, in 1997, the average premium paid by those with employer coverage was $712 annually, compared with $1,249 for those with Medigap. In spite of their paying lower premiums, those with employer-sponsored policies tend to be better off economi-

cally, and they receive more in benefits. The primary example is in the area of prescription drug costs, where 72 percent of those with employer-sponsored coverage have such coverage, versus only 25 percent of those with Medigap.

The trend in employer-sponsored coverage for retirees is for fewer firms to promise these benefits, and when they are offered, there are more eligibility restrictions and higher costs for the retiree. Most notable is the decline in firms offering coverage. One study reports that among large employers, just 31 percent of Medicare-eligible retirees were offered health benefits from their former employer in 1997, compared to more than 50 percent in 1988. Another finds that in 1998, 40 percent of large employers offered such benefits, down from 67 percent in 1984. These changes stem from many factors, but were sparked by the Statement of Financial Accounting Standards No. 106, which was adopted by the Financial Accounting Standards Board (FASB) in 1992. This rule requires employers ''to treat obligations for present and future retiree health benefits on an accrual rather than a pay-as-you go basis.'' This means that the anticipated costs of future retiree benefit payouts have to be accounted for in current financial statements.

Employer-sponsored coverage, when it is offered, has several advantages over individually-purchased Medigap policies: employers share in the cost; these employers may be more effective than an individual in purchasing good coverage; and it is likely to be cheaper than individual coverage, irrespective of any subsidization by the employer, because insurers are less at risk when they insure a large pool of employees. But, like Medigap, there are problems as well, including the potential for high utilization of services and the resulting costs. The main problem, however, is the lack of security of these benefits, which are almost always subject to the Employee Retirement and Income Security Act (ERISA). Although ERISA provides various protections for pension benefits, little protection is required of health benefits.

Medicaid

There are four ways in which Medicare beneficiaries with low incomes can qualify for Medicaid coverage. Under the traditional or ''full coverage'' mechanism, low-income Medicare beneficiaries who qualify for cash payments such as Supplementary Security Income, or who are deemed to be medically needy by their states, can qualify for Medicaid benefits. The second route is the Qualified Medicare Beneficiary (QMB) program, which is aimed at beneficiaries without full Medicaid coverage whose incomes are at or below the poverty level.

Third, the Specified Low-Income Medicare Beneficiary (SLMB) Program is aimed at those with incomes just above the poverty level (not more than 20 percent higher). Finally, the Qualified Individual Programs (QI-1 and QI-2) covers some individuals with incomes that are 20 to 75 percent higher than the poverty level.

Of the 16.5 percent of Medicare beneficiaries who are also covered by Medicaid, just over half (8.3 percent) are enrolled under the traditional program, almost half (7.4 percent) are eligible through QMB, and 0.8 percent have SLMB coverage. Only a negligible percentage (about 0.1 percent) have QI coverage. Those eligible for full coverage, as well as those with QMB coverage, do not have to pay the Medicare Part B premium or the Medicare deductibles and coinsurance. Furthermore, those with full coverage can take advantage of other benefits provided by their state Medicaid program, such as coverage for preventive services, prescription drugs, and long-term nursing home care. In contrast, those with SLMB and QI coverage do not receive any covered benefits besides those provided by Medicare. Rather, they are just exempted from paying the monthly Part B premium ($50.00 per month in 2001).

Disadvantages to Medicaid supplemental coverage include the cost of this coverage to the state and federal government and the fact that seniors are not permanently eligible for coverage. One way to ensure continuous coverage is to purchase individual Medigap coverage, but this is very expensive and generally not recommended. Otherwise, when individuals lose their Medicaid eligibility they find themselves at considerable financial risk as a result of Medicare's substantial premium and cost-sharing requirements.

Another major problem with Medicaid supplementation is the fact that many individuals who are eligible for this coverage are unaware of the fact. It is estimated that between 1.9 and 2.4 million people are eligible but not receiving QMB benefits, and 1.4 million are eligible for but not receiving SLMB. Altogether, this represents about 45 percent of eligibles. Almost none of the

half million people eligible for QI have it. These figures are of concern to policymakers, in part, because these individuals are likely to receive less medical care, but also because of the financial cost. If someone is eligible for but not receiving QMB, SLMB, or QI, they receive $546 less annually in Social Security benefits because the Part B premium is withheld. Furthermore, those who should be receiving QMB are paying the substantial Medicare cost-sharing requirements, or alternatively, have a Medigap policy that they do not need.

Having Medicaid coverage makes a tremendous difference in how much a person has to pay out-of-pocket for medical care. On average, those with Medicaid pay a total of $337 per year out-of-pocket, compared to $1,735 for those with Medicare coverage only. Those below the poverty level who have Medicaid pay an average of only 8 percent of their income towards medical expenses and insurance premiums, compared to 54 percent for poor beneficiaries who have Medigap coverage, and 48 percent for those with HMO coverage.

THOMAS RICE

See also EMPLOYEE HEALTH INSURANCE; HEALTH INSURANCE, NATIONAL APPROACHES; MEDICAID; MEDICARE.

BIBLIOGRAPHY

ALECXIH, L. M, et al. "Key Issues Affecting Accessibility to Medigap Insurance." New York: The Commonwealth Fund, 1997.

CHULIS, G. S., et al. "Health Insurance and the Elderly: Data from MCBS." *Health Care Financing Review* 14, no. 3 (1993): 163–181.

CHULIS, G. S.; EPPIG, F. J.; and POISAL, J. A. "Ownership and Average Premiums for Medicare Supplementary Insurance Policies." *Health Care Financing Review* 12: 255–275.

COOPER, B. S., and DAVIS, M. H. "On the Road to Medicare Drug Coverage." Paper presented at the Seventh Princeton Conference, sponsored by the Robert Wood Johnson Foundation, May 13, 2000.

DOWD, B., et al. "Issues Regarding Health Plan Payments Under Medicare and Recommendations for Reform." *Milbank Quarterly* 70, no. 3 (1992): 423–453.

EPPIG, F. J., and CHULIS, G. S. "Trends in Medicare Supplementary Insurance: 1992–96." *Health Care Financing Review* 19, no. 1 (1997): 201–206.

ETTNER, S. L. "Adverse Selection and the Purchase of MediGap Insurance." *Journal of Health Economics* 16, no. 5 (1997): 499–624.

Families USA Foundation. "Shortchanged: Billions Withheld from Medicare Beneficiaries." Washington, D.C.: Families USA Foundation, 1998.

FOX, P. D.; RICE, T.; and ALECXIH, L. "Medigap Regulation: Lessons for Health Care Reform." *Journal of Health Politics, Policy, and Law* 20, no. 1 (1995): 31–48.

GOLD, M. "Trends Reflect Fewer Choices." *Monitoring Medicare+ Choice Fast Facts*. Washington, D.C.: Mathematica Policy Research, 2000.

GROSS, D. J., et al. "Out-of-Pocket Spending by Medicare Beneficiaries Age 65 and Older: Further Analysis of 1997 Projections." Paper presented at the Association for Health Services Research Annual Meetings, Washington, D.C., June 1998. Prepared by the Public Policy Institute of the American Association of Retired Persons, and the Lewin Group, Inc.

KORNFIELD, T., and GOLD, M. "Is There More or Less Choice?" *Monitoring Medicare+ Choice Fast Facts*. Washington, D.C.: Mathematica Policy Research, December 1999.

KPMG Peat Marwick. *Health Benefits in 1998*. Washington, D.C.: KPMG Peat Marwick, 1998.

LAMPHERE, J., et al. "The Surge in Medicare Managed Care: An Update." *Health Affairs* 16, no. 3 (1997): 127–133.

LANGWELL, K. M., and HADLEY, J. P. "Insights from the Medicare HMO Demonstrations." *Health Affairs* 9, no. 1 (1990): 74–84.

MCCALL, N., et al. "Private Health Insurance and Medical Care Utilization: Evidence from the Medicare Population." *Inquiry* 28 (1991): 276–287.

MCCALL, N.; RICE, T.; and HALL, A. "The Effect of State Regulations on the Quality and Sale of Insurance Policies to Medicare Beneficiaries." *Journal of Health Politics, Policy, and Law* 12, no. 1 (1987): 53–76.

MCCORMACK, L. A., et al. "Medigap Reform Legislation of 1990: Have the Objectives Been Met?" *Health Care Financing Review* 18, no. 1 (1996): 157–174.

MORRISEY, M. A.; JENSEN, G. A.; and HENDERLITE, S. E. "Employer-Sponsored Health Insurance for Retired Americans." *Health Affairs* (Spring 1990): 57–73.

RICE, T.; GRAHAM, M. L.; and FOX, P. D. "The Impact of Policy Standardization on the Medigap Market." *Inquiry* 34 (1997): 106–116.

RICE, T., and BERNSTEIN, J. "Supplemental Health Insurance for Medicare Beneficiaries."

Medicare Brief No. 6. Washington, D.C.: National Academy of Social Insurance, 1999.

U.S. General Accounting Office. "Medigap Insurance: Law Has Increased Protection Against Substandard and Overpriced Policies." Pub. no. GAO/HRD-87-8. Washington, D.C.: USGAO, 1986.

U.S. General Accounting Office "Retiree Health Insurance: Erosion in Retiree Health Benefits Offered by Large Employers." Pub no. GAO/T-HEHS-98-110. Washington, D.C.: USGAO, 1998.

WARE, J. E., JR., et al. "Differences in 4-Year Health Outcomes for Elderly and Poor, Chronically Ill Patients Treated in HMO and Fee-for-Service Systems: Results from the Medical Outcomes Study." *Journal of the American Medical Association* 276 (1996): 1039–1047.

MEMORY

Most people recognize that their memories are changing as they grow older. They have a harder time coming up with names; they have a harder time finding things they need; they have to rely more on external memory cues such as notes or calendars. In fact, research results support these perceptions. The bad news from this research is that memory declines are experienced throughout the adult life span and not just in the older ages. Forty-year-olds as a group are worse than twenty-year-olds, and fifty-year-olds are worse than thirty-year-olds. The good news is that research shows that, unlike the serious and ubiquitous memory declines associated with Alzheimer's disease and other dementias, memory changes associated with healthy aging are selective (e.g., Zack et al.). Some memory tasks show large and reliable adult age differences (e.g., working memory, episodic memory), while other memory tasks show little or no effects of age (e.g., semantic memory, implicit memory).

Figure 1 shows the results from study of 345 adults ranging in age from the twenties to the eighties (Park, Lautenschlager, et al.). Different types of memory were tested, including working memory (computation span), episodic memory (free recall of a word list), and semantic memory (defining words in a vocabulary test). The results were plotted in deviation units from the mean for all the participants on any test (z scores). As can be seen in the graph, the memory changes occur across the entire adult life span and are not limited to old age. Second, the graph shows that age has selective effects on memory. Working memory and episodic memory decline significantly across the life span, while semantic memory increases significantly.

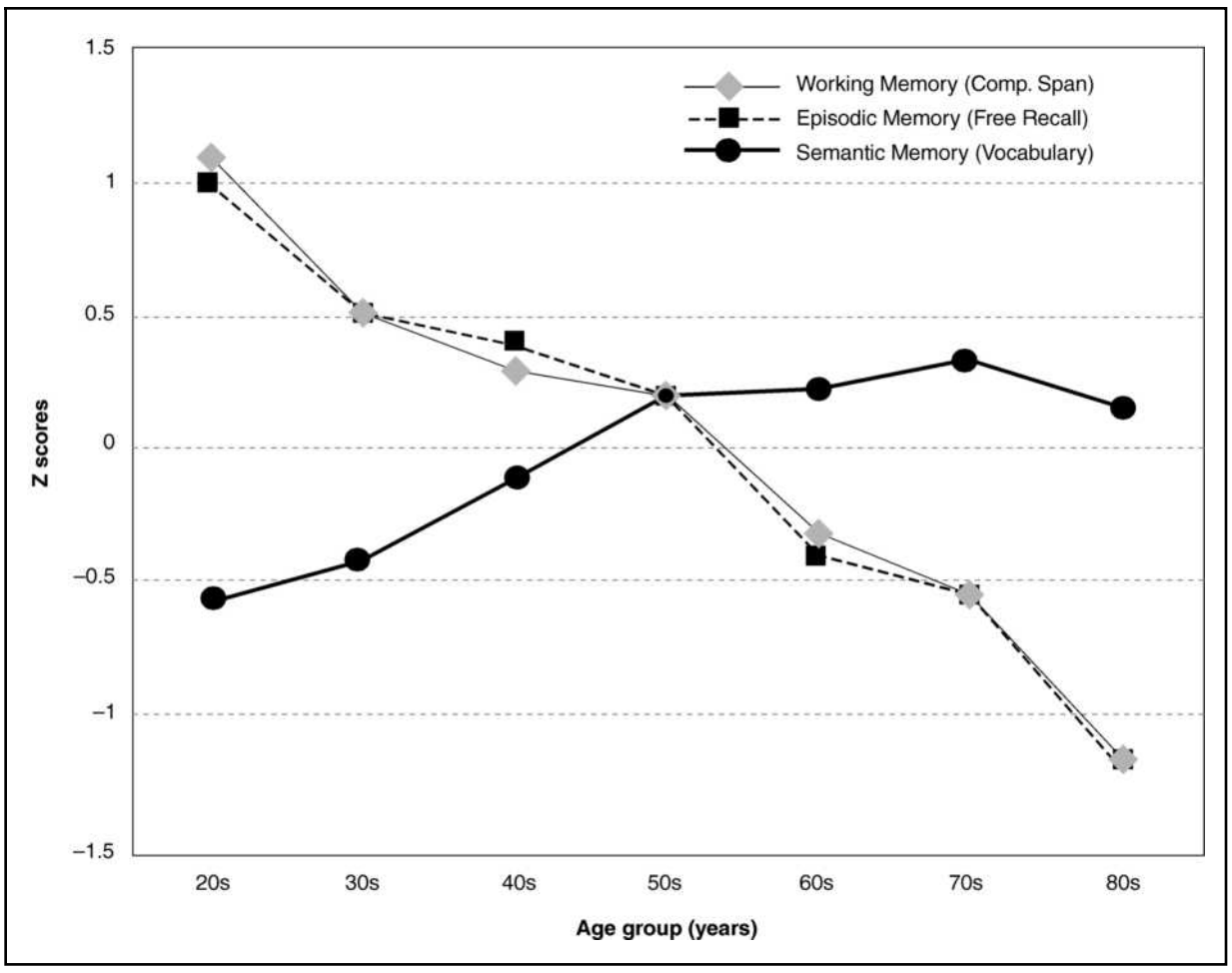
Other theories suggest that age differences in memory depend on the extent of deliberate cognitive processing or cognitive resources required to perform the task (e.g., Park). According to this view, the size of age differences in different memory tasks is determined by the amount of cognitive resources needed to adequately remember in those tasks. Other theories suggest that age effects are limited to specific memory structures or types (e.g., Craik). Clearly, the explanation for the differential effects of age with different memory tasks depends on how one conceptualizes memory.

Memory stage theory

Memory stage theory separates memory into the temporal, sequential components that define any act of remembering. Information first has to be perceived or experienced (i.e., encoding). Then the information has to be maintained over a retention interval of some length of time (i.e., storage). Finally, the information has to be produced at the time memory is tested (i.e., retrieval). Early researchers believed that adult age differences in memory were located primarily at retrieval, the final of the three stages. Early laboratory research, for example, demonstrated that age differences were large when the recall of a word list was measured (with instructions such as "Write down all the words you can remember having seen on the list presented earlier."). Age differences, however, were greatly reduced or even eliminated when recognition memory was used to test memory at retrieval (with instructions such as "Select the words on this list that were presented on the list that you saw earlier."). Because the use of a recognition memory task is assumed to reduce the retrieval requirement of the memory task, it was then inferred that the locus of the age effect must be retrieval. Such findings were prevalent in the 1960s and 1970s.

More recent research, however, has clearly demonstrated that recognition memory is not totally insensitive to aging, and the stage theory lost its appeal because of the methodological difficulties in isolating one memory stage from another in different age groups. In order to isolate retrieval, for example, everything must be held constant until the time retrieval is tested. This is

Figure 1
Age group differences in working memory (as measured by computation span), episodic memory (as measured by free recall), and semantic memory (as measured by vocabulary).



SOURCE: Adapted from Park, Lautenschlager, et al. in press. Copyright © 2002 by the American Psychological Association. Adapted with permission.

difficult to accomplish in aging research, however, because adults of different ages may process information differently at one of the earlier stages, thus violating the requirement that all be held constant until retrieval (Smith).

The major reason, however, for the loss of interest in identifying the stage at which aging had its effects is clear evidence that age has effects on all stages of memory: encoding, storage, and retrieval. For reasons not directly related to memory stage theory, however, memory research in the 1970s and early 1980s focused heavily on the encoding stage of memory. This focus on encoding was due to the development of a conceptual view of memory, the "levels of processing" framework, which proposed that the ability to remember was determined by the extent of semantic processing during the encoding of the to-be-remembered information (Craik and Lockhart). For this reason, much research on memory and aging during this period focused on the nature of encoding processes in different age groups. Even with the magnitude of the research effort, however, the relationship between aging and levels of processing is still unclear. The research did, however, suggest that encoding is especially affected by adult aging. For example, the memory performance of older adults, relative to younger adults, is more detrimentally affected by

performing a divided attention task during the encoding stage of a memory task, but not if the divided attention task occurs at retrieval (Park, Smith, et al.).

Memory system theory

Another view of memory that has both behavioral and neurological support considers memory not as a unitary construct but as a collection of component systems. The general view is that memory consists of sensory memory, short-term memory, and long-term memory. Short-term memory is further divided into primary memory and working memory, and long-term memory is divided into episodic memory, semantic memory, and procedural memory. These memory systems differ in the nature of how memories are represented and in how these representations are maintained and retrieved. They also differ considerably in how they are affected by adult aging.

Sensory memory. After an event is experienced, it is first represented very briefly in the sensory system. Here the information is represented as it is processed and analyzed by the attentional and perceptual systems. There has been very little work on this type of memory and aging, but some research does suggest that older adults are less efficient in this early type of processing, especially in the visual system. It should be pointed out, however, that differences in sensory-perceptual processing would be an unlikely explanatory construct for memory differences found in later memory systems because later memory differences vary according to what system is examined (Craik). Adequate perceptual processing of the to-be-remembered stimulus would seem to be a requirement for all types of long-term memory, and the fact that some long-term memory systems are minimally affected by aging while others show large effects would not support an explanation that relied solely on faulty processing at the very early stage of processing.

Primary memory. Primary memory refers to the number of items that can be represented in the mind at one time. Primary memory is typically measured by digit- or word-span tasks. For example, when strings of numbers are presented one at a time at one-second intervals, primary memory would be the number of items that could be repeated back without errors. The digit-span test found on most intelligence tests is a measure of primary memory. When primary memory is tested by digit-span tests with individuals of different ages, no reliable age differences are found (Craik). Another measure of primary memory is recall of the last few items presented on a word list. Again, research finds no age differences in the ability to recall the most recently presented items in a word list.

Working memory. Age differences are found, however, on a measure of short-term memory called working memory, which takes into account both the ability to keep things in mind and, at the same time, the ability to process information. Working memory, unlike primary memory, requires individuals to keep information in mind while engaging in another processing task. One commonly used working memory task is reading span. Individuals read a series of short sentences (e.g., "The girl hit the ball.") and answer questions about the sentence (e.g., "Who hit?"). At the same time, individuals have to remember the last word in each sentence (e.g., "ball") and report the words when told to do so. The number of sentences presented varies, and reading span is the greatest number of words that can be remembered without making an error. Because working memory tasks require simultaneous storage (remembering the words) and processing (reading the sentences and answering the questions), it is a better simulation of everyday information processing.

Working memory is used to understand a conversation or to write an e-mail message on the computer. Other working memory tasks have been developed that involve different kinds of information processing, such as arithmetic calculations (computational span) and spatial manipulations (spatial working memory). Regardless of the type of information involved, however, large, reliable age differences are found on working memory tasks (Zacks et al.). Therefore, while the more passive primary memory tasks, such as simple digit span, do not show age differences, differences are found with working memory measures. As will be discussed later, working memory capacity is considered by many researchers to be a fundamental mechanism for more complex memory processing.

Long-term memories are not kept in conscious awareness, as short-term memories are, but instead have to be retrieved into consciousness when they are needed.

Episodic memory. Episodic memories are recollections that are actively retrieved as pre-

vious personal experiences. For this reason, episodic memory is sometimes called autobiographical memory. The memory is a reconstruction of an earlier experience very much like looking something up in an internal cognitive diary. For this reason, contextual information about when and how an event was originally experienced is often used to guide retrieval. "What did I have for dinner last night?" "Where did I park my car?" "Did I take my medicine this morning?" "Did you see Joan at the party last night? To answer each question, one attempts to reconstruct the original event.

Older adults do worse on most episodic memory tasks than do younger adults (see Figure 1). In the laboratory, typically a list of words or some other to-be-remembered information is presented to individuals, and later, after a retention interval, memory is tested. Because the items presented are commonly used words, they are already known to the individuals. The memory task, therefore, is to remember the words in the particular context of the original list. Episodic memory requires one to put what one is trying to remember in a specific context. Even though the magnitude of age differences varies considerably among different memory tasks using different materials and types of tests, older adults tend to have greater problems with episodic remembering than do younger adults.

As will be discussed later, the variable that seems important in determining the magnitude of age differences is the degree to which the memory task involves deliberate processing by the individual. At both encoding and retrieval, the more intentional processing required to perform the task, the larger the age differences that will be found with that task. For example, free recall of a word list requires more deliberate processing than recognition tasks, and age differences are larger on free recall (Craik). Instead of trying to actively recall the items, individuals in a recognition task only have to pick out the words they saw earlier on a longer list of words.

Because episodic memory is so dependent on contextual information, one of the reasons for older adults' poorer performance on these tasks is probably their inability to encode and remember contextual information easily. Older adults, for example, do not do as well as younger adults in identifying the way in which information was presented to them (i.e., source memory). They do worse when asked to remember whether a word was presented in uppercase or lowercase, spoken by a male or a female voice, in one color versus another, or in the upper part of a computer screen or the lower part (Zacks et al.). These tasks require individuals to remember contextual detail. Because older adults encode less contextual detail, they do not do as well on tasks in which contextual detail provides the cues for retrieval. In fact, because older adults encode less context, they have problems distinguishing events they actually experience from those they have only thought about, a phenomenon called "reality monitoring." In a reality-monitoring task, individuals either read words at encoding or generate words in response to some cue. Older individuals have greater problems in determining whether remembered events were the ones read or the ones imagined in response to the cue (Norman and Schacter).

In addition to the problems associated with remembering context itself, older adults have problems with binding the context with the to-be-remembered information. In one study, for example, younger and older adults were presented with pairs of words and asked to generate a sentence that included both words. There were no age differences in the nature of sentences generated, but older adults did have more problems generating sentences, especially for unrelated word pairs that required them to generate the binding sentence through deliberate processing (Smith et al.). Older adults were better able to generate sentences when the two words were related to one other. They were also better able to recall one word from the word pair when given the other word as a cue. By having related word pairs, there was less need to bind the two words together because their relationship provided an existing bond. Again, because less deliberate processing was required in both the encoding and the retrieval conditions when related pairs were used, age differences were smaller. In fact, research has shown that age differences in the ability to recall a target picture when another picture is given as a cue depends on the relationship of the cue to the target. Age differences are large when the two pictures are unrelated, but smaller when the two pictures are either semantically related or presented as perceptually interacting (Park, Smith, et al. 1990).

One interesting type of episodic memory, "prospective memory," does not involve remembering something from the past, but instead in-

volves intending to do something in the future. "Stop by the store when you leave work, and bring home some milk." "When you see Wanda, tell her to look at my new Web page." "Take two of these pills every other day after lunch." These are examples of prospective memory tasks. In the laboratory, prospective memory tasks simulate these real-world examples (e.g., "Press the key when you see a word with an 'R' in it" or "Press the key every ten minutes"). The prospective task is combined with some other cognitive task, such as trying to study a word list for a later memory test. With simple laboratory tasks, however, such as pressing a key when a certain letter is found in a word, age differences in prospective memory are often not found. Again, the determinant of whether age differences are found seems to be the degree of deliberate recollection required to perform the task, either for the prospective task or for the background task. As the difficulty of either task is increased, requiring more deliberate processing, age differences are increased.

Age differences are often larger in time-based tasks (e.g., individuals are asked to press a computer key every ten minutes while performing another computer cognitive task) than in event-based tasks (e.g., individuals are asked to press the key when a certain cue word appears). Because event-based prospective remembering involves less deliberate processing, given the external cue, age differences sometimes were not found. It is also clear that prospective memory errors in older adults increase when the background task they have to perform becomes more demanding in terms of processing resources (Einstein et al.).

Semantic memory. Not all remembering requires one to reconstruct the experience of encoding. There are many examples of remembering without reference to how or when what one is trying to remember was originally learned. There is access to a great deal of knowledge that has lost all connection to the context of its original episodic learning. "What is the capital of North Dakota?" "What bug has eight legs and weaves webs?" "Where were you born?" Answering these questions requires semantic memory. Semantic memories are retrieved conceptually rather than contextually, and represent accumulated knowledge. Instead of using a cognitive diary, semantic memory is like looking something up in an internal cognitive encyclopedia. Of course, the information is not alphabetically organized, but instead organized conceptually or semantically.

As mentioned earlier, tests of semantic memory typically show either no age differences or improvement over the adult life span (see Figure 1). Vocabulary tests and tests of general knowledge (such as found in Trivial Pursuit games) show either no age differences or increases for older adults up until very late in life (eighties or nineties). In Figure 1, vocabulary knowledge increased steadily through the seventies and showed only a slight decline in the eighty-year-old group.

There have also been attempts to examine the architecture of semantic memory (i.e., the way semantic organization is conceptually associated). Free association tests are one way to look at semantic organization. Individuals are given a word and asked to generate another word, the first word that comes to mind when thinking about the word given. A category name is given in another type of test (e.g., vehicle), and individuals are asked to generate the first five vehicles they can think of. If semantic information in memory is organized in different ways by different age groups, then there should be qualitative differences in the nature of the responses given on free association tests or category generation tests. If older adults' semantic memories are organized differently, then the organization should produce differences in the strength of associations between different concepts. Norms of free associations, however, as well as norms of generating instances in categories, show no differences between age groups (Smith and Earles).

One aspect of semantic memory that does seem to decline with aging is the ability to find a word, given its definition. This phenomenon extends to finding proper names and to the "tip-of-the-tongue" phenomenon (Craik). A tip-of-the-tongue state is created when a person knows that he or she knows something but cannot think of it at the moment. Often one can generate information about the answer that is correct but cannot think of the answer itself. Some of this effect (word finding, name finding, tip-of-the-tongue), however, is associated with older adults simply being slower to respond. Some research suggests equivalent word finding in different age groups with difficult words (Craik). Other research suggests that older adults eventually can resolve tip-of-the-tongue states when given enough time (MacKay and Abrams).

Procedural memory. Several times in this entry it has been stated that age differences in memory seem to increase when the degree of deliberate processing required to remember increases. Procedural memories are assumed not to require any deliberate, intentional processing at all. They instead involve only automatic processing and, in fact, do not even require conscious awareness of the effects.

Procedural memory tasks, sometimes called implicit memory tasks, often use repetition priming as a measure. For example, individuals first examine a list of words (stand, chair, . . . radio), not aware that a later memory test is involved. Rather, they are told to make some judgment about the words, such as to rate the pleasantness of each word on a five-point scale. Then several other word tasks are performed. Finally, a series of word stems is presented (fe___, ra___, . . . bl___) and the individuals are asked to complete the stem with the first word that comes to mind. Some of the word stems could be completed with a word presented earlier on the list. Even though they are not aware that the word stem list contains stems for words seen earlier, individuals will use the presented words to complete the stems at a level greater than chance. This increase in "remembering" previously presented items represents implicit or procedural memory.

As might be expected, given the lack of deliberate recollection, age differences are typically not seen on implicit memory tasks (Zacks et al.). If they are found, they are very small, especially when compared with the large effects seen in explicit episodic recall.

In summary, the memory systems approach has been very useful in describing when significant age differences in memory are found. Whether or not memory systems eventually are supported by neuroscientific data, they have provided a useful conceptual framework for organizing memory phenomena and for showing dissociations with age.

Cognitive resources

Another view of memory is more closely based on the observation that age differences in memory tasks seem to be determined by the degree of deliberate processing required to perform the task. Deliberate processing requires processing resources, and if processing resources are diminished in older adults, then the ability to engage in deliberate processing will be reduced. According to this view, age differences in memory are assumed to be caused by an age-related reduction in cognitive resources available to perform memory tasks as well as other cognitive tasks. Support for this theoretical position comes from studies which show that individual differences in measures of cognitive resources can account for age-related differences in memory performance. This research approach is represented in Figure 2. The circles in the figure represent individual differences in age, memory, and cognitive resources. Overlap in the circles represents shared variance among the variables. The age-related variance in memory is reflected by the overlap in the age and memory circles (a + b). The degree to which processing resources mediate the relationship between age and memory is shown by b.

Figure 2
Venn diagram showing relationship of age, memory, and cognitive resources.

SOURCE: Author

Four mechanisms have been suggested as estimates of cognitive resources: perceptual speed, working memory, inhibitory function, and sensory function (Park).

Perceptual speed. Older adults are slower at performing simple perceptual/motor operations.

In one test, for example, individuals are asked to look at two strings of letters (e.g., xpltvg — xpltvg) and indicate in the space between them whether the strings are the same or different. The number of letter comparisons that can be completed in ninety seconds declines significantly across the life span. Perceptual speed is assumed to be an estimate of the efficiency of neural functioning, and thus to be a possible mechanism to account for age differences on memory and other cognitive tasks (Salthouse). Timothy Salthouse has produced an impressive amount of evidence that individual differences on simple measures of perceptual speed can account for most of the age-related variance in complex cognitive tasks, even those that do not require completion in a given time (i.e., speeded).

Working memory. Many researchers believe that working memory is a good measure of processing resources. Like perceptual speed, individual differences in working memory can account for much of the age-related differences on long-term memory tasks. Denise Park and her colleagues conducted a study with over 300 adults of different ages that measured perceptual speed, working memory, and different measures of long-term episodic memory. The long-term memory measures included free recall of a word list (looking at a word list and then recalling as many words as possible), cued recall (presenting word pairs at encoding and then presenting one word from each pair as a cue for the other word at retrieval), and spatial recall (remembering what quadrant of the computer screen words had been presented in earlier) (Park, Smith, et al. 1996). This study showed that when perceptual speed as a construct was included in a model of memory performance, it accounted for essentially all of the age-related variance in memory performance. Measures of working memory, however, were also important in the model with the more effortful measures of episodic memory, free and cued recall. Speed alone accounted for the age differences in the less effortful spatial recall task, but both speed and working memory were necessary to account for the age differences in free and cued recall, tasks that are assumed to require more processing resources. These results suggest that no single mechanism may be adequate and that multiple measures may be necessary to account for age differences in memory.

Inhibitory function. Another construct that has been suggested as the mechanism for cognitive resources is inhibition (Hasher and Zacks). Inhibitory function allows the individual to focus on information relevant to the task and suppress information that may be activated but is irrelevant to the task. Lynn Hasher and Rose Zacks suggest that older adults are less able to inhibit irrelevant information, and thus cannot focus as well on the information needed to perform the task. According to this view, it is not working memory capacity that is limited in older adults, but the inability to inhibit irrelevant information from cluttering up the content of working memory. The result of this "mental clutter" is that older adults experience more interference at both encoding and retrieval. There is a great deal of evidence that older adults are in fact deficient in inhibiting irrelevant information when performing memory tasks (Zacks et al.).

Sensory function. Paul Baltes and Ulman Lindenberger, in their large-scale Berlin Aging Study, found that auditory and visual acuity can account for much of the age-related variance on a variety of cognitive tasks, including associative memory. In one study, they found that sensory function accounted for over 90 percent of the age-related variance in cognition. Other research, however, has shown that this relationship is not simply due to the fact that poorer vision and hearing cause a decline in cognition. Instead, Baltes and Lindenberger suggest that the sensory measures are one of a large number of physical and cognitive variables that reflect the efficient functioning of the nervous system. According to their view, there is a "common cause" related to biological aging that affects a variety of abilities, both cognitive and somatic, are affected by aging.

Deliberate processing

In summary, different theoretical mechanisms have been proposed to account for age differences in memory performance. Each mechanism has been shown to be important, and research is needed to better understand the relationship among the different constructs. It is becoming clear that no single mechanism can account for all age-related variance in memory performance, and future research will address the relationship among the mechanisms when predicting performance on different types of memory tasks. All of the theoretical mechanisms, however, assume that older adults have more limited processing resources.

One theme that has emerged from the discussion is that age differences in memory are determined by the degree of deliberate processing. Fergus Craik has suggested that memory performance is determined by an interaction between internal (self-initiated processing) and external (environmental support) factors (Zacks et al.). The amount of deliberate processing required in a task decreases as the task itself becomes more supportive. As mentioned earlier, a great deal more processing resources are needed to remember the words in a free recall task than in a recognition task. In a recognition task, the words themselves serve as retrieval cues and the processing required to recognize is minimal. No explicit cues, however, are provided in a free recall task, and the individual must engage in a great deal of self-initiated processing in order to retrieve the words. Age differences in recall therefore are much greater than age differences in recognition (Craik). As the amount of deliberate processing increases, age differences should increase; as the environmental support provided by the task increases, age differences should decrease.

There have been some research attempts to determine the extent to which a task requires deliberate processing versus the extent to which it relies on automatic processing. One such attempt is known as the "remember-know" procedure. After individuals correctly identify words in a recognition memory experiment, they are asked to estimate whether the word was deliberately recollected ("remember") or whether the recognition was based on familiarity, with no specific recollection of encoding the word ("know"). Several different experiments have found that older adults produce a smaller proportion of "remember" judgments for the words they recognize, and a greater proportion of "know" judgments (Zacks et al.). This finding implies a reduced ability to deliberately recollect the items at the time of test and a greater reliance on familiarity.

Another method for examining deliberate and automatic remembering has been developed by Larry Jacoby and his colleagues. The "process dissociation" procedure actually provides quantitative estimates of the deliberate and automatic processing requirements of different memory tasks. As an example of process dissociation, Jennings and Jacoby looked at age differences in recognition memory. Younger and older participants first looked at a list containing words that they simply read. Then they listened to a second list and were told they would be tested on the second list later. Following the two lists, they were given two different recognition tests. In both tests they were given pairs of words, one of which they saw earlier, either as a word they read in list 1 or as a word they heard in list 2. The second word in the pair was a new word they had not seen or heard previously.

On the first memory test, they were misinformed that one word in each pair had been presented auditorially in list 2, and the other word was either new or one that they read in list 1. They were to pick the word that they had heard in list two (exclusion test). If they picked a word that was presented in list 1, they could do that only through familiarity, because if they had recollected the word, they would have correctly rejected it because it was a list 1 word. In the second memory test, they were told that one word from each pair was a new item, and they were to pick the one they had either seen or heard before. In this case, their judgments could be based on either familiarity or recollection (inclusion test). By subtracting the estimate of recognition due to familiarity derived from the first test (exclusion) from the scores on the second test (inclusion), an estimate of recall based on recollection alone could be derived. The results showed that the age effects were limited to the deliberate recollection component of recognition memory. Estimates of familiarity showed no age effects. This analytical procedure provides further support for the conclusion that age effects are determined by the extent of deliberate processing required in a task.

Dementia: age-related memory pathologies

So far, the discussion has been limited to healthy older adults. For most of this research, good health is a requirement for participation in the research. A small percentage of older adults, however, develop dementias that have a primary symptom of memory loss. There are many types of dementia, the most common one being Alzheimer's disease, which accounts for over two-thirds of all cases.

Because there are memory changes associated with normal, healthy aging, it is very difficult to diagnose Alzheimer's disease and other dementias early. There are many neuropsychological memory tests that can determine the progression of the disease once it has been estab-

lished, but it is much more difficult to determine the early signs of dementia that distinguish Alzheimer's disease from normal memory change and that could be used as a diagnostic test. Unfortunately, the types of memory that are associated with very early dementia (episodic memory and working memory) are the very ones most affected in normal aging (Hodges). This means that the boundary between healthy memory change and unhealthy memory change is often not clear. One possible early difference is in the ability to remember things after retention intervals (delayed recall). One of the earliest symptom of Alzheimer's disease seems to be the loss of newly learned information after delay intervals (Albert and Killian). Forgetting rates often are the same in healthy adults if information is learned to the same criterion of performance. Alzheimer's patients, on the other hand, show greater delayed recall and more forgetting over the retention interval.

Very accurate cognitive diagnosis, however, remains difficult until the patient reaches the mild to moderate level, when other memory changes occur that are not typically associated with normal aging except for the very old (e.g., semantic memory and visuospatial memory). Category fluency (generating instances of categories) and providing verbal definitions seem to show the greatest sensitivity to early Alzheimer's disease (Hodges).

ANDERSON D. SMITH

See also ALZHEIMER'S DISEASE; BRAIN; DEMENTIA; MEMORY DYSFUNCTION, DRUG TREATMENT; MEMORY, EVERYDAY; MEMORY TRAINING; METAMEMORY; NEUROPSYCHOLOGY.

BIBLIOGRAPHY

ALBERT, M. S. and KILLIANY, R. J. "Age-Related Cognitive Change and Brain-Behavior Relationships." In *Handbook of the Psychology of Aging,* 5th ed. Edited by J. E. Birren and K. W. Schaie. San Diego: Academic Press, 2001. Pages 161–185.

BALTES, P. B., and LINDENBERGER, U. "Emergence of a Powerful Connection between Sensory and Cognitive Functions across the Adult Life Span: A New Window to the Study of Cognitive Aging?" *Psychology and Aging* 12 (1997): 12–21.

CRAIK, F. I. M. "Age-Related Changes in Human Memory." In *Cognitive Aging: A Primer*. Edited by D. C. Park and N. Schwarz. Philadelphia: Psychology Press, 2000. Pages 75–92.

CRAIK, F. I. M., and LOCKHART, R. S. "Levels of Processing: A Framework for Memory Research." *Journal of Verbal Learning and Verbal Behavior* 11 (1972): 671–684.

EINSTEIN, G. O.; SMITH, R. E.; MCDANIEL, M. A.; and SHAW, P. "Aging and Prospective Memory: The Influences of Increased Task Demands at Encoding and Retrieval." *Psychology and Aging* 12 (1997): 479–488.

HASHER, L., and ZACKS, R. T. "Working Memory, Comprehension, and Aging: A Review and a New View." In *The Psychology of Learning and Motivation,* vol. 22. Edited by G. H. Bower. San Diego: Academic Press, 1988. Pages 193–225.

HODGES, J. R. "Memory in the Dementias." In *The Oxford Handbook of Memory*. Edited by E. Tulving and F. I. M. Craik. Oxford: Oxford University Press, 2000. Pages 441–459.

JENNINGS, J. M. and JACOBY, L. L. "Automatic Versus Intentional Uses of Memory: Aging, Attention, and Control." *Psychology and Aging* 8 (1992): 283–293.

MACKAY, D. G., and ABRAMS, L. "Language, Memory, and Aging: Distributed Deficits and the Structure of New-Versus-Old Connections." In *Handbook on the Psychology of Aging,* 4th ed. Edited by J. E. Birren and K. W. Schaie. San Diego: Academic Press, 1996. Pages 251–265.

NORMAN, K. A., and SCHACTER, D. L. "False Recognition in Younger and Older Adults: Exploring the Characteristics of Illusory Memories." *Memory & Cognition* 25 (1997): 838–848.

PARK, D. C. "The Basic Mechanisms Accounting for Age-Related Decline in Cognitive Function." In *Cognitive Aging: A Primer*. Edited by D. C. Park and N. Schwarz. Philadelphia: Psychology Press, 2000. Pages 3–21.

PARK, D. C.; LAUTENSCHLAGER, G.; HEDDEN, T.; DAVIDSON, N.; SMITH, A. D.; and SMITH, P. K. "Models of Visuospatial and Verbal Memory Across the Adult Life Span." *Psychology and Aging* 17 (2002).

PARK, D. C.; SMITH, A. D.; DUDLEY, W. N.; and LAFRONZA, V. N. "Effects of Age and a Divided Attention Task Presented during Encoding and Retrieval on Memory." *Journal of Experimental Psychology: Learning, Memory, and Cognition* 15 (1989): 1185–1191.

PARK, D. C.; SMITH, A. D.; LAUTENSCHLAGER, G.; EARLES, J. L. K.; FRIESKE, D.; ZWAHR, M.; and GAINES, C. "Mediators of Long-Term Memory Performance across the Life-Span." *Psychology and Aging* 11 (1996): 621–637.

PARK, D. C.; SMITH, A. D.; MORRELL, R. W.; PUGLISI, J. T.; and DUDLEY, W. N. "Effects of Contextual Integration on Recall of Pictures by Older Adults." *Journal of Gerontology: Psychological Science* 45 (1990): P52–P57.

SALTHOUSE, T. A. "The Processing-Speed Theory of Adult Age Differences in Cognition." *Psychological Review* 103 (1996): 403–428.

SMITH, A. D. "Age Differences in Encoding, Storage, and Retrieval." In *New Directions in Memory and Aging*. Edited by L. Poon, J. Fozard, L. Cermak, D. Arenberg, and Larry Thompson. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1980. Pages 23–46.

SMITH, A. D., and EARLES, J. L. K. "Memory Changes in Normal Aging." In *Cognitive Changes in Adulthood and Aging*. Edited by F. Blanchard-Fields and T. Hess. New York: McGraw-Hill, 1996. Pages 192–220.

SMITH, A. D.; PARK, D. C.; EARLES, J. L. K.; SHAW, R. B. and WHITING, W. W. "Age Differences in Context Integration in Memory." *Psychology and Aging* 13 (1998): 21–28.

ZACKS, R. T.; HASHER, L.; and LI, K. Z. H. "Human Memory." In *The Handbook of Aging and Cognition,* 2d ed. Edited by F. I. M. Craik and T. A. Salthouse. Mahwah, N.J.: Lawrence Erlbaum Associates, 2000. Pages 293–358.

MEMORY DYSFUNCTION, DRUG TREATMENT

Memory deficits in the adult can develop from lesions that disrupt circuits that interconnect structures involved in encoding and retrieving recently acquired information, as well as from those involved in transferring information to long-term storage. The most important structure of this memory system is the hippocampal-entorhinal complex. Other areas involved in memory processes include the amygdala, paralimbic cortices, thalamic nuclei, mammillary bodies, fornix, hypothalamic nuclei, basal forebrain, and ventral striatum. Therefore, amnestic, or memory, disorders can occur from lesions at any part of this system and have a wide variety of causes, including infections, exposure to toxic substances, medications, vitamin deficiency, head trauma, cerebrovascular disease, tumors, and some neurodegenerative disorders. However, the most frequent cause of amnestic disorders in the adult is Alzheimer's disease (AD). Indeed, focal memory deficits precede the development of dementia, and episodic memory deficits (i.e., inability to recall recent events) and semantic memory deficits (i.e., loss of factual knowledge and object recognition) are the hallmark characteristics of the AD dementia syndrome, with episodic memory deficits preceding semantic memory deficits. AD has been reported in up to 10 percent of the population age sixty-five or older, and it is estimated that by the year 2040, 14 million Americans will have AD. Therefore, there is a significant effort to develop medications that can treat or ameliorate AD symptoms.

Neuropathological basis for cognitive disorders in Alzheimer's disease

Although the primary causes (or cause) of AD are not known, significant advances have furthered our understanding of the genetic and environmental factors, as well as the pathophysiological mechanisms, that can lead to AD. The latter has been a critical area of research, as it has given rise to therapies aimed at slowing the progression of AD. The neuropathological and biochemical changes in AD can be divided into two general areas: (1) structural changes and (2) alterations in neurotransmitter systems.

Structural changes. Structural changes in AD are concentrated in the cortical association regions and portions of the limbic system, and involve amyloid metabolism alterations, neurofibrillary tangles, neuritic plaques, synapse loss, and neuronal death. In the neocortex, large neurons are preferentially lost, relative to small neurons. Beta-amyloid proteins (they are major constituent neurotic plaques, which are the key lesion in Alzheimer's disease) accumulate in affected and unaffected regions of brain, but only in the association cortices and limbic regions does it evoke an inflammatory response that leads to tissue destruction and formation of neurofibrillary tangles.

Neurotransmitter systems. One of the most consistent findings in the brain of AD patients is the loss of cholinergic neurons (neurons that produce the neurotransmitter acetylcholine) in the nucleus basalis of Meynert (nbM). The nbM sends cholinergic projections to all areas of the neocortex, especially the temporal lobes and frontal and parietal association areas, and the indemnity of this system is essential for normal cognitive functioning. However, the major depletion of cholinergic neurons occurs in the temporal lobes. Other neurotransmitters are affected in AD, such as serotonin and norepineph-

rine, and they are though to be associated with the noncognitive behavioral symptoms of AD.

Pharmacological therapy for cognition

Drugs that can modify structural changes in AD. The understanding of molecular pathology and neurotransmitter dysfunction has led researchers to delineate several therapeutic approaches for AD. One such approach involves the highly suspected inflammatory mechanisms thought to contribute to AD pathology. It has been suggested the inflammatory process is necessary in amyloid metabolism, and population studies have shown that the use of steroids and nonsteroidal anti-inflammatory drugs (NSAIDs) reduces the risk of developing AD. However, two clinical trials have shown that neither prednisone (a corticosteroid) nor diclofenac (a NSAID) and misoprosol ("a prostanglandin E1 analogue that reduces the NSAID related gastrointestinal ulcers" or "medication that reduces gastrointestinal side effects of NSAID") improve cognition in AD patients. Studies investigating a new type of anti-inflammatory drug called cyclo-oxygenase 2 (COX2) inhibitors are under way.

It has been reported that ovarian steroids, especially estrogens, play a critical role in the memory process of normal individuals and individuals with AD. Experimental studies have found that estrogens and progestins stimulate neuronal growth in the hippocampus of animal models and modulate the cholinergic system and levels of beta-amyloid in the human brain. However, placebo-controlled studies have shown that estrogen replacement therapy (ERT) does not modify the course and progression of AD. Therefore, current evidence suggests that while ERT can delay AD onset (although this needs to be confirmed in prospective studies), it has no effect on the course of AD.

Modulation of neurotransmitter systems in AD patients. Acetylcholine is the most affected neurotransmitter in patients with AD. Its synthesis is begun at the presynaptic level by the enzyme acetylcholine transferase. The acetylcholine diffuses across the synaptic membrane and stimulates the postsynaptic cholinergic receptor. Its activity is then halted by the enzyme acetylcholine esterase, which is present on both presynaptic and postsynaptic membranes. Therefore, administration of acetylcholine esterase inhibitors can prolong the half-life of acetylcholine and have been found to be an effective treatment of AD.

For several years, researchers have been able to modulate cholinergic system activity, especially using acetylcholine esterase inhibitors such as physostigmine, in nondemented individuals. Coupled with the fact that acetylcholine is the most affected neurotransmitter in AD, this has made it possible to develop acetylcholine esterase inhibitors as the main line of treatment of AD. Indeed, in 1986, Summers et al. demonstrated that the long-term (twelve months) use of tacrine can improve cognition in AD patients, and in 1993 this drug was approved by the Food and Drug Administration as the first palliative treatment for AD. Since then, three other acetlcholine esterase inhibitors have been approved: donepezil, rivastigmine, and galantamine.

Experimental Compounds that modulate oxidative stress. There are a number of mechanisms that protect the human body from free-radical damage at the molecular level—including enzymes such as superoxide dismutase and catalase, and reduced gluthatione. Because free-radical damage increases with age, and because evidence exists that suggests increased lipid peroxidation (oxidation of fat tissue) in AD cases, the use of medication that can modulate oxidative stress has been a logical approach to the treatment of AD. Most importantly, the majority of the compounds that can modulate the oxidative stress can also have effects in other metabolic pathways that lead to neuronal loss.

A study investigating two antioxidants, alpha-tocopherol (vitamin E) and selegiline (an antiodixant commonly used in the treatment of Parkinson's disease), showed a possible beneficial effect of vitamin E on AD. The authors found that the amount of time before patients reached any of the primary outcomes (death, nursing home admission, or loss of the ability to perform two activities of daily living) was longer in patients taking vitamin E than in those taking selegiline, both drugs, or a placebo. However, the use of either vitamin E or seleginine did not modify cognitive decline. Interestingly, prevention studies have shown that the combination of vitamin E and C can lower the risk of developing vascular dementia, but not AD.

Neuroprotective agents. There are several lines of research that suggest that there is a common pathway for neuronal damage in neurological disorders. For example, a noxious stimulus can activate the N-methyl-D-aspartate (NMDA) receptor-operated channels, resulting in an ex-

cessive influx of calcium leading to neuronal damage. This results in the release of glutamate (the excitator neurotransmitter that activates NMDA receptors), and the cycle continues causing more nonreversible neuronal damage. Because it is believed that amyloid deposits can activate the NMDA receptor, it has been proposed that NMDA receptor blockers can prevent neuronal death in AD. Menantine is a noncompetitive NMDA receptor blocker that also modulates the glutamargic system. As of 2001, it was available in Europe, Canada, and Latin America. However, clinical trials have shown that memantine is effective only in the late stages of AD.

Herbal alternative medicine. There has been a considerable increase in the use of herbal medicines in neuropsychiatry (see Lafrance, et al.). The most commonly used herbal medicine for the treatment of AD is ginkgo biloba. It was estimated that 10 million Americans took ginkgo biloba in 1998. In the United States, ginkgo biloba is considered an herbal preparation, and it is regulated as a dietary supplement. Therefore, its manufacturers are not obligated to complete the strict approval process that the Food and Drug Administration require for drugs.

The major components of ginkgo biloba are flavonoids and terpenoids, which act as scavengers, are antagonists of platelet-activating factor, provide membrane protection, increase γ-aminobutiric acid and glutamic (or glutamate) decarboxilase levels, and increase the muscarinic receptor population. Multiple publications have found a cognitive improvement from the use of ginkgo biloba in the treatment of AD, and a few have reported a lack of efficacy. However, the majority of these studies did not use current standardized measures to determine cognitive improvement, and they have been conducted in mixed populations. In other words, patients with Alzheimer's disease associated with other brain disorders that can cause dementia (e.g., strokes).

The goal of the treatment of AD is to prevent, slow, or reverse the neurodegenerative process, and practically all suspected mechanisms of the metabolic cascade of AD have been explored with specific and nonspecific treatments. There have been significant advances in the treatment of AD over the past twenty years. However, as of 2001, only medications that can slow down the process for an unknown period of time exist. Nevertheless, there is a significant effort underway to develop new cholinergic compounds, nerve growth factors, anti-inflammatories, antioxidant agents, and drugs that may affect the production of neurofibrillary tangles and neuritic plaques (including peripherally administered antibodies against beta-amyloid proteins, providing hope for improved treatment of AD.

OSCAR LOPEZ

See also ALZHEIMER'S DISEASE; DEMENTIA; HERBAL THERAPY; MEMORY; MEMORY TRAINING; NEUROTRANSMITTERS.

BIBLIOGRAPHY

AISEN, P. S.; DAVIS, K. L.; BERG, J. D.; SCHAFER, K.; CAMPBELL, K.; THOMAS, R. G.; et al. "A Randomized Controlled Trial of Prednisone in Alzheimer's Disease." *Neurology* 54 (2000): 588–593.

CROWELL, E. B., and KETCHUM, J. S. "The Treatment of Scopolamine-Induced Delirium with Physostigmine." *Clinical Pharmacolology & Therapeutics* 8, no. 3 (1967): 409–414.

FARLOW, M.; GRACON, S. I.; HERSHEY, L. A.; LEWIS, K. W.; SADOWSKY, C. H.; and DOLAN-URENO, J. "A Controlled Trial of Tacrine in Alzheimer's Disease. The Tacrine Study Group." *Journal of the American Medical Association* 268, no. 18 (1992): 2523–2529.

FRIEDLICH, A. L., and BUTCHER, L. L. "Involvement of Free Oxygen Radicals in Beta-Amyloidosis: An Hypothesis." *Neurobiology of Aging* 15 (1994): 443–455.

JORM, A. F., and JOLLEY, D. "The Incidence of Dementia: A Meta-Analysis." *Neurology* 51, no. 3 (1998): 728–733.

LAFRANCE, W. C.; LAUTERBACH, E. C.; COFFEY, C. E.; SALLOWAY, S. P.; KAUFER, D. I.; REEVE, A.; et al. "The Use of Herbal Alternative Medicines in Neuropsychiatry." *Journal of Neuropsychiatry and Clinical Neurosciences* 12 (2000): 177–192.

MASAKI, K. H.; LOSONCZY, K. G.; IZMIRLIAN, G.; FOLEY, D. J.; ROSS, G. W.; PETROVITCH, H.; et al. "Association of Vitamin E and C Supplement Use with Cognitive Function and Dementia in Elderly Men." *Neurology* 54 (2000): 1265–1272.

MCHEER, P. L.; SCHULZER, M.; and MCGEER, E. G. "Arthritis and Anti-Inflammatory Agents as Possible Protective Factors for Alzheimer's Disease: A Review of 17 Epidemiologic Studies." *Neurology* 47 (1996): 425–432.

OKEN, B. S.; STORZBACH, D. M.; and KAYE, J. A. "The Efficacy of Ginkgo Biloba on Cognitive

Function in Alzheimer Disease." *Archives of Neurology* 55 (1998): 1409–1415.

SANO, M.; ERNESTO, C.; THOMAS, R. G.; KLAUBER, M. R.; SCHAFE, K.; GRUNDMAN, M.; et al. "A Controlled Trial of Selegiline, Alpha-Tocopherol, or Both as Treatment for Alzheimer Disease." *New England Journal of Medicine* 336 (1997): 1216–1222.

SCHARF, S.; MANDER, A.; UGONI, A.; VAJDA, F.; and CHRISTOPHIDIS, N. "A Double-Blind, Placebo-Controlled Trial of Diclofenac/Misoprostol in Alzheimer's Disease." *Neurology* 53 (1999): 197–201.

SCHENK, D.; BARBOUR, R.; DUNN, W.; GORDON, G.; GRAJEDA, H.; GUIDO, T.; et al. "Immunization with Amyloid-Beta Attenuates Alzheimer-Disease-Like Pathology in the PDAPP Mouse." *Nature* 400, no. 6740 (1999): 173–177.

SUMMERS, W. K.; MAJOVISKI, L. V.; MARSH, G. M.; TACHIKI, K.; and KLING, A. "Oral Tetrahydroaminoacridine in Long-Term Treatment of Senile Dementia, Alzheimer Type." *New England Journal of Medicine* 315, no. 20 (1986): 1241–1245.

WANG, P. N.; LIAO, S. Q.; LIU, R. S.; LIU, C. Y.; CHAO, H. T.; LU, S. R.; et al. "Effects of Estrogen on Cognition, Mood, and Cerebral Blood Flow in AD: A Controlled Study." *Neurology* 54 (2000): 2061–2066.

WINBLAD, B., and PORITIS, N. "Memantine in Severe Dementia: Results of the 9M-Best Study (Benefit and Efficacy in Severely Demented Patients During Treatment with Memantine)." *International Journal of Geriatric Psychiatry* 14, no. 2 (1999): 135–146.

MEMORY, EVERYDAY

Everyday memory refers to memory operations that routinely occur in one's daily environment. Examples of everyday memory include remembering names, remembering plans for the day, recalling items that one needs to purchase at the grocery store, remembering to take medications, and remembering telephone numbers, directions, or recent newsworthy events. The hallmark of everyday memory and associated research, then, is that it involves the performance of tasks that occur naturalistically in the real world. This is in contrast to typical laboratory tasks on memory, in which individuals may be asked to do things not typical of what they do in the real world, such as memorize unrelated lists of words or pictures, remember to press a key when a certain word appears on a computer screen, or perform mental arithmetic and report a series of answers later.

It is important to recognize that everyday memory studies can occur both within the laboratory and outside of the laboratory. In laboratory studies, individuals are asked to perform memory tasks that they might perform every day on a daily basis in the real world—such as learn a list of groceries, remember phone numbers, or remember information from a news program. In field studies, individuals are tracked throughout their day, and their memory function on specific everyday tasks is recorded. For example, one could measure the accuracy with which an individual takes his or her medications over a period of time, using microelectronic monitors to track the behavior remotely. The advantages of laboratory studies of everyday memory are that the experimenter has very precise control over the conditions under which memory occurs and can precisely standardize the material to be remembered across individuals. The disadvantage of these studies is that laboratory environments cannot reflect all of the variables that operate on individuals in the real world and affect their everyday memory. The advantage of field or naturalistic studies is that one can study events of real consequence to the individual enrolled in the study, but the disadvantage is that the researcher has less control over and knowledge of what is going on in the naturalistic environment. Both types of studies will be discussed here.

Older adults tend to worry about some types of everyday memory performance but not others. For example, Reese et al. reported that older adults have few worries about remembering important dates but have considerable worry about difficulty remembering names. These authors reported that older adults' fear that declines in everyday memory functions could lead to a loss of independence. Thus, the topic of everyday memory function is one of concern to older adults, and the focus of their concern seems to be on everyday functions where they perform poorly.

Laboratory studies

Laboratory studies generally provide evidence for a decline with age in everyday memory processes. One of the most complete studies was conducted by West et al. They found evidence for age-related declines on a wide range of everyday memory laboratory tasks. The tasks included requiring subjects to remember names, locations

of objects, grocery lists, faces, telephone numbers, and news events. In another study, Frieske and Park studied older and younger adults' memory for news presented in a radio, television, or newspaper format. For all three formats, older adults remembered less information than young adults, and both groups fared best with television compared to the other two formats. Because television has both visual and auditory information, those dual sources of information appear to be supportive of memory for both young and old. These laboratory studies required older adults to learn unfamiliar material, and there is little doubt that the learning of new information, even if it is of the everyday variety, suffers with increased age.

Field studies

The picture of how everyday memory declines with age is quite different when one studies memory in a naturalistic context. In a series of studies Park and colleagues have examined how accurately older adults remember to take medications, using microelectronic monitors to record the date and time that medication was taken. Park et al. (1992) reported that adults age sixty to seventy-seven made almost no medication errors whatsoever over a one-month period, even though they were taking a minimum of three different medications. In contrast, the oldest adults in the study, age seventy-eight to ninety, made significantly more errors but were helped measurably by the introduction of memory charts and medication organizers. In a subsequent lifespan study of adults age thirty-five to seventy-five who were taking hypertension medications, Morrell et al. found that adults aged sixty-five to seventy-five made the fewest medication errors of any age group and almost never forgot to take their hypertension medication. They hypothesized that the reason for this high level of adherence is that older adults have sufficient cognitive resources to take medication, and also have health beliefs and a schedule that are congruent with taking medication accurately.

In a later study, a complex array of cognitive, psychosocial, and contextual variables were used to understand medication adherence in a sample of rheumatoid arthritis patients who were taking many medications (Park et al. 1999). These patients were given a large battery of cognitive tests and completed questionnaires about their health beliefs, lifestyle, stress level, and perceived self-efficacy. These variables were used in structural equation models to predict adherence. In this study, 47 percent of the older adults (ages fifty-five to eighty-four) made no errors in taking their medication over a one-month period, whereas the middle-aged participants (ages thirty-four to fifty-four) had a significantly higher overall rate of nonadherence. The single best predictor of nonadherence was reporting a busy lifestyle that was high in environmental demands. Beliefs about health, anxiety, and depression were not strong predictors of adherence. Although age did not predict nonadherence, individuals who were low in cognitive ability at any age were also more likely to be nonadherent.

The importance of context

These studies suggest that it is very important to understand the context in which everyday memory occurs, and that the context may be more important than age in predicting who will remember and who will forget. In the medication adherence study (Park et al., 1999), older adults were less busy and had a more routine schedule. This type of routine lifestyle can enhance repetitive everyday memory events like taking medications by automatizing these events (Park et al., 1999). Older adults may not have to use much of their active memory resources to remember to take medications if they take pills every morning at breakfast and at night after they brush their teeth. They will automatically reach for the pill bottle due to the chaining of taking medication to other regularly occurring events. In contrast, middle-aged adults' everyday memory is functioning against considerable background noise. Middle-aged adults in the study of Park et al. (1999) reported having too many things to do and leading irregular, unscheduled lives. They were juggling so many competing tasks in their working memory that they allocated less attention to remembering to take medications, and thus forgot more often than older adults, even though they had objectively better memories than older adults. Finally, health likely has a special status for older adults who are experiencing an increasing number of chronic conditions. Failure to take medications may result in serious harm and ill health compared to middle-aged adults, who have fewer conditions and more physical reserves. Thus, older adults are likely to prioritize remembering

to take medication and to develop strategies to do so.

All everyday memory events are not equally important to individuals, which explains some of the differences in findings between laboratory studies and naturalistic studies. In laboratory studies, participants are asked to remember information that is essentially irrelevant to their everyday life, and it is not possible to prioritize what is important to them and what is not. If you were traveling in Europe, you would be more likely to forget where you put the token for the subway than where you put your passport, because you would prioritize keeping track of your passport very highly, given the consequences of losing it. It seems likely that older adults will perform well on everyday tasks that are highly prioritized. Laboratory studies on everyday memory also show age differences because older adults are most disadvantaged on everyday tasks that are new to them, since they cannot rely on existing knowledge or routines that have become automatized to support their memory.

When memory supports and routines are removed from a naturalistic environment (as they are in a laboratory), older adults who function very well in their everyday environment may appear to be cognitively compromised. If, for example, an older adult were to move to a new environment, simple tasks such as finding the grocery store, remembering where the bills are kept in the new house, and remembering the new address and phone number would require expenditure of cognitive resources, which do become limited with age (see Park and Gutchess for a review). In addition, memory aids the individual may have relied upon, such as landmarks (a familiar bank or grocery), medical personnel, and friends and family who know the individual's needs, may no longer be present. An older adult in a new naturalistic environment may perform much more like older adults tested on everyday memory tasks in the laboratory. In contrast, older adults in a familiar environment may perform as well as or better than distracted middle-aged adults.

In sum, a full understanding of everyday memory functioning of older adults can occur only if the person, the cognitive demands of a task, and the environment are considered together. To the extent that environmental or task demands on cognitive resources are high, it is likely that older adults will function less effectively than younger adults. For example, if an older adult who has just had heart surgery has to take six new medications upon returning home, he or she may not fare well, because the cognitive demands of this new task are high due to its unfamiliarity. However, this same adult might may take six medications with a high degree of accuracy if this is a long-term medication regimen, because cognitive resource demands would be low due to the high familiarity of the task. Much remains to be understood about everyday memory in older adults, and this is a fertile ground for future research.

DENISE C. PARK
MEREDITH MINEAR

See also MEMORY; MEMORY TRAINING; METAMEMORY.

BIBLIOGRAPHY

FRIESKE, D. A. P., and PARK, D. C. "Memory for News in Young and Old Adults." *Psychology and Aging* 14, no. 1 (1999): 90–98.

MORRELL, R. W. P.; PARK, D. C.; KIDDER, D. P.; and MARTIN, M. "Adherence to Antihypertensive Medications Across the Life Span." *Gerontologist* 37, no. 5 (1997): 609–619.

PARK, D. C., and GUTCHESS, A. H. "Cognitive Aging and Everyday Life." In *Cognitive Aging: A Primer*. Edited by D. C. Park and N. Schwarz. Philadelphia: Psychology Press/Taylor & Francis, 2000.

PARK, D. C.; HERTZOG, C.; LEVENTHAL, H.; MORRELL, R. W.; LEVENTHAL, E.; BIRCHMORE, D.; MARTIN, M.; and BENNETT, J. "Medication Adherence in Rheumatoid Arthritis Patients: Older is Wiser." *Journal of the American Geriatrics Society* 47 (1999): 172–183.

PARK, D. C. M.; MORRELL, R. W.; FRIESKE, D.; and KINCAID, D. "Medication Adherence Behaviors in Older Adults: Effects of External Cognitive Supports." *Psychology and Aging* 7, no. 2 (1992): 252–256.

REESE, C. M. C.; CHERRY, K. E.; and NORRIS, L. E. "Practical Memory Concerns of Older Adults." *Journal of Clinical Geropsychology* 5, no. 4 (1999): 231–244.

WEST, R. L. C.; CROOK, T. H.; and BARRON, K. L. "Everyday Memory Performance Across the Life Span: Effects of Age and Noncognitive Individual Differences." *Psychology & Aging* 7, no. 1 (1992): 72–82.

MEMORY TRAINING

Research on the effectiveness of memory training in older adults is important for practical

and theoretical reasons. Much of the applied research on this topic is motivated by the aim of trying to identify the techniques that are most effective for improving the memory of older adults. Memory training research also has importance for theories of aging because knowing the potentials and limits of memory function bears on questions of cognitive plasticity in adulthood and aging. This entry summarizes the effectiveness of memory training studies with older adults and reviews some of the techniques used for trying to improve memory function.

Memory functioning decreases with advancing age. Across many studies, the age difference between younger and older adults in recall and recognition from episodic memory is about one standard deviation (see La Voie and Light; Verhaeghen, et al., 1993). The negative effects of aging on memory must depend in large part on age-related declines in the efficiency of brain mechanisms. For example, neuro-imaging studies have provided descriptions of age-related differences in the recruitment and activation of the brain mechanisms that are involved in memory function (for a review, see Raz). However, memory performance depends not only on neurobiological factors but also on strategies for remembering and retrieving information. Training studies demonstrate that some portion of the memory decline of older adults has to do with the use of nonoptimal learning and memory strategies, and that older adults can learn to use more effective strategies so as to improve memory.

Programs designed to improve the memory of older adults generally do produce improved memory performance. In a meta-analysis of thirty-two studies, based on data from 1,539 persons, Verhaeghen et al. (1992) reported that memory training boosted performance by 0.73 standard deviation. The effects of training on performance were larger than the effects of mere retesting (0.38 standard deviation) or placebo treatments (0.37 standard deviation). The results of the meta-analysis also showed that the effects of memory training appear to be durable over six-month periods or longer after training. Across studies, performance gains associated with training were larger when participants were told in advance about the nature of the training. Gains were also larger when training was carried out in groups rather than individually, and when training sessions were relatively short.

Memory training programs produce improvements in the person's subjective evaluations of memory as well as in actual memory performance. Subjective evaluations of memory functioning are typically measured using self-report questionnaires. In a meta-analysis of twenty-five studies that examined the effects of memory training on subjective measures of performance, Floyd and Scogin reported that the magnitude of improvement is less for subjective measures than for objective measures. Subjective evaluations of memory performance improved by about 0.2 standard deviation as a result of memory training. As with the results for objective measures, subjective measures were enhanced by including pretraining information about the use of memory skills such as imagery.

Comparing across studies in the Verhaeghen et al. meta-analysis, the pattern of effect sizes for objective measures of improvement indicated that no one type of training procedure was any more effective than any other. In a study directly comparing the effectiveness of several types of memory training procedures, Rasmusson et al. reported that there was no evidence to suggest that any one type of training was superior to any of the others used. In this study, residents of a retirement community age sixty-five to ninety-two years of age were given a microcomputer-based memory training program, a commercially available audiotape memory improvement program, or a group-based memory course in weekly ninety-minute sessions for nine weeks.

Retrieval of information from memory is likely to be better when information is distinctly encoded and systematically organized or stored or filed. Frequently the procedures used in memory training studies are variations on a method that teaches individuals to associate items to be remembered with a familiar series of locations. In this method, called the method of loci, individuals are taught to remember lists of items by forming visual associations between the *n*th item in a list and the *n*th place or locus within a familiar sequence of loci. Retrieval of the items occurs by mentally traveling through the familiar sequence, and retrieving the associated item at each locus. Some writers have noted that ancient Roman orators used this procedure as an aid for remembering the main points or themes in long speeches. The orators would first memorize a large number of places in a serial order, such that each locus could be clearly visualized. Next, after a speech was prepared, its content was divided into a series of visual images which represented key words or themes in the speech. Each of these

images was serially associated with one of the loci. For example, the first theme in the speech would be visually associated with the entrance to a building; the second idea would be associated with the second place in the building; and so on. To recall the main themes of the speech, one simply imagined traveling through each of the places in the building.

A similar mnemonic technique is the peg word method. Images of concrete objects rather than locations are used as the pegs to which the images to be remembered are attached. This method requires the person to readily retrieve both the peg words and their order. In a rhyming peg word method, for example, each peg word rhymes with the number indicating its position in the list: "One is a bun, two is a shoe, three is a tree," and so on.

It is important to emphasize that improvements associated with memory training effects are specific to the type of training provided. That is, there is little or no evidence to suggest that general-purpose memory function can be improved by training. In other words, memory training probably does not affect general speed of processing or brain plasticity per se, but instead exerts its beneficial effects by instilling specific strategies for the effective retrieval of specific kinds of information. There is very little if any work on the training of working memory or on the training of speed of processing that seems to underlie most, if not all, age-related deficits in cognitive performance (e.g., Salthouse). Measures of the extent to which the fundamental processes of memory could be improved with training might provide a metric for the description of individual differences in the potentials and limits of cognitive plasticity. Along these lines, aging is associated with reduced cognitive plasticity or cognitive adaptability, and training or testing the limits generally serves to enlarge or amplify the magnitude of age differences (e.g., Baltes; Baltes and Kliegl; Kliegl et al.; Verhaeghen and Marcoen).

It is important to point out that the descriptions of the negative effects of aging on memory are drawn almost entirely from studies using measures of recall or recognition of previous events or ideas (for a review, see Zacks et al.). However, many of the situations that require memory in everyday life involve keeping track of things to do or remembering to do something in the future (e.g., remembering an appointment). Only a few studies have examined the remediation of age-related declines in prospective memory (see Villa and Abeles). That prospective memory tasks can easily be relegated to external aids such as lists and calendar notations suggests that effective memory functioning involves distinguishing what information is best to commit to memory and what information is best to assign to external aids. Perhaps memory intervention programs could be designed to be even more effective or useful by giving training on *what* to remember as well as on *how* to remember.

WILLIAM J. HOYER

See also MEMORY.

BIBLIOGRAPHY

BALTES, P. B. "On the Incomplete Architecture of Human Ontogeny." *American Psychologist* 52 (1997): 366–380.

BALTES, P. B., and KLIEGL, R. "Further Testing of Limits of Cognitive Plasticity: Negative Age Differences in a Mnemonic Skill are Robust." *Developmental Psychology* 28 (1992): 121–125.

FLOYD, M., and SCOGIN, F. "Effects of Memory Training on the Subjective Memory Functioning and Mental Health of Older Adults: A Meta-analysis." *Psychology and Aging* 12 (1997): 150–161.

KLIEGL, R.; SMITH, J.; and BALTES, P. B. "On the Locus and Process of Magnification of Age Differences During Mnemonic Training." *Developmental Psychology* 26 (1990): 894–904.

LA VOIE, D. L., and LIGHT, L. L. "Adult Age Differences in Repetition Priming: A Meta-analysis." *Psychology and Aging* 9 (1994): 539–553.

RASMUSSON, D.; REBOK, G. W.; BYLSMA, F. W.; BRANDT, J. "Effects of Three Types of Memory Training in Normal Elderly." *Aging, Neuropsychology, and Cognition* 6 (1999): 56–66.

RAZ, N. "Aging of the Brain and Its Impact on Cognitive Performance: Integration of Structural and Functional Findings." In *The Handbook of Aging and Cognition,* 2d ed. Edited by F. I. M. Craik and T. A. Salthouse. Mahwah, N.J.: Erlbaum, 2000. Pages 1–90.

ROWE, J. W., and KAHN, R. L. "Successful Aging." *The Gerontologist* 37 (1997): 433–440.

SALTHOUSE, T. A. "The Processing Speed Theory of Adult Age Differences in Cognition." *Psychological Review* 103 (1996): 403–428.

VERHAEGHEN, P., and MARCOEN, A. "On the Mechanisms of Plasticity in Young and Older

Adults After Instruction in the Method of Loci: Evidence for an Amplification Model." *Psychology and Aging* 11 (1996): 164–178.

VERHAEGHEN, P.; MARCOEN, A.; and GOOSSENS, L. "Improving Memory Performance in the Aged Through Mnemonic Training: A Meta-analytic Study." *Psychology and Aging* 7 (1992): 242–251.

VERHAEGHEN, P.; MARCOEN, A.; and GOOSSENS, L. "Fact and Fiction About Memory Aging: A Quantitative Integration of Research Findings." *Journal of Gerontology: Psychological Sciences* 48 (1993): P157–P171.

VILLA, K. K., and ABELES, N. "Broad Spectrum Intervention and the Remediation of Prospective Memory Declines in the Able Elderly." *Aging and Mental Health* 4 (2000): 21–29.

ZACKS, R. T.; HASHER, L.; and LI, K. Z. H. "Human Memory." In *The Handbook of Aging and Cognition*. Edited by F. I. M. Craik and T. A. Salthouse. Mahwah, N.J.: Erlbaum, 2000. Pages 293–358.

MENOPAUSE

Menopause is defined as a mature woman not having a period for one year. The average age of women entering menopause in North America is 51.2 years. Most women will spend more than a third of their lives in menopause. For many, this is a fulfilling time in their lives, as they are relieved from dealing with menstruation and fears of pregnancy; while for some it means dealing with a new set of symptoms.

Menopause occurs at a time of transition in women's lives. Children are usually grown and living independently. However, there is often an increased level of responsibility and stress related to caring for aging parents. It is a time of change that can redefine partners' intimate roles in what has become an empty nest. This provides both opportunities for personal growth due to the freeing up of child-care responsibilities, but may also unmask previously avoided tensions in the relationship. These psychosocial variables profoundly affect a woman's perception of her passage through menopause.

Seventy percent of women have only a few, time-limited symptoms going through menopause. The remainder suffer to varying degrees from hot flushes, sweats, mood swings, fatigue, weight gain, vaginal dryness, pain with intercourse, and loss of sexual desire. Menopausal loss of estrogen increases the future risk of osteoporosis and coronary artery disease.

The physiological basis for menopause

The effects of menopause are due to the loss of hormone production by the ovaries. Besides producing eggs over a woman's reproductive life span, the ovaries are also responsible for producing most of a woman's estrogen ("female" hormones) as well as half of her androgens, including testosterone ("male" hormones). Most symptoms of menopause are due to the loss of estrogen, though increasing attention is being paid to the effects of the loss of androgen production.

Menopause is not one moment in time, but rather a process called *perimenopause* that evolves over three to five years before the cessation of menses. During this time a woman's ovaries gradually become less responsive to stimulation from the central control of the pituitary gland at the base of the brain. Over this time, menstrual periods become gradually more irregular, both in timing and in flow. The pituitary gland at the base of the brain responds to circulating estrogen levels and the brain's hypothalamic stimulation by increasing secretion of luteinizing hormone (LH) and follicle stimulating hormone (FSH). Elevated levels of FSH are the cause of hot flushes.

Premenopausal women who have both ovaries removed, usually as part of a hysterectomy and bilateral oophorectomy, have a precipitous decline in their hormones and are suddenly thrust into the symptoms of menopause. The loss of ovarian function causes an 80 percent decrease in estrogen levels. The low levels remaining are produced by the adrenal glands, as well as by peripheral conversion of cholesterol to estrogen in the skin.

Estrogen has effects on many tissues in the body, especially the mucosal lining of the vagina. As estrogen levels drop, this lining thins, produces less lubrication, and becomes more vulnerable to trauma. The urethra is also affected by this increasing the chances of bladder infection and incontinence.

Ovarian testosterone production drops by half, starting as much as three years before a woman's final period. This decline can adversely affect overall mood and energy, as well contribute to decreased sexual desire. The ratio of androgens to estrogen can flip to androgen excess for some women, contributing to increases in hair growth in such "male" areas as the upper lip and chin.

Sexuality during menopause

Menopause frees a woman's sexuality from fear of pregnancy. Up to 70 percent of women note no effects of menopause on their sexuality. These women are more likely to be in mature relationships and have worked through relationship issues that can otherwise confound sexual intimacy. Women who have previously had an active, comfortable sex life tend to have fewer problems with post-menopausal sexuality. The stimulation of intercourse helps keeps the vaginal mucosa thickened and more youthful, supporting the old adage of "Use it or lose it." Cultural values may also play a role in how menopause affects sexuality. In societies where the elderly are more likely to be respected for their wisdom, such as in Japan, most women make the transition through menopause with far fewer symptoms than women in the West.

The most common change in sexual function in menopause is decreased vaginal lubrication in response to sexual stimulation. This loss of arousal can lead to sexual pain, reduced orgasmic intensity, and, ultimately, in decreased desire. Much of this can be helped by taking replacement estrogen. Desire and orgasmic capacity can drop on their own as a result of menopause, independent of any pain or discomfort. Many women loose the sense of sexual passion. These changes can be due to decreased testosterone.

The menopausal woman is not the only one going through changes at this point in her life. Married women's husbands are dealing with their own physical changes. The slowing of the sexual response allows many couples to savour their sexual interaction, in contrast to the mad rush of youth. While it takes longer for both men and women to get aroused, lovemaking can last longer due to the aging male's decreased pressure for orgasm. Indeed, many older men do not need to ejaculate in order to enjoy the sexual experience. For most, this is an enjoyable experience. For some couples, however, not understanding the physical changes that go with aging creates concerns. Some women, having been used to a stronger sexual response from their partner, personalize these changes and wonder if they are no longer seen as attractive by their mate, or if he is having an affair. This often increases the pressure to perform that is already worrying the man, who may be wondering if he is developing impotence.

When women have sexual dysfunction, about half of their partners will also have sexual difficulties of their own. Women who have no sexual difficulties may still have to deal with their partner's loss of potency. Male erectile dysfunction increases with age, with complete loss of erection occurring in 5 percent of men at forty, and increasing to 15 percent by age seventy. More than half of older men have some partial degree of erectile dysfunction that interferes with sexual intercourse. Most erectile dysfunction in men is not due to hormonal changes, but rather to aging of blood vessels and the mechanisms that increase the blood flow to the penis. The revolution brought about by Viagra™ and other therapies can often help men and women dealing with these difficulties.

Men also appear to go through a *male menopause*. In contrast to women, men have a more gradual decline in their own testosterone, starting in the late forties and continuing over the next two to three decades. This results in similar changes seen in women, including decreased desire and orgasmic drive, and ultimately in the loss of erections.

Many women become single, either through widowhood or divorce, in the years following menopause. For many this leaves them to deal with their sexual needs alone. Women who reenter the world of dating and becoming sexual with a new partner face a number of concerns. The vaginal changes of menopause leading to atrophy and loss of elasticity progress more quickly if a women is not sexually active. If a woman has not had a partner for a long time, she is at increased risk of having discomfort. This can usually be treated with local estrogen. Many physicians desexualize their older female patients and do not think to counsel them about safe sex. Many older women are not conscious of the risks of sexually transmitted disease in this population. The thinner vaginal walls are more vulnerable to infection with intercourse. While numbers are still small, the greatest rate of increase in HIV/AIDS is in women over fifty.

Women in menopause are aging and may have other medical illnesses that can affect sexual function. Hypertension, diabetes, depression, and heart disease are but a few examples that can have profound effects on sexual function. The drugs used to treat these conditions frequently have sexual side-effects as well. Antidepressants commonly cause sexual difficulties, decreasing

desire, arousal, and orgasm for both women and men.

Many sexual concerns during menopause are not related to hormonal changes at all. Sexual behavior involves an interaction between two people. Women are generally more sensitive to the context and connection they feel within the relationship than men are, and sexual dysfunctions are often symptomatic of other stresses, either on an individual or a couple. Sex can deteriorate due to psychological problems for either partner, or due to relationship strains. Effective treatment of sexual concerns needs to take into account the physical and psychological health of both partners, as well as the state of their relationship both inside and outside of the bedroom.

Estrogen replacement/hormone-replacement therapy (HRT) and androgen replacement

The loss of estrogen affects more than the reproductive organs. Decreased estrogen leads to increased bone loss and the risk of osteoporosis, with concerns about hip and vertebral fractures. The protection that estrogen provides premenopausal women against heart attack (relative to men) is also lost in menopause. Skin, in general, becomes thinner and more susceptible to trauma, and thinning of the vaginal mucosa leads to decreased lubrication and potentially painful intercourse. A woman's mood can become more unstable around menopause, with greater mood swings and an increased risk of depression.

The use of hormone replacement therapy (HRT) with estrogen (and progesterone to protect against uterine cancer if the woman still has a uterus), helps prevent and treat vaginal atrophy, as well as providing proven benefits such as osteoporosis prevention. The use of HRT to treat post-menopausal mood problems may help some women previously labeled *depressed* as much as antidepressants do.

Clinical trials currently underway with estrogen replacement may show benefit in reducing the rate of bowel cancer. Further studies are needed to see if estrogen can prevent the risk of heart attack and coronary heart disease. At this point estrogen does not seem to reduce future heart attacks in women who have already had one.

Women who receive estrogen replacement need to also take progesterone if they still have their uterus. Progesterone is produced along with estrogen in the pre-menopausal woman. It is more active in the second half of the menstrual cycle and maintains the lining of the uterus until levels drop to trigger the next period. Progesterone serves a protective function for the endometrial lining, balancing the stimulating effects of estrogen. Post-menopausal women taking estrogen alone are at increased risk of developing endometrial or uterine cancer. This increased risk is eliminated with the combination use of progesterone with estrogen.

Many women have decreased sexual desire and responsiveness in spite of HRT. This is due to a reduction in testosterone and other androgenic hormones. When women enter menopause, they lose half of their testosterone production when the ovaries stop functioning. While traditionally thought of as a "male" hormone; in reality, men and women have both estrogen and testosterone, just in different ratios. More than half of women with post-menopausal decreased desire will respond positively to testosterone replacement. The potential risks of androgen replacement can include possible virilization, with skin changes such as acne, increased and coarser body hair, deepening of the voice, and enlargement of the clitoris.

Adding replacement testosterone increases women's sexual desire, arousal, and ability to orgasm; as well as nonsexual energy and mood levels. Within a few years, *triple hormone therapy* with estrogen, testosterone, and progesterone may well become the standard of care.

Effect of HRT on sexual problems

All three stages of the human sexual response cycle (desire, arousal, and orgasm) can be affected by the hormonal changes of menopause.

Sexual desire is mainly modulated by testosterone. Women with decreased desire due to low testosterone respond with increased sexual frequency and improved sexual pleasure. Estrogen contributes in a limited way to desire, primarily by reducing the negative effects of vaginal atrophy. Otherwise, the effects of estrogen on desire are limited. Testosterone replacement for women is a rapidly advancing field, with oral and injectable forms, topical creams, patches, and implantable pellets all being available.

The loss of natural estrogen can lead to vaginal dryness and lack of lubrication, which HRT

can help. Estrogen can be given in a number of ways as well, with vaginal cream, oral pills, patches, and injectable medications being available. All have similar effectiveness, although the intravaginal cream provides the most rapid healing for vaginal atrophy.

When given over an extended time, estrogen must be given in combination with progesterone to reduce the risk of uterine cancer. Most women notice little change on their sexuality from progesterone therapy. Those women who have had a hysterectomy do not need to take additional progesterone.

For some women, the use of HRT is generally contraindicated (such as those with advanced breast cancer.) For those women not responding to alternative therapies, local vaginal symptoms can be treated using a soft plastic pessary (Estring™) that is impregnated with estrogen. It is only locally absorbed and is believed to not increase the risk of cancer recurrence.

Many women who loose the intensity, or even the capacity, to orgasm after menopause will benefit from replacement testosterone. This is especially noticeable after surgical menopause (the operative removal of both ovaries, which causes a sudden loss of estrogen). Sexual satisfaction, as well as overall psychological well-being is generally improved by testosterone replacement.

Some women may not be able to take HRT for medical or personal reasons. Nearly half of adults have used alternative therapies in the last year. There is great clinical demand to have more products available to help these women. While there has been an increase in sexual health research, especially for men, there are still many more questions than answers that await study to demonstrate effective therapies for women. Many alternative products exist to try to help women with menopausal, including sexual, concerns. Some of these include phytoestrogens, dong quai, evening primrose oil, black cohosh, and ginkgo biloba. Few of these have been evaluated using placebo-controlled studies, and some have negative side-effects and interactions with other medications. Given the strong psychological effect on sexual function of taking a placebo, these therapies need to be viewed with caution.

Specific products for post-menopausal vaginal dryness include Replens™, which is a longer-acting vaginal moisturizer that is inserted into the vagina every few days as needed. This is helpful for nonsexual sensations of vaginal dryness.

Other nonhormonal options that are effective include vaginal artificial lubricants to help with intercourse, such as Astroglide™, Just Silk™ and K-Y™ personal lubricant. All of these are safe to use with condoms. Oil-based products, however, can cause condoms to leak. The use of unscented oils, such as peanut oil and Alpha-Keri Bath Oil™, is also more acceptable than petroleum jelly, which is too sticky.

There are no other aphrodisiacs better than a placebo available to help women have more sexual desire or better orgasms.

Conclusion

Menopause has historically been a time when women were considered to be in the twilight of their lives, and when they were often disregarded in society. Today, however, women are entering menopause healthier and more active than ever before. Recognition that they have many roles to play allows them to have productive lives longer than their mothers and grandmothers. Much of this is due to social change and new perceptions of aging women, especially with respect to how menopausal women look at their sexuality. Medical treatments have been expanding to help reduce the effects of changes in hormonal status, helping maintain energy, well-being and sexual function.

STEPHEN HOLZAPFEL

See also ANDROPAUSE; BREAST; DEPRESSION; ENDOCRINE SYSTEM; HAIR; OSTEOPOROSIS; SEXUALITY; URINARY INCONTINENCE; URINARY TRACT INFECTION.

BIBLIOGRAPHY

BRAUNSTEIN, G. D.; BURKI, R. E.; BUSTER, J. E.; CARAMELLI, K. E.; CASSON, P. R.; GINSBURG, E. S.; LEIBLUM, S. R.; MAZER, N. A.; REDMON, G. P.; ROSEN, R. C.; SHIFFREN, J. L.; and SIMON, J. A. "Transdermal Testosterone Treatment in Women with Impaired Sexual Function after Oophorectomy." *New England Journal of Medicine* 343 (2000): 682–688.

BUSH, T.; GRADY, D.; HULLEY, S.; et al. "Randomized Trial of Estrogen, Plus Progestin for Secondary Prevention of Coronary Heart Disease in Postmenopausal Women." *Journal of the American Medical Association* 280 (1998): 605–618.

DANACEAU, M. A.; NUEMAN, L.;SCHMIDT, P. F.; et al. "Estrogen Replacement in Perimenopaus-

al-Related Depression—a Preliminary Report.'' *American Journal of Obstetrics and Gynecology* 183 (2000): 414–420.

EISENBERG, D. M.; DAVIS, R. B.; ETTNER, S. L.; et al. ''Trends in Alternative Medicine Use in the United States, 1990–1997: Results of a Follow-Up National Survey.'' *Journal of the American Medical Association* 280 (1998): 1569–1575.

FELDMANN, H. A.; GOLDSTEIN, I.; HATZICHRISTOU, D. G.; et al. ''Impotence and Its Medical and Psychological Correlates: Results of the Massachusetts Male Aging Study.'' *Journal of Urology* 151, no. 1 (1994): 54–61.

LAUMANN, E. O.; PAIK, A.; and ROSEN, R. C. ''Sexual Dysfunction in the United States: Prevalence and Predictors.'' *Journal of the American Medical Association* 291 (1999): 537–544.

National Institute on Aging (NIA). ''Menopause.'' World Wide Web document. www.nih.gov/nia

North American Menopause Society (NAMS). ''Scientific News About Menopause.'' World Wide Web document. www.menopuase.org

SPEROFF, L. ''Alternative Therapies for Postmenopausal Women.'' ACOG, 29 April 2001.

MENTAL HEALTH SERVICES

The mental health needs of older Americans are a matter of increasing attention, a fact reflected in the growing number of services available since 1975. Even so, the mental health needs of older adults are poorly understood, mental health services are fragmented, and existing services are underutilized. Consequently the older population is especially vulnerable to preventable outcomes: related physical health problems, social isolation, risk of alcohol or medication misuse or abuse, a high rate of suicide, and a reduced quality of life.

As in any discussion about the older population, it is first important to recognize the wide age range and considerable diversity of the category of people we call ''old.'' Conventionally, age sixty or sixty-five-plus has been used to mark entry into old age or older adulthood. A 1999 report on mental health and aging from the U.S. Surgeon General classifies ''older adults'' as the population age fifty-five and older, a categorization that includes centenarians, their children, and many of their grandchildren. Significant variability in physical health and mental health exists within and across age groups from the young old to the oldest old. The older population also is increasingly ethnically diverse; the minority share of the older population is projected to grow significantly, and the Latino population is expected to outnumber the African-American population by 2010 (Kart and Kinney). The heterogeneity of the older population has significant implications for the way mental health services are planned and implemented.

Epidemiology of mental disorders in late life

It is also important to understand age/generational differences in mental disorder prevalence, risks, and needs, all of which are difficult to measure for several reasons. First, definitions of mental health, mental illness, and mental disorder are ambiguous and the terms are used loosely. Second, ageist assumptions about emotional and mental capacity in late life lead to confusion of mental disorders with ''normal aging.'' Third, determining the incidence and prevalence of mental disorders is difficult when indicators are somewhat arbitrary and when people have biases against seeking treatment; needs in these cases remain hidden. Fourth, mental disorders in late life may mimic or mask other problems, particularly physical illnesses or the effects of medications. Fifth, cultural and/or generational differences may affect the identification and/or reporting of disorders. Sixth, distinctions between community- and institution-dwelling populations must be made when studying risks and needs, particularly in the eighty-five-plus age group; 20 percent of them live in nursing homes, and nearly 60 percent of those are affected by at least one mental disorder (including dementia) (Strahan and Burns). And finally, distinctions must be made between chronic and acute, mild and severe, and early- and late-onset disorders. These conceptual and measurement challenges inevitably affect the provision and delivery of mental health services.

Older and younger adults compared

The most reliable studies suggest that when dementia is excluded from the mental health profile, the older population appears to fare slightly better, or at least no worse, than younger cohorts in the prevalence of mental disorders. In some sense this is remarkable, given that older adults are more vulnerable to known mental health risk factors, such as physical illness, poor nutrition, social isolation, bereavement, and financial insecurity. The U.S. Surgeon General re-

ports that 21 percent of adults age eighteen to fifty-four and nearly 20 percent of older adults have a diagnosable mental disorder, excluding dementia, in any given one-year period. Age-associated dementia, such as Alzheimer's disease, is a significant threat to the quality of life of older adults, and although its manifestations may include depression, anxiety, paranoia, behavior problems, and even psychosis, dementia is more often studied and treated as a medical, not a mental, illness. Mental disorders conventionally addressed through mental health services include anxiety, depression, schizophrenia, and adjustment disorders.

Although the prevalence of mental disorders in the older population is similar to that in the younger adult population, the unique effects of these disorders on older adults represent correspondingly unique challenges for mental health treatment and services. Some of these challenges are closely associated with the epidemiological issues identified above. In general, older adults with mental disorders have high rates of coexisting and mutually complicating physical illnesses; are vulnerable to the complications of the use of multiple medications; are more likely to become malnourished; are at special risk of social isolation and loss of social supports; have significantly higher suicide rates; and are especially vulnerable to loss of autonomy.

Early- vs. late-onset disorders

Many older adults are survivors of chronic, lifelong mental disorders, such as schizophrenia, bipolar (manic-depressive) disorder, or chronic major depression. These adults are more likely to enter old age with irregular work histories, legal and/or financial problems, impaired family relationships, substance abuse, and physical health problems. Such individuals are likely to be known and served by a system of mental health services throughout their adulthood. Other older adults experience the first onset of disorder late in life. Late-onset disorders can be destabilizing to individuals and families. Service needs and issues are different for early- and late-onset disorders.

Treatment and services

Older adults' mental health needs are identifiable and treatable. Effective interventions include individual and group psychotherapy; psychoactive medications; support groups, including support for family caregivers; hospitalization; electric shock therapy; family counseling; pastoral counseling; special therapies such as art, pet, and music therapies; community support services; and stress management and other skills training. Services are provided in a variety of settings, including, but not limited to, private clinical practices, community mental health centers, adult day care, group homes, foster care, nursing homes, general hospitals, psychiatric hospitals, and state hospitals.

There is no comprehensive service system for older adults with mental disorders. Older adults needing mental health services must depend on multiple care systems that are not well integrated to meet their complex needs: the aging network, the health care system, and the mental health system. Mental health interventions may be provided through one or any combination of these systems, through both the public and the private sector. Public sector mental health services are historically state-directed, although funding through Medicare, Medicaid, and block grants has increased the federal role since the 1960s. Older adult mental health programs and services vary in level and type across states. Some states have aging-specific services, while others do not specialize. State and nationwide mental health and aging coalitions, a phenomenon of the 1990s, promise improved coordination of care.

The primary care physician is a commonly utilized point of entry and treatment resource for older adults experiencing mental health problems, especially of the late-onset type. This is explained in part by the fact that mental health symptoms of older adults are likely to be linked to somatic symptoms, such as weight loss, insomnia, or shortness of breath. It is also explained in part by the generations-old stigma associated with mental health treatment. Primary care practitioners are in a good position to treat interrelated physical and mental health conditions, but mental health-related training and experience of health professionals vary widely.

Special issues of nursing home residents

Approximately 5 percent of adults age sixty-five and over live in nursing homes (U.S. Bureau of the Census). The rate of mental disorder in this institutionalized population is high, and access to services is disturbingly low. Deinstitution-

alization of state mental hospital patients in the 1960s and 1970s resulted in the reinstitutionalization, into nursing homes, of many elderly patients. Nursing homes became de facto mental health settings but lacked the capacity to provide appropriate care. Related nursing home reforms were instituted in the late 1980s and early 1990s. Although improvements in care were achieved, studies measuring the effects of these reforms have confirmed, without exception, a continuing problem with low mental health treatment and service utilization rates among nursing home residents (Smyer and Qualls).

Access to services

The older population underutilizes mental health services. Older adults represent nearly 13 percent of the U.S. population but account for only approximately 6 percent of those served by community mental health centers and only 5 percent of the clinical hours of psychiatrists (Colenda and van Dooren). Use of mental health services is affected by availability, appropriateness, eligibility, and affordability of services. Mental health services may be available, but not appropriate to the lifestyles, physical capacities, and social attitudes of older adults. Ethnic minorities are especially underserved, in part due to language and/or other cultural barriers. Older adults living in rural or inner-city areas are more likely to be isolated from mental health services.

Mental health coverage by Medicare, Medicaid, and private insurance is generally more limited than coverage for other health care services. A national movement to improve parity, or equality, in mental health coverage led to federal legislation (the Mental Health Parity Act of 1996), and ultimately to expanded Medicare and private insurance coverage. At the turn of the twenty-first century, continuing growth and changes in the managed care industry make the future of mental health care uncertain. The effects of managed care on mental health service access, quality, and outcomes are being studied. Meanwhile, an aging, expanding, and increasingly diverse older population will create new demands for mental health services.

KATHRYN B. MCGREW

See also DEMENTIA; DEPRESSION; GERIATRIC PSYCHIATRY; PSYCHOTHERAPY.

BIBLIOGRAPHY

COLENDA, C. C., and VAN DOOREN, H. "Opportunities for Improving Community Mental Health Services for Elderly Persons." *Hospital and Community Psychiatry* 44 (1993): 531–533.

FOGEL, B. S.; FURINO, A.; and GOTTLIEB, G. L. *Mental Health Policy for Older Americans: Protecting Minds at Risk*. Washington, D.C.: American Psychiatric Association, 1990.

KART, C. S., and KINNEY, J. M. *The Realities of Aging*, 6th ed. Boston: Allyn and Bacon, 2001.

SMYER, M. A., and QUALLS, S. H. *Aging and Mental Health*. Malden, Mass.: Blackwell Publishers, 1999.

STRAHAN, G. W., and BURNS, B. J. "Mental Illness in Nursing Homes: United States, 1985." *Vital Health Statistics Series* 13, no. 105 (1991).

U.S. Bureau of the Census. *Aging in the United States: Past, Present, and Future*. July, 1997. Available from www.census.gov

U.S. Surgeon General. *Mental Health: A Report of the Surgeon General*. 1999. Available from www.surgeongeneral.gov

ZARIT, S. H., and ZARIT, J. M. *Mental Disorders in Older Adults: Fundamentals of Assessment and Treatment*. New York: Guilford Press, 1998.

MENTAL STATUS EXAMINATION

Almost everyone is familiar with the idea of going to the doctor for a physical examination for school, employment, a driver's license, or for summer camp. Such an examination includes measurement of pulse and blood pressure, listening to the heart and lungs through a stethoscope, tapping tendons to elicit neurological reflexes, and so on. Everyone may not be aware, however, that the doctor is also making an assessment of mental status. Put simply, in order to assess the patient as a whole person, doctors determine not just how the heart and the lungs are working, but also how the brain is working.

For all organ systems (e.g., cardiovascular, respiratory, neurological) the assessment includes two components. The first part, the *history,* takes place when the doctor asks the patient about any symptoms or problems that may have been experienced subjectively. The second part, the *examination,* consists of objective observations that the doctor makes. For example, a patient may report heart palpitations, and the doctor may observe that the patient's pulse is rapid. Similarly, the patient may complain of having

difficulty remembering, and the doctor may observe that the patient is repeating himself or herself during the conversation. The doctor may also perform a brief memory test as part of the mental status examination.

A mental status examination comprises a number of components. *Orientation* refers to the person knowing where he or she is (the location and address), what the date is, and so on. *Attention* refers to the person being able to concentrate on a mental task, such as doing a series of simple subtractions. *Registration* is the ability to listen and repeat back (showing that one has learned) a few words; *recall* is the ability to remember those words a few minutes later. The doctor may also ask the patient to name some familiar objects or write a simple sentence, to test *language* functions. The patient may be asked to copy a simple diagram, or draw a familiar object, to test *constructional* or *visuospatial* functions. The patient may also be asked to explain the meaning of a common phrase or proverb, or to explain the difference between two different objects or concepts, to test *abstract thinking*. The above are all examples of different cognitive functions that make up one's day-to-day intellectual functioning. They are not trick questions, and while they are not especially hard, they are designed to challenge patients sufficiently for the doctor to determine where potential problems may lie. Quite often, the end result of the examination is that the doctor can reassure the patient that his or her mental status seems normal. Or, for example, a memory problem may be present, possibly caused by depression, a stroke, Alzheimer's disease, or thyroid disease. One must first recognize the problem before one can identify the cause and recommend the appropriate treatment. Thus, the mental status examination is an important and essential part of the overall health assessment, and should be performed routinely.

MARY GANGULI

See also PSYCHOLOGICAL ASSESSMENT.

BIBLIOGRAPHY

FOLSTEIN, M.; FOLSTEIN, S.; and MCHUGH, P. R. "Mini-Mental State: A Practical Method of Grading the Cognitive State of Patients for the Clinician." *Journal of Psychiatric Research* 12 (1975): 189–198.

STRUB, R. L., and BLACK, F. W. *The Mental Status Examination in Neurology,* 3rd ed. Philadelphia, Pa.:, FA Davis, 1993.

METAMEMORY

Adults of all ages often wonder about their memory—how it works or does not work, why one remembers some things but not others, and whether memory skills will change over the life course. The term "metamemory" refers to such cognitions about memory—thinking about how, why, and whether memory works. Specific aspects of metamemory include knowledge of memory functioning, insight into memory changes or impairment, awareness of current memory processes, beliefs about and interpretations of memory skills and demands, and even memory-related affect. This entry features an overview of the concept of metamemory and how it applies to aging. The view of metamemory presented here is useful when considering both basic (e.g., how memory and metamemory change and relate to one another in aging) and applied (e.g., the role metamemory may play in compensating for memory impairments and decline) research questions.

Concept of metamemory

In recent decades the concept of metamemory has been the topic of considerable attention in a variety of neighboring domains of psychological research and practice. The range of both the substantive interests and the theoretical perspectives of the researchers is notable, for they span numerous "disciplines" of the psychological sciences. Five such disciplines are briefly noted here. First, cognitive psychologists have examined metacognition as bridging and reflecting such processes as self-monitoring, decision making, learning and memory, motivation, plans and strategies, and cognitive development (see Metcalfe and Shimamura). Second, neuropsychologists have examined metacognition as it bridges cognitive psychology, neuroscience, and clinical neuropsychology. For example, researchers may be concerned with metacognitive impairment (e.g., anosognosia, or unawareness or denial of memory problems or disease) that has occurred as a function of brain injury, dementia, or normal aging-related neurological changes (e.g., Prigatano and Schacter).

Third, some social and personality psychologists have contributed the perspective that

metamemory operates in conjunction with, rather than in isolation from, personality and social cognitive processes. For example, researchers may examine the effects of self-concept, self-regulation, self-efficacy, and sense of mastery or control on cognitive performance in children and also in adults (e.g., Cavanaugh). Fourth, child developmental and educational psychologists have examined metamemory as it relates to the growth or improvement of basic cognitive skills in children (e.g., Kuhn). An important pedagogical concern is when and how children learn and apply strategies that improve their learning performance in school and other settings. Fifth, life span developmental psychologists have examined metamemory development in adulthood. The focus has been on multidimensional views of metamemory, how metamemory per se develops in adulthood, and whether metamemory failures may be related to some aging-related declines in memory performance (Dixon; Hertzog and Hultsch).

Metamemory in adulthood

Overall, research and theory in metamemory in adulthood incorporate many of the issues raised in the neighboring domains of metamemory research. They do so in part through implementation of an inclusive and multidimensional concept of metamemory (e.g., Dixon; Hertzog and Hultsch). Four principal characteristics are the following: (a) metamemory includes a wide variety of behaviors (knowledge, beliefs, evaluations, and estimates), indicating the level, degree, or extent of an individual's metamemory performance or skill; (b) it features a multidimensional concept, in that the multiple facets or behaviors are viewed as separable but linked dimensions of a coherent construct of metamemory; (c) it assumes that multiple operations and dimensions would converge on a higher-order construct of metamemory and that metamemory can be discriminated from related constructs; and (d) metamemory is a construct of intrinsic interest in the study of normal cognitive aging, but one that may also have substantial implications for understanding impairments of memory late in life.

Metamemory represents one's knowledge, awareness, and beliefs about the functioning, development, and capacities of one's own memory and human memory in general. As such, it includes three principal categories. First, declarative knowledge about how memory functions includes knowledge of how the characteristics of memory tasks have an impact on memory performance, whether strategies are required, and which strategies may be usefully applied to particular situations. Second, self-referent beliefs about one's capability to use memory effectively in memory-demanding situations defines memory self-efficacy and controllability (e.g., Cavanaugh). One's beliefs about one's ability to remember may determine (a) the extent to which one places oneself in memory-demanding situations, (b) the degree of effort one applies to perform the memory task, (c) one's expectation regarding level of memory performance, and (d) one's actual memory performance. Certain aspects of affect regarding memory (in general) or one's memory performance and change (in particular) may also play a role (e.g., motivation to do well, fear of memory-demanding situations).

Third, awareness of the current, general, and expected states of one's memory performance includes processes of memory insight and memory monitoring. Effective rememberers are able to actively and accurately monitor their performance vis-á-vis the demands of the memory task. A high degree of accuracy in predictions of performance, evaluations of encoding demands, and on-line judgments of learning may indicate an effective and accomplished rememberer (e.g., Hertzog and Hultsch). In clinical situations, an awareness of a deficit may be an important precursor to memory compensation (e.g., Wilson and Watson).

In aging research, these categories of metamemory have been related to one another both theoretically and empirically (see Hertzog and Hultsch). In principle, for older adults, high performance on given memory tasks should be promoted by the following metamemory profile: (a) a well-structured declarative knowledge base about how memory functions in given tasks, (b) refined knowledge of one's own memory skills, (c) accurate and high memory self-efficacy, and (d) skill at the monitoring and control activities during acquisition, retention, and retrieval. In addition, it could be useful to have (e) stable or low memory-related affect, such that the potential deleterious effects of memory-related anxiety or depression could be avoided. In contrast, some older adults with poorer—and perhaps impaired—performance could be experiencing some components of the following profile: (a) and (b) an ill-structured, incomplete, or erroneous knowledge base pertaining to general memo-

ry functioning or one's own memory skills, (c) inaccurate or low memory self-efficacy, (d) an inability to monitor and control the requisite activities of effective remembering, and (e) fluctuant, uncontrolled, or excessive memory-related anxiety or depression. These profiles define two hypothetical ends of a continuum.

Two clinical implications of these hypothetical profiles in older adults are evident. First, can some aging-related memory disorders or impairments be remedied through clinical intervention designed to assess and improve selected categories of metamemory? Second, can the diagnosis and remediation of some organic memory disorders (e.g., the result of injuries or disease) be advanced through the use of metamemory or awareness information? Research on these questions is advancing on a variety of fronts, including cognitive neurorehabilitation (e.g., Wilson and Watson), memory compensation in late life (e.g., Dixon et al.), awareness of and insight into neuropsychological conditions (e.g., Lovelace), memory complaints and their origins and implications (e.g., Gilewski and Zelinski et al.), and potential effects of metamemory training on memory.

Conclusion

Metamemory refers to processes also known as cognition about memory, memory complaints, memory control, memory self-efficacy, memory knowledge, memory affect, memory monitoring, and memory insight or awareness. A theoretically coherent concept of metamemory includes several interrelated components: declarative knowledge of memory functioning, awareness of or insight into memory skills or problems, monitoring of current memory processes, beliefs about memory skills and change, and memory-related affect. Research on aging has provided numerous fascinating portrayals of metamemory—its range, development, and influences. The simultaneous measurement of multiple dimensions of metamemory is useful, especially when considering issues pertinent to normal aging (e.g., how memory normally changes—grows and declines—across the life span) and to clinical aging (e.g., how memory disorders are developed, supported, and remedied). Important issues of current and future research include (a) the extent to which dimensions of metamemory interact in determining memory performance, impairment, or decline; (b) the extent to which dimensions of metamemory may serve as early indicators of progressive memory decline, such as that associated with organic diseases; and (c) the extent to which intervention in dimensions of metamemory may have indirect influence on memory performance, maintenance, improvement, or recovery.

ROGER A. DIXON

See also MEMORY.

BIBLIOGRAPHY

CAVANAUGH, J. C. "Memory Self-Efficacy as a Moderator of Memory Change." In *Perspectives on Cognitive Change in Adulthood and Aging*. Edited by F. Blanchard-Fields and T. M. Hess. New York: McGraw-Hill, 1996. Pages 488–507.

DIXON, R. A. "Questionnaire Research on Metamemory and Aging: Issues of Structure and Function." In *Everyday Cognition in Adulthood and Old Age*. Edited by L. W. Poon, D. C. Rubin, and B. A. Wilson. New York: Cambridge University Press, 1989. Pages 394–415.

DIXON, R. A.; DE FRIAS, C. M.; and BÄCKMAN, L. "Characteristics of Self-Reported Memory Compensation in Late Life." *Journal of Clinical and Experimental Neuropsychology*. 23 (2001): 650–661.

GILEWSKI, M. J., and ZELINSKI, E. M. "Questionnaire Assessment of Memory Complaints." In *Handbook for Clinical Memory Assessment of Older Adults*. Edited by L. W. Poon. Washington, D.C.: American Psychological Association, 1986. Pages 93–107.

HERTZOG, C., and HULTSCH, D. F. "Metacognition in Adulthood and Old Age." In *The Handbook of Aging and Cognition,* 2d ed. Edited by F. I. M. Craik and T. A. Salthouse. Mahwah, N.J.: Erlbaum, 2000. Pages 417–466.

KUHN, D. "Metacognitive Development." *Current Directions in Psychological Science* 9 (2000): 178–181.

LOVELACE, E. A., ed. *Aging and Cognition: Mental Processes, Self Awareness, and Interventions*. Amsterdam: North-Holland, 1990.

METCALFE, J., and SHIMAMURA, A. P., eds. *Metacogniton Knowing About Knowing*. Cambridge, Mass.: MIT Press, 1994.

PRIGATANO, G. P., and SCHACTER, D. L., eds. *Awareness of Deficit After Brain Injury: Clinical and Theoretical Issues*. New York: Oxford University Press, 1991.

An elderly Palestinian in a traditional Arab head dress reads from the Quran at a mosque in the West Bank town of Ramallah, which was the sight of intense fighting between Israelis and Palestinians during the fourteen months preceding this November 2001 photo. (AP photo by Nasser Nasser.)

RYAN, E. B. "Beliefs About Memory Changes Across Adulthood." *Journal of Gerontology: Psychological Sciences* 47 (1992): P41–P46.

WILSON, B. A., and WATSON, P. C. "A Practical Framework for Understanding Compensatory Behaviour in People with Organic Memory Impairment." *Memory* 4: (1996): 456–486.

MIDDLE EASTERN COUNTRIES

The southern part of Asia, known as the Middle East, covers an area about the size of the United States and Mexico. The Middle Eastern countries are Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, Turkey, the United Arab Emirates (UAE), the West Bank and Gaza Strip, and Yemen. Although often discussed collectively, they are different in as many ways as they are similar. For example, all Middle Eastern countries are Arab except Iran, Israel, and Turkey (which account for 59 percent of the region's population). In 1981 the *Congressional Quarterly* defined the so-called Arab countries as "those in which Arabic is the primary language and who share a common culture."

Most residents of these countries are Sunni Muslim. Exceptions are the Israelis, 90 percent of the Iranians, and two-thirds of the Iraqis, who are Shi'a Muslim. The Middle Eastern countries also differ in historical development, social and ethnic composition, economic history, natural resources, size, population, and forms of government.

This entry reviews the demographic, economic, political, cultural, and social support structures that influence aging and the older people of the Middle Eastern countries. The North African countries of Algeria, Egypt, Libya, Morocco, and Tunisia, which share a culture and religious beliefs with the Arab population of the Middle East, are included in Table 1 along with the Middle Eastern countries. Although Israel is mentioned for comparison, that country is not discussed at length here.

Economic conditions, population, and aging

The Middle Eastern countries possess different resources and are at different stages of economic development. Some, such as Saudi Arabia,

Oman, Qatar, Kuwait, and the UAE, have vast oil reserves and oil-dependent economies; others, such as Iran, Iraq, and Syria, are partially oil-dependent. Still others, such as Israel, Jordan, Lebanon, Turkey, and Yemen, have no oil reserves; their economies rely on agriculture and young industries. Oil in the Middle East is a national property. Most of the oil-dependent countries, such as Saudi Arabia and Kuwait, are rich in capital, have labor shortages, and employ guest workers. Turkey and Yemen are low on capital but have a large supply of labor, which they export to the oil-producing countries. The generous old-age benefit programs in some of these countries, which also cover migrant workers, allow the workers to return to their homelands and collect a pension.

Iran and Turkey, each with an estimated population of about 65 million in 2000, account for 56.4 percent of the 232.5 million inhabitants of the Middle East. Turkey has enjoyed a relatively stable government during the last quarter of the twentieth century (except for Kurdish independence movements). Six percent of Turkey's population was estimated to be sixty-five and older in 2000; this figure is projected to increase to 10.8 percent in 2025 (see Table 1). Perhaps more than women elsewhere in the Middle East, women in the Turkish Republic enjoy equality with men in employment opportunities and social freedom. Except for Israel, Turkey has the region's most extensive old-age benefit program: it covers all residents and the benefits are adjusted periodically for changes in the cost of living. Employees and employers finance the system jointly with no government supplement. The amount of benefits is related to past earnings and allows for disability and survivors' benefits.

Iran's experience in the late twentieth century was very different. The country underwent an Islamic revolution, a change in the system of government, an eight-year war with Iraq, and an economic blockade by the United States. In addition, the new regime pursued an isolationist policy in the years following the 1978 revolution. These changes created a difficult economic situation with little or no growth, double-digit inflation for several years, and a reduction in oil-production capacity. The sharp increase in the population due to strict adherence to Islamic laws, which prohibits family planning and birth control, led to a population explosion after the revolution. Although the policy has been reversed, Iran has a very young population. In 2000, fewer than 5 percent of Iranians were sixty-five or older; this proportion is expected to reach 7.3 percent by 2025.

The old-age benefits cover nearly all workers with some employment history. Self-employed persons can join by paying the employer's and employee's portion of the contribution. The health care system is almost universal, covering the employees and their dependents, especially in nonagricultural areas.

Another one-third of the region's population lives in the next four largest countries—Iraq, Saudi Arabia, Syria, and Yemen—with a total population of 78.5 million. Saudi Arabia has been able to maintain stability and allow its oil industry to expand. This country, more than any other Islamic nation, follows strict Islamic laws. Men are permitted to have up to four wives at a time; family planning and birth control are not practiced. With an estimated fertility rate of 6.3 children per woman in 2000, Saudi Arabia has one of the fastest-growing populations in the world. The population is expected to more than double by 2025 (see Table 1). The proportion of the population age sixty-five or older will also double during that period. Because of generous old-age pension and health care benefits, which are subsidized by the government and cover nearly everyone except agricultural workers and seamen, life expectancy is projected to increase by seven years between 2000 and 2025.

Iraq faced other challenges during the 1980s and 1990s. It fought an eight-year war against Iran, in which both countries suffered heavy casualties, and then turned its attention to another neighbor, Kuwait. The international community, concerned about the flow of oil to the West and Iraq's weapon buildup as a threat to its neighbors, collectively punished Iraq in what is known as the Persian Gulf War. The country's infrastructure and armed forces were destroyed, and Iraq was subjected to severe economic sanctions and isolation. These conditions resulted in major health problems and malnutrition, with high rates of infant mortality and childhood diseases. The full impact of these events on the population's age distribution will become clear in the future. In 2000, only 3.1 percent of the Iraqi population was estimated to be sixty-five and older; by 2025, the proportion age sixty-five and older is projected to increase to 4.3 percent (see Table 1). These figures represent one of lowest

Table 1
Population Characteristics, Middle East and North African Countries

	Estimated Population, 2000					Projected Population, 2025				
	Total Pop. (1000s)	% 65+	Of 65+ % Female	Life Exp. at Birth	Fertility Rate	Total Pop. (1000)	% 65+	Of 65+ % Female	Life Exp. at Birth	Fertility Rate
*Algeria	31,194	4.0	53.7	69.7	2.8	44,270	7.1	52.8	76.1	2.0
Bahrain	634	2.9	49.1	73.0	2.8	865	12.4	37.8	78.3	2.1
*Egypt	68,360	3.8	56.0	63.3	3.2	95,164	10.6	57.2	71.6	2.1
Iran	65,620	4.6	47.0	69.7	2.2	88,409	7.3	53.2	76.1	1.9
Iraq	22,676	3.1	53.3	66.5	4.9	40,418	4.3	54.0	74.3	2.7
Israel	5,842	9.9	57.0	78.6	2.6	7,612	13.8	55.5	81.6	2.0
Jordan	4,999	3.2	50.3	77.4	3.4	8,652	6.2	52.3	81.0	2.0
Kuwait	1,974	2.3	34.8	76.1	3.3	4,175	3.4	45.1	79.9	2.2
Lebanon	3,578	6.7	54.2	71.3	2.1	4,565	8.4	65.5	77.2	1.7
*Libya	5,115	3.9	50.0	75.5	3.7	8,323	6.1	50.0	79.8	2.4
*Morocco	30,122	4.6	54.5	69.1	3.1	42,553	7.6	56.1	75.8	2.1
Oman	2,533	2.4	46.7	71.8	6.1	5,294	5.7	34.2	77.5	3.7
Qatar	744	2.3	29.1	72.4	3.3	1,154	4.3	24.3	77.9	2.2
Saudi Arbia	22,024	2.6	45.6	67.8	6.3	48.517	5.6	36.0	74.8	4.8
Syria	16,306	3.2	51.0	68.5	4.1	26,548	4.9	53.2	75.3	2.2
*Tunisia	9,593	6.0	49.7	73.7	2.0	12,028	10.4	54.7	78.7	1.7
Turkey	65,667	6.0	53.9	71.0	2.2	82,205	10.8	54.2	77.0	1.7
United Arab Emirates (UAE)	2,369	2.2	31.4	74.1	3.3	3,270	17.0	30.9	79.0	2.2
West Bank and Gaza Strip	3,152	3.3	56.2	71.7	5.5	6,472	4.2	53.7	76.0	3.0
Yemen	17,479	3.1	49.1	59.8	7.1	39,644	2.9	55.7	68.8	4.7

*North African countries

SOURCE: U.S. Bureau of the Census, International Database, www.census.gov

life expectancies in the Middle East, second only to Yemen, which has suffered similar circumstances. Iraq has an old-age pension system that is designed to cover all employees except agricultural and temporary workers. It is not clear whether the system has been able to pay for health care and fulfill its obligations to retired and disabled persons since the Persian Gulf War.

The Syrian government, which has strong ties to the military after some modernization, liberalization, and purging, has maintained stability since the early 1980s. Syria contains oil reserves and arable land, and other industries exist beside oil production and refining; yet the country's economic development has been slow. Syria's political and military involvement in Lebanon and

its continued role as peacekeeper have proved very costly. It is estimated that in 2000, only 3.2 percent of Syria's population was sixty-five or older; by 2025 this proportion is expected to reach 4.9 percent, with a decrease in the fertility rate (see Table 1).

Syria has an old-age pension system that covers everyone except domestic and temporary workers. The system, which is fully financed by employees and employers, also pays for health care, disability, and survivor benefits.

Yemen has few natural resources, and agriculture has declined because of prolonged droughts; the result is very slow economic development. Because of the harsh economic conditions and severe climate, estimated life expectancy in Yemen was the lowest in the region (59.8 years) in 2000. A major improvement in life expectancy is expected by 2025 (see Table 1) with cessation of hostilities between north and south and with improved stability and economic conditions. In 2000, Yemen had the highest estimated fertility rate in the Middle East (7.1 per woman); by 2025 the fertility rate is projected to be lower, but still very high (4.7, second only to Saudi Arabia). The old age pension system in Yemen is new, established in 1987 and revised in 1995. Employees and employers fund the program with no government support. It covers everyone except agricultural workers, fishermen, and domestic and temporary workers. The benefits are paid in a lump sum and are less generous than in some of the wealthier nations in the region.

In Western industrialized nations, where health care is better and retirement income security is greater, women enjoy a higher life expectancy; therefore they make up a larger proportion of older persons in those nations. In the Middle East, Turkey and Iraq are the only sizable countries (excluding Israel) in which women account for a higher proportion of the older population. The old-age benefits and pension programs in all of the Middle Eastern countries are conscious of females' shorter life expectancy and have instituted lower retirement ages for women than for men.

In the larger Middle Eastern countries such as Iran, Turkey, Iraq, and Syria, many urban women have received Western-style higher education. Women's labor force participation in these countries is much lower than in the West, however. Among the countries with a sizable proportion of the female population in the labor force—Iran, Iraq, Jordan, Bahrain, and Yemen—the ages of eligibility for pension benefits are sixty for men and fifty-five for women when the qualifying conditions are met. In Turkey the eligibility ages are fifty-five for men and fifty for women; in Israel, sixty-five for men and sixty for women.

The population characteristics of the Middle Eastern nations and some North African countries are presented in Table 1. All of these countries have old-age benefits programs, which provide income security and health care to almost all citizens with some employment history. The improved life expectancy in all of these countries, also shown in Table 1, may be due to the expansion of the social and health care programs from an early age, which reduce infant and childhood mortality and provide income security in later life.

Role of Islam in policies and practices related to aging

Although they differ ideologically, almost all Middle Eastern countries except Israel have laws based, to some extent, on the holy book of the Qur'an. The influence of Islamic teachings and recommended practices is most notable in family law. Hammudah Abd al Ati, after reviewing definitions of family in an Islamic context, suggests the following: "The term family will be used to designate a special kind of structure whose principals are related to one another through blood ties and/or marital relationships, and whose relatedness is of such a nature as to entail 'mutual expectations' that are prescribed by religion, reinforced by law, and internalized by the individuals" (p. 19). In cultural and traditional norms as well as Islamic teachings and laws, the family is regarded as an inclusive and supportive unit whose success and well-being are connected to the well-being of other members of the unit. Islamic teachings emphasize honor and respect for parents and older members of the family, comparing respect for elders to the honor offered to God.

The old-age pension/benefits programs in Middle Eastern countries define family very broadly. Not only a pensioner's surviving spouse and children but also the parents and siblings are defined as survivors eligible to receive benefits. The benefits for daughters continue as long as they are not married, reflecting the conditions in

nations where only a small percentage of females are employed. The eldest son in the household has the acknowledged responsibility of caring for his parents and sibling(s) if necessary. This most often begins with coresidency, when a newly widowed parent moves in with the son's family. In the beginning, while this relative is still in good health, she or he assists in household chores, introduces the children to traditional and cultural values, and often cares for the younger children, teaching them a skill or a trade. This cultivated relationship later is reversed, when older family members need assistance in caring for themselves. Yet the arrangement is always viewed as mutually beneficial; caring for a disabled grandparent, aunt, or uncle is not viewed as a burden but as a natural extension of family life.

This is not to say that Middle Eastern countries have no agencies or institutions that provide daily care to disabled older people. In Iran, Iraq, Syria, and Turkey, an increasing number of women in the urban areas seek employment outside the home, which limits their availability for caregiving. In addition, some elders have no family members and no financial means of their own to hire domestic workers. To serve these isolated cases, a few institutions, mostly in urban areas, are available in the larger countries. It is more common, however, to hire a domestic worker to help care for the older persons in the family.

SHAHLA MEHDIZADEH

See also ISRAEL; POPULATION AGING; SUB-SAHARAN AFRICA.

BIBLIOGRAPHY

ABD AL ATI, H. *The Family Structure in Islam*. Lagos, Nigeria: Islamic Publication Bureau, 1982.

LOPATA, H. Z. *Widows: The Middle East, Asia, and the Pacific*. Vol. 1. Durham, N.C.: Duke University Press, 1987.

The Middle East Information Network. Available on the World Wide Web at www.mideastinfo.com/maproom

MOGHADAM, V. M. *Modernizing Women: Gender and Social Change in the Middle East*. Boulder, Colo.: Lynne Riener Publishers, Inc., 1993.

National Institute of Statistics, Geography and Informatics. "Land Area, Borders, Coastlines and Exclusive Economic Zone." Available on the World Wide Web at www.inegi.gob.mx

SMITH, J. I. *Women in Contemporary Muslim Societies*. London: Associated University Presses, 1980.

Social Security Administration. "Social Security Programs Throughout the World." Available on the World Wide Web at www.ssa.gov/statistics

United Nations. *World Population Prospects: The 1998 Revision*. Vol. 3, *Analytical Report*. New York: United Nations, 2000.

United States Bureau of the Census. "International Database." Available on the World Wide Web at www.census.gov

United States Bureau of the Census. *Statistical Abstract of the United States: 1998*, 118th ed. Washington, D.C.: United States Bureau of the Census, 1998.

WORMSER, M. D., ed. *The Middle East*, 5th ed. Washington, D.C.: Congressional Quarterly Inc., 1981.

MIDLIFE CRISIS

One of the most intriguing puzzles of lifespan developmental psychology is the myth of a midlife crisis, a mental health crisis occurring in the midlife years. In 1965, Elliot Jacques proposed the midlife crisis as a normative crisis in early middle adulthood on the basis of a psychoanalytic approach to an awareness of death surfacing in early midlife (the mid-thirties). Although the notion of a midlife crisis attracted much acclaim in both the scientific and public debate, it has continually failed to receive empirical support. Empirical investigations have shown the existence of midlife developmental patterns of continuous development, maintained well-being, and adaptivity and resilience throughout midlife; and they have not uncovered a midlife mental health crisis as a universal, or even a common developmental, experience.

Adaptation to growth potential and resilience in managing losses are two major components of developmental regulation. Midlife, more than any other period of the life span, requires the conjoint mastery of both these components of regulating one's own development. It is during midlife that adults can expect a radical increase in loss-related changes, including crossing some developmental deadlines that require disengagement from an important life goal, such as having children. At the same time, several domains of life and functioning (e.g., professional expertise, social skills) come into their prime in midlife.

The regulatory challenge of juggling both gains and losses does not overwhelm most midlife adults, however. Instead, these challenges are met with a rich and elaborate array of resources that most adults command at this point in life. Midlifers typically are at the peak of their vocational careers, earning power, social status, and social influence. Moreover, and maybe even more importantly, midlife adults have accumulated knowledge about adult development and life courses and have experience with mastering challenges, overcoming losses, and regulating emotional responses. In addition, many midlife adults hold optimistic beliefs about their own self efficacy, occupy multiple social roles that can balance losses, and enjoy supportive social networks. Finally, midlife adults can self-regulate their goal engagement and goal disengagement based on their knowledge and anticipation of final deadlines for achieving certain goals (e.g., child-bearing, career promotion). This way they can avoid experiencing disappointment and despair when time runs out for achieving long-cherished life goals.

In spite of the evidence contradicting it, the notion of a midlife crisis has survived as a public myth about development during the fourth and fifth decades of life. This survival of the midlife crisis myth is an intriguing phenomenon—which calls for scientific explanation. It seems likely that the myth itself fulfills an adaptive function, which lends credibility and resilience to it. In a cross-sectional study of adults from early adulthood to old age (Heckhausen and Brim, 1997), perceptions of self and "most others my age" reflected a view that most others are burdened with problems, whereas each individual considers himself or herself to be the favorable exception. This tendency was expressed by adults at all ages, and was particularly pronounced for domains of functioning for which the respective adult experienced a threat (e.g., health, career, stagnation, conflicts with one's children). It thus appears that *social downgrading* (underestimating others' qualities) based on negative age-related stereotypes (e.g., the elderly, the midlife crisis) is a compensatory interpretation used by adults who experience loss or threat. Such age-related stereotypes are not only present with regard to old age but also exist for midlife. The myth of the midlife crisis may serve this function by organizing a social stereotype about midlife that allows social downgrading of one's age peers and, thereby, relative self-enhancement. In this way, the myth of the midlife crisis is an adaptive stereotype, just as negative stereotypes about aging are.

Another adaptive implication of the midlife crisis myth is the fact that it renders certain problems predictable, such as the increased tendency for feelings of regret, disappointment, and lack of purpose and meaning, which are probably more likely to be experienced at midlife because of the growing salience of finite lifespan. Thus, based on expectations implied in the notion of a midlife crisis, individuals might move into midlife anticipating and prepared to disengage from certain goals that have become obsolete.

JUTTA HECKHAUSEN

See also LIFE-SPAN THEORY OF CONTROL; PERSONALITY.

BIBLIOGRAPHY

CHIRIBOGA, D. A. "Stress and Loss in Middle Age." In *Midlife Loss: Coping Strategies*. Edited by R. A. Kalish. Newbury Park, Calif.: Sage, 1989. Pages 42–88.

FARRELL, M. P., and ROSENBERG, S. D. *Men at Midlife*. Boston, N.J.: Auburn House, 1981.

HARRIS, L., and Associates. *Aging in the Eighties: America in Transition*. Washington, D.C.: National Council on the Aging, 1981.

HECKHAUSEN, J. *Developmental Regulation in Adulthood: Age-Normative and Sociostructural Constraints as Adaptive Challenges*. New York: Cambridge University Press, 1999.

HECKHAUSEN, J. "Adaptation and Resilience in Midlife." In *Handbook of Midlife Development*. Edited by M. E. Lachman. New York: John Wiley, 2001. Pages 345–394.

HECKHAUSEN, J., and BRIM. O. G. "Perceived Problems for Self and Others: Self-Protection by Social Downgrading Throughout Adulthood." *Psychology and Aging* 12 (1997): 610–619.

HECKHAUSEN, J.; WROSCH, C.; and FLEESON, W. "Developmental Regulation Before and After a Developmental Deadline: The Sample Case of 'Biological Clock' for Child-Bearing." *Psychology and Aging* 16 (2001): 400–413.

HUNTER, S., and SUNDEL, M. "An Examination of Key Issues Concerning Midlife." In *Midlife Myths: Issues, Findings, and Practice Implications*. Edited by S. Hunter and M. Sundel. Newbury Park, Calif.: Sage, 1989. Pages 8–28.

JACQUES, E. "Death and the Midlife Crisis." *International Journal of Psychoanalysis* 46 (1965): 502–514.

O'GORMAN, H. J. "False Consciousness of Kind: Pluralistic Ignorance among the Aged." *Research on Aging* 2 (1980): 105–128.

ROSENBERG, S. D.; ROSENBERG, H. J.; and FARRELL, M. P. "The Midlife Crisis Revisited." In *Life in the Middle: Psychological and Social Development in Middle Age*. Edited by S. L. Willis and J. D. Reid. San Diego, Calif.: Academic Press, 1999. Pages 47–73.

WHITBOURNE, S. K. *The Me I Know: A Study of Adult Identity*. New York: Springer, 1986.

WROSCH, C., and HECKHAUSEN, J. "Control Processes before and after Passing a Developmental Deadline: Activation and Deactivation of Intimate Relationship Goals." *Journal of Personality and Social Psychology* 77 (1999): 415–427.

MIGRATION AND GEOGRAPHIC DISTRIBUTION

If a survey asked respondents what they knew about the geographic distribution and migration patterns of older people in the United States, two observations would be frequently repeated. First, with respect to distribution, respondents would comment on the concentration of older people in Florida. Second, regarding migration, most would report something about retirement migration, with older people moving from the Snowbelt to the Sunbelt. While not incorrect, these responses are very imprecise and miss a great deal of what is interesting about these issues. In fact, there is widespread misunderstanding about which regions of the United States have the oldest populations and about how uncommon retirement migration really is.

Geographic distribution

Focusing on the geographic distribution of the older population at the state level, two different questions can be asked. First, which states have the largest number of older people? The answer to this question is quite unremarkable: the states with the largest total populations tend to have the largest populations of persons age sixty-five and over. In 2000, the four largest states (California, Texas, New York, and Florida) contained 31 percent of the total U.S. population and 31 percent of the elderly population. More than half (52 percent) of all senior citizens live in the nine largest states (the four listed above plus Illinois, Pennsylvania, Ohio, Michigan, and New Jersey). Among the nine states with the largest populations of older people, only three are in the Sunbelt.

The more interesting question about variations across states concerns the proportion of the population that is age sixty-five and over. For the United States as a whole, 12.4 percent of the population was age 65+ in 2000. But only two states (Indiana and Tennessee) had exactly this percentage of their populations in this age category. The state with the oldest population was, of course, Florida, which stands out with 17.6 percent of its population age 65+. But the other states with especially old populations were not states that attract a lot of retired migrants. In 2000, seven of the ten states with the oldest populations were in the Northeast or Midwest (Pennsylvania, Iowa, North Dakota, Rhode Island, Maine, South Dakota, and Connecticut), while three were in the South (Florida, West Virginia, and Arkansas) and none were in the West. At the opposite end of the distribution, the states with the youngest populations were Alaska (5.7 percent age 65+) and Utah (8.5 percent age 65+). All fourteen states in which older people made up less than 12 percent of the population were in the West and the South. As suggested by the above discussion, the oldest regions of the United States were the Northeast (13.8 percent) and Midwest (12.8 percent), and the youngest were the West (11.0 percent) and South (12.4 percent).

Excluding the extremes (Florida and Alaska), the proportion of older adults in state populations ranged from 8.5 percent to 15.6 percent in 2000. Moving to areas smaller than states, however, much greater variations are apparent. Some counties could be classified as "gerontic enclaves." In two counties (one in Florida and one in North Dakota), over one-third of the population was age 65+ in 2000, and there were fifty-seven counties in which over one-fourth of the population is in this age group. Half of these counties were in Florida, South Dakota, and North Dakota. The three counties where less than 3 percent of the population was sixty-five and older were in Georgia and Alaska. Clearly, more than temperature is determining the proportion of older adults in various geographic locations.

Why does age distribution vary across areas?

Four factors determine the proportion of elderly people in a population: past death rates, past birth rates, past in-migration rates, and past out-migration rates. Of these four factors, the least important is death rates. Although there are some variations in death rates across states, these variations are not very large and they play a very insignificant role in determining age distributions. Fertility patterns have a larger effect on the age composition of a population—high fertility rates are associated with younger age distributions. The intuitive notion that higher fertility leads to a larger proportion of children in the population, and consequently a smaller proportion of older people, is correct. This relationship between birth rates and age structure helps to explain why Utah, with the highest fertility rate of any state, ranks forty-ninth in proportion of older adults. Seven of the ten highest fertility states are among the fifteen youngest states. But there are exceptions. Arizona, for example, has the second highest fertility rate of any state, but also has an above average proportion of older age. This suggests that effects of migration on age distribution must also be considered.

In-migration and out-migration do not necessarily alter the age distribution of a county or state. If migration rates did not vary by age, then migration would affect the size of the population but not the age composition. However, migration rates almost always do vary with age. Out-migration from an area is predictably higher for young people than for older people. The tendency of young adults to migrate at higher rates than older people has been true across time and across cultures. In other words, there is almost no exception to the pattern of a declining propensity to migrate after the young adult years. Recent patterns of migration in the United States are consistent with this broad generalization. Between March of 1999 and March of 2000 it was eight times as likely for someone between twenty and twenty-four years of age to change place of residence as it was for someone age sixty-five or over (35.2 percent vs. 4.4 percent).

States (or counties) in which out-migration exceeds in-migration over a sustained period of time tend to have relatively old populations. Older people in these areas tend to *age in place,* while a disproportionate number of younger people move out. In recent decades, the areas that have experienced substantial net out-migration have been concentrated in the farm states of the Midwest and the declining industrial states of the Northeast. These two regions, as noted above, are the regions with the highest concentration of older people.

If a disproportionate number of migrants are young, one should anticipate that areas with substantial net in-migration would tend to have relatively young populations. This is the general pattern, and accounts for the below average proportion of older adults in the Sunbelt (which has gained population through migration in recent decades). But there is one major exception to this pattern: Florida. Florida has been such a magnet for older retirees who move out of the Northeast, that the in-migration rate for older people has exceeded that of younger people. Arizona and Oregon also have been magnets for older migrants, so despite high levels of total in-migration their populations are not especially young (Arizona ranked 22nd in percentage of population 65+ in 2000, and Oregon ranked 25th).

Retirement migration

As noted above, most older people age in place, and retirement migration is not a common experience. In any given year, only about 1 percent of the older population moves from one state to another (by comparison, about 6 percent of people in their twenties make an interstate move each year). Nevertheless, researchers have studied the motivations of those who move around the time of their retirement. Older migrants tend to mention several considerations as being important in deciding where to relocate. Compared to younger people, they express less concern about employment opportunities and more concern about cost of living. Thus, areas with low taxes and a low cost of services are, other things being equal, particularly attractive to retirees. Also important are location-specific amenities, such as warm weather, attractive environments (e.g., seashores or mountains), and good health care services and facilities. Areas that combine several of these attractive features are magnets for retirement migrants.

A good deal of attention has been given to the economic impact that retirement migrants have on the areas they move into. The conclusion has been that older migrants provide an economic boom to their destination communities. Those who make a retirement move tend to be healthy,

married, and have above average incomes. They thus contribute to the local community through their consumption and the taxes they pay, and they do not compete for the jobs that they help to create. Further, they do not draw heavily on local public service expenditures, such as schools. The health care expenses they have add to, rather than drain, local resources because they are paid for from Medicare, from other insurance policies, and out-of-pocket. Based on these findings, some argue that developing policies to attract retirees may be a good strategy for promoting economic growth in a community. Others note, however, that increasing the percentage of senior citizens in a community may alter local politics and decrease public support for public schools and other public services that older people seldom use.

Why people move in later life

Theories of why people voluntarily move start with the plausible assumption that individuals are motivated by a desire to improve (or maintain or minimize loss of) their quality of life. Job-related moves become less common in later life, while three other reasons for migration become more important. One reason is the desire to improve the quality of one's physical environment. With incomes coming from social security, pensions, and investments, older people have greater freedom than younger people to put a high priority on the physical amenities of potential destination communities. Moves for lifestyle reasons characterize recent retirees who move to a warmer climate or to an area with greater recreational opportunities. Studies find that retirement migrants often plan these moves long in advance and vacation at their destination community for several years before actually making the permanent move. Those who fit this description are often relatively affluent, healthy, and married. As noted above, these are the older migrants that some retirement communities actively seek because they bring economic resources into the community. Still, it is important to remember that most older people age in place—retirement migration to the Sunbelt is the exception.

A second reason for moving in later life is to improve the social environment by locating closer to children, grandchildren, or other kin. The motivation to move in order to increase potential social support is frequently stimulated by a life course transition that increases vulnerability, such as widowhood or declining health. Compared to those moving to improve physical amenities, people moving to strengthen support networks tend to be older, unmarried, and physically frail. An interesting illustration of these two types of moves is provided by comparing the stream of migrants from New York to Florida with the counterstream of migrants from Florida to New York. Those moving to Florida, compared to those moving back to New York, are more often married, healthy, young-old (65–75 years old), have a high income, and live independently. The plausible explanation for why vulnerable older people leave Florida to return to their former place of residence in the Northeast is that they are seeking to be nearer children and other kin who can provide support.

The third type of late life move, often involuntary and of a short distance, is to an assisted-living facility or nursing home. An increasing functional dependency and inability to live independently precede these generally dreaded moves. Making the decision to move to a nursing home is generally difficult, being the only choice left after other options have been exhausted. Moving to a nursing home is often the final move that an individual will make.

Snowbirds

Snowbirds is the term coined to identify older people who, like some birds, leave their usual residence in the north to settle in warmer settings during the winter. Reliable statistics on the magnitude of seasonal migration do not exist, but it is known that Florida, Arizona, Texas, and California have large populations of temporary residents during the winter. As cold temperatures arrive in October and November in the northern states, the snowbirds head south to live in RVs, mobile homes, apartments, condominiums, and second houses in the warmer climates. Additional snowbirds move from Canada—Statistics Canada has estimated that a quarter of a million Canadians reside in Florida during the winter months. These cyclical migrants between the North and the South may make the same journey between their summer and winter residences for many years.

Studies of snowbirds in their winter communities have found that these migrants tend to resemble retirement migrants in several ways—they are young-old, married, healthy, and

financially well-off. Although seasonal migrants do not tend to become involved in the larger communities of their winter residence, they do generate distinctive enclaves within their travel parks or condominium complexes. Life in these enclaves is characterized by a high degree of sociability, activity, and equality. The culture that develops in these subcommunities allows the snowbirds to feel at home, rather than to function as tourists or vacationers. Some snowbirds become permanent residents of their winter communities, but most do not.

Conclusion

In any particular year, older people are much less likely than younger adults to change their place of residence. Further, the annual proportion of people age sixty-five and over who make an interstate move has not increased since the mid–twentieth century, and in 2000 was only about 1 percent. The typical experience of older people is to age in the same community and in the same house that they lived in prior to reaching old age. When older people do make interstate moves, they often follow well-established streams of migration to particular destinations. Retirement migrants from the Northeast tend to settle in the South Atlantic states; those from the Midwest more often head to states in the Southwest. These retirement migrants tend to have a positive impact on the communities they move into.

PETER UHLENBERG

See also AGING IN PLACE; IMMIGRATION; LIVING ARRANGEMENTS; RETIREMENT COMMUNITIES.

BIBLIOGRAPHY

BEAN, F. D.; MYERS, G. C.; ANGEL, J. L.; and GALLE, O. R. "Geographic Concentration, Migration, and Population Redistribution Among the Elderly." In *Demography of Aging*. Edited by L. G. Martin and S. H. Preston. Washington, D.C.: National Academy Press, 1994. Pages 314–351.

FREY, W. H. "Elderly Demographic Profiles of U.S. States: Impacts of 'New Elderly Births,' Migration, and Immigration." *The Gerontologist* 35 (1995): 761–770.

GALE, L. R., and HEATH, W. C. "Elderly Internal Migration in the United States." *Public Finance Review* 28 (2000): 153–170.

HAZELRIGG, L. E., and HARDY, M. A. "Older Adult Migration to the Sunbelt: Assessing Income and Related Characteristics of Recent Migrants." *Research on Aging* 17 (1995): 209–234.

LONGINO, C. F. "Geographic Distribution and Migration." In *Handbook of Aging and the Social Sciences,* 5th ed. Edited by R. H. Binstock and L. K. George. San Diego: Academic Press, 2000. Pages 103–124.

LONGINO, C. F. *Retirement Migration in America*. Houston, Tex.: Vacation Publications, 1998.

MCHUGHES, K. E., and MINGS, R. C. "The Circle of Migration: Attachment to Place in Aging." *Annals of the Association of American Geographers* (1996): 530–550.

NEWBOLD, K. B. "Determinants of Elderly Interstate Migration in the United States, 1985–1990." *Research on Aging* 18 (1996): 451–476.

ROGERS, A. *Elderly Migration and Population Redistribution*. London: Belhaven Press, 1992.

SEROW, W. J. "Retirement Migration Counties in the Southeastern United States." *The Gerontologist* 41 (2001): 220–228.

SILVERSTEIN, M., and ZABLOTSKY, D. L. "Health and Social Precursors of Later Life Retirement-Community Migration." *Journal of Gerontology: Social Sciences* 51 (1996): S150–S156.

STOLLER, E. P., and LONGINO, C.F. "'Going Home' or 'Leaving Home'? The Impact of Person and Place Ties on Anticipated Counterstream Migration." *The Gerontologist* 41 (2001): 96–102.

U.S. Census Bureau. *The 65 Years and Over Population: 2000*. (Census 2000 Brief). Washington, D.C.: U.S. Government Printing Office, 2000.

U.S. Census Bureau. *Census 2000. Summary File 1*. World Wide Web document, 2001. www.census.gov

U.S. Census Bureau. *Current Population Reports: Geographic Mobility*. Washington, D.C.: U.S. Government Printing Office, 2001.

MITOCHONDRIA

Mitochondria are organelles found in the cytoplasm of all eukaryotic cells. They vary considerably in shape and size, but are all composed of four compartments: a smooth outer membrane, a convoluted inner membrane that forms recognizable structures called cristae, the intermembrane space, and the matrix. Mitochondria are the "powerhouses" of cells; their function is to convert energy found in nutrient molecules and store it in high-energy phosphate bonds in a molecule called adenosine triphosphate, which is the

universal energy-yielding component necessary for the reactions that modulate many fundamental cellular processes. Mitochondrial ATP is produced through the process of oxidative phosphorylation, a process that uses molecular oxygen as the final electron acceptor.

The products of metabolism are carried from the cytoplasm into the mitochondrial matrix, where they go through the citric acid, or Krebs cycle. The Krebs cycle promotes the reduction of the catabolism-generated coenzymes NAD^+ (nicotinamide adenine dinucleotide) and FAD (flavin adenine dinucleotide) to NADH and $FADH_2$, respectively, which are rich in electron energy. As these molecules are reoxidized, they supply electrons that are carried to final electron acceptor via an elaborate respiratory, or electron, transport chain. The electron transport system is a chain of electron acceptors located in the inner membrane of the mitochondria.

Hydrogens are passed down from NADH to the electron transport chain in a series of redox reactions, where they become dissociated from their electrons and are released as protons. The electrons entering the electron transport system have a relatively high energy content. As they are transferred from one acceptor molecule to the next, they lose much of their energy, some of which is used to pump the protons across the inner mitochondrial membrane. This sets up an electrochemical gradient across the inner mitochondrial membrane, which provides the energy for ATP synthesis. Therefore, the function of this chain is to permit the controlled release of free energy to drive the synthesis of ATP from ADP (adenosine diphosphate, formed from the breakdown of ATP) and inorganic phosphate. This oxidative phosphorylation process engages five respiratory-chain enzyme complexes located within the inner mitochondrial membrane. Four of these complexes—I (NADH dehydrogenase), II (succinate dehydrogenase), III (cytochrome-c reductase), IV (cytochrome-c oxidase)—catalyze the transport of electrons to molecular oxygen. Complex V (ATP synthase) uses the proton motive force to form ATP from ADP and inorganic phosphate. Oxygen is the final electron acceptor in the electron transport system, which is why organisms that respire aerobically require oxygen.

Mitochondria contain their own deoxyribonucleic acid (DNA). Each human cell contains several hundred mitochondria and thousands of copies of the mitochondrial genome (mtDNA). The human mtDNA molecule is a closed circular molecule and is 16,569 base pairs (bp) in length. Out of the thirty-seven mitochondrially encoded genes, thirteen encode polypeptides that are subunits of the respiratory chain enzyme complexes; twenty-two encode transfer RNA and two encode ribosomal RNA. The twenty-four genes that encode RNA are needed for mitochondrial protein synthesis.

Relationship of energy functions to cellular and organismic aging

Although oxygen plays an essential role as the terminal electron acceptor during respiration, oxygen and its metabolites are potentially cytotoxic (toxic to cells). During the course of normal oxidative phosphorylation, between 1 percent to 3 percent of all oxygen reduced by mitochondria escape from the electron transport chain into the mitochondrial inner membrane and are converted into reactive oxygen species (ROS) that have the ability to oxidize macromolecules. These oxidants, produced continuously as by-products of the anaerobic metabolic process, include superoxide (0_2^-), hydrogen peroxide (H_20_2), and hydroxyl radicals (HO^-) and are a continuous threat to cellular macromolecules—ROS attacks result in molecular defects found in proteins, lipids, and DNA. However, the damage to the cells is balanced by the existence of cellular enzymatic defenses, which have evolved to battle reactive oxygen species. Unfortunately, these defenses are not perfect, and, cellular macromolecules can become damaged. The accumulation of damaged macromolecules is thought to contribute significantly to aging.

In 1956, Denham Harman first proposed that free radicals play a major role in the aging process by causing cumulative macromolecule damage. Harman subsequently extended his theory and proposed that mitochondria are the major players in aging, since mitochondria are the major targets of free radicals (Harman, 1981). The free-radical theory of aging has gained a lot of support. Many age-correlated genetic data implicate mitochondrial dysfunction in the process of aging. Because of their vulnerability, the mitochondrial DNA molecules are particularly affected. In contrast to nuclear DNA, which is assembled in nucleosomes and protected by histones and other proteins, mtDNA is "naked," facilitating direct ROS attacks. In addition, mtDNA is attached to the inner mitochon-

drial membrane, and is therefore accessible by the by-products of respiration and a primer target for damage by ROS. Yakes and Van Houten (1997) have shown that the mtDNA damage is more extensive and persists longer than nuclear DNA damage in human cells following oxidative stress.

Age-related mitochondrial bioenergetic defects have also been reported in the electron transport chain and oxidative phosphorylation. Defective electron transport chains increase the production of mitochondrial free radicals, which in turn cause a further decline in mitochondrial functions, leading ultimately to a decline of the ATP level. Since a sufficient supply of ATP is necessary for life, the accumulation of bioenergetically defective cells is a key factor in the process of aging. Furthermore, during aging the ROS-scavenging enzymes decline, which further increases both free radicals and oxidative stress within the mitochondria.

Three different kinds of studies have been used to show that mitochondrial respiratory functions decline with age. First, histochemical analysis of respiratory enzymes has revealed an age-correlated deficiency in cytochrome-c oxidase (complex IV of the respiratory chain). This was first shown by Josef Müller-Höcker (1989) using cardiomyocytes in the human heart. Cox-deficient cardiomyocytes (heart muscle cells) are regularly present in humans beginning in the sixth decade of life. The second type of study, derives from measurements of enzymatic activities of each respiratory chain complex, as shown first by Yen et al. (1989) and Trounce et al. (1989). The third kind of study involves monitoring the changes of the mitochondrial membrane potential. The development of mitochondrial fluorescent indicators and sophisticated fluorescence microscopy has enabled organellar events to be studied (Smiley et al., 1991). As explained above, the energy released during oxidation reactions in the mitochondrial respiratory chain is stored as an electrochemical gradient consisting of transmembrane electrical potential. Since maintenance of membrane potential is essential for ATP synthesis, the decline seen in mitochondrial membrane potential is a good indicator of mitochondria malfunction.

Potential role of DNA damage and DNA mutations

What happens to the mitochondrial genome as it gets older has now been extensively studied and documented. It is known that mtDNA mutations can compromise the mitochondria function in many ways: they can disrupt both transcription and the translation of encoded proteins; they can produce nonfunctional ribosomal RNA, (RNA), transfer RNA (+RNA) and proteins; and they can impair mtDNA replication. The mitochondrial genome has a great ability to mutate during the life span, producing a heterogeneous array of somatic mutations. The mutation rate for the mitochondrial genome is ten to twenty times larger than for nuclear DNA study by Khrapko et al. (1997) showed a several-hundred-fold higher rate of somatic mutations both in vivo and in vitro in human mtDNA than in nuclear DNA. This increased rate is due to both a high spontaneous mutation rate and the sensitivity of the mitochondrial genome to exogenous environmental mutagens. Five different types of mtDNA mutations have been shown to be age-associated: point mutations, deletions, additions, duplications and rearrangements. One problem that has been raised by some experts concerning studies of the age-related accumulation of specific mutations in human mtDNA is that although the level of a specific mtDNA mutation increases substantially with age, any of these age-associated mutations affects no more than 1 percent of the organelle mtDNA molecules. However, a large number of specific mutations are likely to occur at each of the 16,569 nucleotide positions within the mitochondrial genome during a lifetime, so that even if each mutation is found at a low level, the increasing accumulation of a large number of mutations will eventually reach a critical level, leading to nonfunctional mitochondria. Furthermore, the load of mtDNA mutations is usually underestimated, since most of the mutations are only detectable using the polymerase chain reaction (PCR). This technique, routinely used to estimate the relative proportions of age-associated mutant DNA may give biased results, as it is dependent on the choice of primers and PCR conditions selected by the individual conducting the study.

One of the most reported mtDNA mutations is the so-called common deletion. Initially identified by Cortopassi and Arnheim (1990), the accumulation of mtDNA molecules exhibiting a 4,977 base pairs deletion increases with age. This deletion occurs between two thirteen base pairs sequence repeats, removing almost five kilobase pairs of mtDNA that encodes six essential polypeptides of the respiratory chain as well as five

tRNAs. This deletion was subsequently shown by many other investigators to increase with age in many different tissues. Many other age-associated mtDNA mutations have been identified Khrapko et al. (1999) used long PCR techniques in single cell cardiomyocyte from elderly patients to show that multiple mutations coexist in various tissues of aged individuals and that single mutations occur within individual cells. A large age-dependent accumulation of specific mutations in a critical control region for mtDNA replication has been shown in human fibroblasts (Michikawa et al., 1999).

The incidence of mutant mtDNA has been found to correlate with oxidative damage to mtDNA. Adachi et al. (1993) provided the first evidence that ROS is responsible for the occurrence of mtDNA deletions. A large number of DNA base modifications resulting from oxidative stress have been reported—the one that has been the most widely studied is oxidized nucleotide 8-OH-dG (8-hydroxy-deoxyguanosine). This specific product of oxidative damage to DNA has been shown to accumulate with age, and it correlates with an increase of mtDNA 7.4 kilobase pairs deletion (Mecocci et al., 1993).

As mitochondrial respiration and oxidative phosphorylation gradually uncouple from each other, the activity of the mitochondrial respiratory chain gradually declines. The immediate consequence of a decline of respiratory functions is a decline of ATP synthesis, which will further elevate ROS generation. As the production of ROS species in mitochondria increases, the oxidative damage is reflected by an increasing number of mtDNA mutations. Therefore, respiratory enzymes will incorporate the defective mtDNA-encoded subunits and show impaired respiratory function. This vicious circle operates in an age-dependent manner and plays an important role in aging. This scenario can be also amplified by exogenous factors—many types of mtDNA mutations occur more frequently in sun-exposed skin and mtDNA deletions in the human lung are significantly increased by cigarette smoking, suggesting that ROS resulting from environmental factors play a role in promoting mtDNA damage during aging. Although the mitochondrial free-radical theory of aging has gained prominence, it is important to remember that aging is a multifactorial biological process and that many other cellular components are involved.

Ultrastructural changes are also seen in the mitochondria of aged individuals. The mitochondria become larger and less numerous and they exhibit vacuolization, cristae rupture, and accumulations of occlusions.

CHRISTIANE FAURON

See also CELLULAR AGING; DNA DAMAGE AND REPAIR; THEORIES OF BIOLOGICAL AGING: DNA DAMAGE; THEORIES OF BIOLOGICAL AGING: ERROR CATASTROPHE.

BIBLIOGRAPHY

ADACHI, K.; FUJIURA, Y.; MAYUMI, F.; NOZUHARA, A.; SUGIU, Y.; SAKANASHI, T.; HIDAKA, T.; and TOSHIMA, H. "A Deletion of Mitochondrial DNA in Murine Doxorubicin-Induced Cardiotoxicity." *Biochemistry Biophysics Research Communication* 195 (1993): 945–951.

ANDERSON, S.; BANKIER, A. T.; BARRELL, B. G.; DE BRUIJN, M. H.; COULSON, A. R.; DROUIN, J.; EPERON, I. C.; NIERLICH, D. P.; ROE, B. A.; SANGER, F.; SCHREIER, P. H.; SMITH, A. J.; STADEN, R.; and YOUNG, I. G. "Sequence and Organization of the Human Mitochondrial Genome." *Nature* 290 (1981): 457–465.

BITTLES, A. H. "The Role of Mitochondria in Cellular Ageing." In *Human Ageing and Later Life*. Edited by A. M. Warnes. London: Edward Arnold, 1989. Pages 22–37.

BROWN, W. M.; GEORGE, M. J.; and WILSON, A. C. "Rapid Evolution of Animal Mitochondrial DNA." *Proceedings of the National Academy of Science, U.S.A.* 76 (1979): 1967–1971.

CORTOPASSI, G. A., and ARNHEIM, N. "Detection of a Specific Mitochondrial DNA Deletion in Tissues of Older Humans." *Nucleic Acids Research* 18 (1990): 6927–6933.

FAHN, H. J.; WANG, L. S.; KAO, S. H.; CHANG, S. C.; HUANG, M. H.; and WEI, Y. H. "Smoking-Associated Mitochondrial DNA Mutations and Lipid Peroxidation in Human Lung Tissues." *American Journal of Respiratory Cellular and Molecular Biology* 19 (1998): 901–909.

HARMAN, D. "Aging: A Theory Based on Free Radical and Radiation Chemistry." *Journal of Gerontology* 11 (1956): 298–300.

HARMAN, D. "The Aging Process." *Proceedings of the National Academy of Science, U.S.A.* 78 (1981): 7124–7128.

KHRAPKO, K.; BODYAK, N.; THILLY, W. G.; VAN ORSOUW, N. J.; ZHANG, X.; COLLER, H. A.; PERLS, T. T.; UPTON, M.; VIJG, J.; and WEI, J. Y. "Cell-By-Cell Scanning of Whole Mitochondrial Genomes in Aged Human Heart Reveals a Significant Fraction of Myocytes with Clonally Expanded Deletions." *Nucleic Acids Research* 27 (1999): 2434–2441.

KHRAPKO, K.; COLLER, H. A.; ANDRE, P. C.; LI, X. C.; HANEKAMP, J. S.; and THILLY, W. G. "Mitochondrial Mutational Spectra in Human Cells and Tissues." *Proceedings of the National Academy of Science, U.S.A.* 94 (1997): 13798–13803.

MECOCCI, P.; MACGARVEY, U.; KAUFMAN, A. E.; KOONTZ, D.; SHOFFNER, J. M.; WALLACE, D. C.; and BEAL, M. F. "Oxidative Damage to Mitochondrial DNA Shows Marked Age-Dependent Increases in Human Brain." *Annals of Neurology* 34 (1993): 609–616.

MICHIKAWA, Y.; MAZZUCCHELLI, F.; BRESOLIN, N.; SCARLATO, G.; and ATTARDI, G. "Aging-Dependent Large Accumulation of Point Mutations in the Human mtDNA Control Region for Replication." *Science* 286 (1999): 774–779.

MÜLLER-HÖCKER, J. "Cytochrome C Oxidase Deficient Cardiomyocytes in the Human Heart, an Age-Related Phenomenon." *American Journal of Pathology* 134 (1989): 1167–1173.

PANG, C. Y.; LEE, H. C.; YANG, J. H.; and WEI, Y. H. "Human Skin Mitochondrial DNA Deletions Associated With Light Exposure." *Archives Biochemistry Biophysics* 312 (1994): 534–538.

RICHTER, C. H.; PARK, J. W.; and AMES, B. N. "Normal Oxidative Damage to Mitochondrial and Nuclear DNA is Extensive." *Proceedings of the National Academy of Science, U.S.A.* 85 (1988): 6465–6467.

SMILEY, S. T.; REERS, M.; MOTTOLA-HARTSHORN, C.; LIN, M.; CHEN, A.; SMITH, T. W.; STEELE, G. D. J.; and CHEN, L. B. "Intracellular Heterogeneity in Mitochondrial Membrane Potentials Revealed by a J-Aggregate-Forming Lipophilic Cation JC-1." *Proceedings of the National Academy of Science, U.S.A.* 88 (1991): 3671–3675.

SOHAL, R. S.; SOHAL, B. S.; and BRUNK, U. T. "Relationship Between Antioxidant Defenses and Longevity in Different Mammalian Species." *Mechanisms of Ageing and Development* 53 (1990): 217–227.

TROUNCE, I.; BYRNE, E.; and MARZUKI, S. "Decline in Skeletal Muscle Mitochondrial Respiratory Chain Function: Possible Factor in Ageing." *The Lancet* 1 (1989): 637–639.

YAKES, F. M., and VAN HOUTEN, B. "Mitochondrial DNA Damage Is More Extensive and Persists Longer Than Nuclear DNA Damage in Human Cells Following Oxidative Stress." *Proceedings of the National Academy of Science. U.S.A.* 94 (1997): 514–519.

YEN, T.-C.; CHEN, Y.-S.; KING, K.-L.; YEH, S.-H.; and WEI, Y.-H. "Liver Mitochondrial Respiratory Functions Decline With Age." *Biochemical and Biophysical Research Communications* 165 (1989): 994–1003.

MODERNIZATION THEORY

See STATUS OF OLDER PEOPLE: TRIBAL SOCIETIES; THEORIES, SOCIAL

MOLECULAR BIOLOGY OF AGING

Molecular biology can be loosely defined as the study of biology at the molecular level. However, the term is usually used in a more limited sense to mean the study of macromolecules such as proteins, DNA, and RNA, and their specific roles in living systems. This use of the term came into being in the 1960s, largely as the result of the elucidation of the structure of DNA in 1953, and the realization, beginning in 1961, of how this structure encodes information for synthesizing proteins. These findings made it possible to turn the emphasis in biochemistry away from elucidating metabolic pathways in cells, and towards understanding how chromosomes direct and regulate the functioning of the cell. The next breakthroughs arrived through the development of technologies to isolate and sequence specific genes through gene cloning—made possible by the discovery, characterization, and use of special enzymes, that break DNA only at very specific sites.

The application of molecular biology to the study of aging did not begin in earnest until the 1980s. Most early research on aging focused on developing animal models for studying aging, describing various aging processes, and characterizing age-related changes in both humans and animal models. Of particular interest was the need to identify and quantitate age-related changes in gene expression. This became possible once genes could be cloned and used as probes to measure the amount of specific messenger RNA molecules present in the cell under any given condition, such as a specific age, nutritional status, or disease status. Such measurements provide information about the rate of transcription of any given gene into messenger RNA, as well as the rate of translation of this RNA into protein. For example, this technology has been used to identify age-related changes in liver gene expression, and to determine which of these changes are delayed by caloric restriction,

an intervention known to slow down aging and extend both mean and maximum life span in rodents.

The ability to measure the relative quantities of specific messenger RNA molecules in the cell made a quantum leap forward in the late 1990s with the development of technologies to carry out this analysis using fluorescent tags and thousands of gene probes attached to small glass plates or filters. These *microarrays* are able to do thousands of measurements in a single experiment, and thus markedly speed up the rate of research.

The ability to clone genes and manipulate DNA sequences led also to a new approach to understanding how genes function in cells through the creation of genetically altered mice. This area of research is now called *functional genomics.* Rather than relying on random mutation to generate interesting mutants, the early 1990s saw the exploitation of techniques for introducing new genes into mice and overexpressing these genes. Alternatively, genes, or parts of genes, can be "knocked out" to look at the impact of loss of expression of any given gene or part of a gene. This has been of particular importance in developing mouse models of age-related human diseases and syndromes such as Alzheimer's disease, Huntington's disease, amyotrophic lateral sclerosis, Werner's syndrome, and muscular dystrophy. Genetically altered mice are also useful for studying normal cell function. For example, the introduction and continued expression of the telomerase gene in human cells in culture was shown to prevent the proliferation block that normally occurs after about fifty to eighty cell divisions of human cells, thereby showing that telomere shortening could cause this replicative senescence. An important remaining challenge is to develop better strategies for turning these transgenes "on" and "off" at will.

Finally, it is now known through gene sequencing studies that some base differences occur frequently in human DNA, and these are called *single nucleotide polymorphisms* (SNPs). SNPs presumably occur in all genes as frequently as one per thousand base pairs of DNA. Thus, different individuals contain varying amounts of slightly different forms of any given gene; these different forms of genes are called *alleles.* The best example of this is the human apolipoprotein E gene, of which there are at least three major alleles: apoE2, apoE3, and apoE4. The frequency of these three alleles in any given population varies with age, suggesting that certain alleles are risk factors for aging, presumably by increasing susceptibility to age-related diseases. For example, the E4 allele of the apoE gene increases the risk for developing Alzheimer's disease. It is suspected that the existence of these SNPs in critical genes at varying frequencies in each individual is at least partly responsible for the very different aging patterns seen among individuals in a population. Examples of critical genes might include genes for DNA repair enzymes, antioxidant enzymes, tumor suppressor proteins, and signal transduction proteins.

The highly mutable human mitochondrial genome is known to contain at least eleven different SNPs, but it is not yet known how these SNPs impact aging. Mitochondrial mutations and SNPs have been implicated in a wide range of age-related pathologies and diseases in humans, including deafness, muscle weakness, diabetes, and cardiomyopathy. Determining the frequency and biological impact of mitochondrial SNPs and other SNPs in human populations promises to be an intense area of research in the twenty-first century.

HUBER R. WARNER

See also CELLULAR AGING; DNA DAMAGE AND REPAIR; GENETICS; MITOCHONDRIA; THEORIES OF BIOLOGICAL AGING.

BIBLIOGRAPHY

LANDER, E. S. "The New Genomics: Global Views of Biology." *Science* 274 (1996): 536–539.

RICHARDSON, A.; HEYDARI, A. R.; MORGAN, W. W.; NELSON, J. F.; SHARP, Z. D.; and WALTER, C. A. "The Use of Transgenic Mice in Aging Research." *ILAR Journal* 38 (1997): 124–136.

YOUNG, R. A. "Biomedical Discovery with DNA Arrays." *Cell* 102 (2000): 9–15.

MOLECULAR THERAPY

Molecular therapy comprises methods to provide a needed gene product to a patient, with the intent to produce a desired effect on health. Genetically engineered viruses can be used to deliver genes to cells in the body, and the cells that receive the gene then synthesize the protein that the gene encodes. Alternatively, in a cell-based form of gene therapy, termed *ex vivo gene therapy,*

the patient receives cells that have been engineered to produce the required gene product. No forms of gene therapy are currently in use for the treatment of aging and age-related diseases, but it is widely anticipated that these medical technologies will be used to treat age-related diseases in the future. This article describes the possible types of therapies that could be used, and their limitations and potentials.

Possible molecular therapies to alter maximal life span

The treatment of age-related diseases must be distinguished from attempts to change the aging process per se. By definition, aging comprises those processes that ultimately limit life span by affecting all individuals within a population. On the other hand, diseases of aging are specific pathological processes that affect the older individuals within a population, but nevertheless can be separated from aging because not all individuals are affected and because there are other causes of the disease in addition to age itself.

The development of therapies for aging per se, leading to life span extension or immortality, is a popular theme in literature—the "fountain of youth". The idea that such a therapy might at some point be applicable to humans has been strengthened by recent findings that genetic changes in other organisms can lead to substantial increases in maximal life span. For example, in the nematode *Caenorhabditis elegans* and in the fruit fly *Drosophila melanogaster,* mutations of genes have been discovered that cause substantial extensions of life span. In the mouse there are several examples of life span extension by the inactivation of single genes. Particularly noteworthy are the large extensions in life span that result from inactivation of any of a group of genes that affect body size, including growth hormone and other genes of the growth hormone axis. These genetic changes affect maximal life span and not average life span. The maximal life span of a species is the length of life of individuals of that species under circumstances in which they do not die prematurely due to predation, starvation, or specific disease processes such as infections or cancer. It is usually thought that maximal life span changes very slowly over evolutionary time, whereas the average life span achieved by individuals within a population can change rapidly over historical time. It is also relevant to consider here that maximal life span in rodents can be extended by a nongenetic manipulation, caloric restriction; the lifetime feeding of substantially reduced calories robustly leads to an extension of maximal life span.

It is a simple extrapolation from these results in other organisms to suggest that the manipulation of the same genetic processes in humans would lead to similar extensions of life span. However, it is not clear that the potential for manipulation of life span exists in humans as it does in rodents, *C. elegans,* and *Drosophila.* If a single gene mutation can cause extension of life span in the mouse, why is this genotype a mutant and not the wild type? The answer must lie in the concept of *antagonistic pleiotropy*, i.e., the gene must provide a benefit to the animal in early life, such as increased reproduction or increased fitness for survival in the wild, despite conferring a shorter overall life span. A mutation in such a gene then confers longer life, but will have a trade-off in the form of some negative effect in early life, which might not even be apparent under laboratory conditions. The presence of such genes in the genome requires that the species has experienced recent evolutionary selection pressure to change from slower reproduction/longer life span toward rapid reproduction/shorter life span. The present-day life history of many rodent species is consistent with this assumption. Because of cyclical variations in food supply, the population must be able to undergo rapid increases when food is plentiful, in order to allow for decreases later, as food becomes scarce. Similarly, the modulation of life span by caloric restriction in rodents may reflect a switch between two physiological states—one with slower reproduction/longer life span and one with rapid reproduction/shorter life span. In rodents, and in short-lived species generally, maximal life span has evolved to an optimum that is neither longer nor shorter than is required by the demands of their life history. From an anthropocentric viewpoint it may be difficult to understand that a shorter life span in some species may be a recently evolved, more "advanced," state. An analogy is provided by the existence of cave-dwelling fishes that have no eyes as adults. In the laboratory, such species can be made to develop almost normal eyes. The loss of eyes is a recent evolutionary event, and the genome retains almost full capacity for normal eye development. Similarly, rodents and other short-lived species may have evolved from ancestors that were longer-lived,

and therefore may retain in their genome the potential for a longer life span, which is normally latent until genetic or other manipulations reveal it.

However, the same is probably not true of humans as a species. There is no evidence that the current maximal life span of humans is in some way a compromise between a potentially longer life span with less reproduction and a shorter life span with greater reproduction. In fact, *Homo sapiens* represents an extreme of longevity among mammals, even among primates. Therefore, it is unlikely that a mutation in a human gene could lead to a dramatic extension in maximal life span. It follows that it would be unlikely that a molecular therapy could be developed that extends human life span either by germ-line manipulation (which would also raise severe ethical questions) or by a somatic process that has an effect equivalent to inactivating a gene (such as antisense RNA, which inactivates the normal RNA product of a gene, or dominant negative proteins, which bind normal proteins and prevent them from activity).

Another approach to changing the rate of aging would be to devise therapies to counteract known or suspected molecular aging processes. For example, in very old persons telomere shortening may compromise the potential for extensive cell division in the hematopoietic (blood-forming) system. It is possible that preventing this by introduction of telomerase reverse transcriptase (TERT), a gene that is not expressed in most somatic cells, might improve immune function or prevent some types of anemia. Other possibilities include new therapies based on enzymes designed to repair or prevent molecular damage. For example, one form of molecular damage that accumulates in aging, and is thought to be a contributing factor to many age-related pathologies, is the formation of advanced glycation end products (AGE: complex reaction products of proteins with sugars and oxygen). It may be possible to devise a form of gene therapy to eliminate these molecules. However, therapies based on reversal and prevention of molecular damage would require solutions to many problems, such as at what age the therapy would have to begin; what fraction of the overall damage in the body would need to be prevented to have an effect on tissue and organ function; and whether, even if the therapy were successful, it would have any effect on maximal life span.

This analysis suggests that finding molecular therapies that produce substantial increases in maximal human life span would be very difficult, principally because our genomes do not harbor latent mechanisms for increased longevity; to put it another way, our genes are already fine-tuned for maximal life span. This is not to say that such therapies are inherently impossible. Understanding the mechanisms for life span extension in rodents and other species, including the molecular basis for the action of caloric restriction in modulating life span, may enable the development of new therapies, but at the present time it seems equally possible that no therapy that actually affects the rate of aging per se in humans would be possible.

Molecular therapies for age-related diseases

Realistic forms of gene therapy that are likely to be applied in the near future are those that affect diseases of aging rather than aging processes. Some of the potential future therapies are listed in Table 1, but this is not a comprehensive list. Because these therapies have the aim of restoring normal health by correcting an abnormal condition, and do not involve germ-line manipulations, they do not have the ethical problems associated with attempting to change maximal life span. Some of these therapies are close to being used in human subjects, having been successfully demonstrated in experimental animals. The idea of using gene therapy is especially attractive for chronic diseases in which current forms of medication must be administered frequently, often several times per day; compliance with such regimens is a problem, especially for older people. There is an obvious advantage to replacing drug therapy with a form of molecular therapy if the effects are equivalent. Moreover, for many diseases of older individuals, present treatments are inadequate or nonexistent, making the development of new therapies very desirable.

Since the beginning of gene therapy as an idea, different delivery methods have been developed in parallel, without any one of them eclipsing the others, and the existence of multiple strategies for gene delivery is likely to persist in the foreseeable future. Different genes may require different delivery methods for optimal effects. Several recombinant (genetically engineered) viruses can be used as vectors (i.e., carriers of genes). Adenovirus-mediated gene

Table 1
Proposed gene and cell therapies applicable to age-related diseases.

Disease process	Genes (delivered by viral or nonviral vectors, or by genetically modified cells)
Anemia (renal disease or other causes)	Erythropoietin
Stroke	Neurotrophins (e.g., nerve growth factor, NT-3, epidermal growth factor, fibroblast growth factor-2 (FGF-2)); chaperones (e.g., heat shock protein 72); anti-apoptotic proteins (e.g., Bcl2); inhibitors of inflammatory cytokines (e.g., interleukin-1 receptor antagonist protein (IL-1ra))
Neurodegenerative diseases (Alzheimer's disease, Parkinson's disease)	As for stroke; also enzymes of neurotransmitter biosynthesis (e.g., tyrosine hydroxylase)
Growth hormone deficiency	Growth hormone, growth hormone secretagogues
Muscle loss and weakness	Insulin-like growth factor-I
Congestive heart failure	Calcium adenosine triphosphatase of the sacroplasmic reticulum (SERCA2a), adrenergic receptors
Coronary artery disease	Angiogenic factors (e.g., vascular endothelial growth factor, FGF-2)
Peripheral artery disease (atherosclerosis, complications of diabetes)	Nitric oxide synthase, angiogenic factors
Diabetic retinopathy	Anti-angiogenic factors (e.g., endostatin, angiostatin)
Type II diabetes	Glucose transporters
Osteoporosis, fractures	Osteogenic factors (e.g., bone morphogenetic proteins, parathyroid hormone, FGF-1)
Rheumatoid arthritis, Osteoarthritis	Thymidine kinase (as suicide gene for synovial lining cells); inhibitors of inflammatory cytokines (e.g., IL-1ra); inhibitors of matrix degrading enzymes (e.g., tissue inhibitors of metalloproteinases)
Chronic skin ulcers	Growth factors (e.g., platelet-derived growth factor), angiogenic factors
	Cells (as stem cells or differentiated cells, may be genetically modified)
Joint degeneration caused by arthritis	Chondrocytes
Chronic skin ulcers	Keratinocytes, fibroblasts
Stroke, neurodegenerative diseases	Neurons
Myocardial infarction	Myocytes
Type II diabetes	Pancreatic ß-cells
Age-related macular degeneration	Retinal pigmented epithelial cells
Osteoporosis	Osteoblasts

SOURCE: Author

delivery has been used successfully in young individuals, and has the advantage of very efficient delivery to nondividing cells, particularly the liver. However, earlier generations of adenovirus vectors were highly immunogenic, leading to dangerous patient reactions. These problems appear to have been solved in later generations of these vectors, but all adenoviruses exert a therapeutic effect only over a short time. Longer-term effects have been achieved with vectors based on the adeno-associated virus (AAV) and the herpes simplex virus, and with lentivirus vectors based on components of HIV (human immunodeficiency virus). These vectors can infect nondividing cells, and their genetic material becomes stably integrated into the infected cell's DNA. Vectors based on other retroviruses, such as mouse leukemia virus, can be used only to infect dividing cells, and so have not been particularly successful in in vivo applications, but they can be very useful in ex vivo cell modification. Gene delivery can also be accomplished without the use of viruses. Nonviral DNA delivery suffered until recently from a lack of efficiency, making it im-

practical, but trials of newer versions of liposomes have been very promising. Nonviral vectors could be just as efficient as viruses and could obviate the problems associated with viruses—not only side effects but also public acceptance of the therapy, especially for the treatment of diseases that are not immediately life-threatening.

An inherent problem with the use of viral and nonviral vectors is the difficulty of ensuring that the gene is delivered to the appropriate number of the patient's cells. The number of cells infected, and hence the amount of product delivered, is hard to control. A second major problem is maintaining long-term gene product delivery, so as to avoid the necessity for repeated administration of the vector. Another concern is that because gene therapy either intentionally modifies cells of the body (introduces genes into the host genome) or has the potential for accidental permanent genetic modification, expression of endogenous genes in the modified cells could be altered, potentially causing the cells to become cancerous. A concern that is of more importance in young patients is that germ-line cells will be unintentionally modified. More generally, it may be undesirable to create the potential for continued production of the gene product in cases where only temporary delivery is required. These concerns are less important in critically ill patients, of course, but must be satisfactorily addressed before these forms of gene therapy are widely adopted.

Cell-based delivery, or ex vivo gene therapy, uses genetically modified cells as the gene product delivery system. In this method, possible unintended alterations in gene expression can be tested before the cells are used. There is no potential for accidental germ-line modification. However, two disadvantages to cell-based therapy are that introduction of the cells into the patient requires a surgical procedure, and that cells must be protected from immune rejection. The cell transplantation procedure may require only minor surgery, however, and in some sites in the body the cells could be removed after their task is completed. In other sites into which they might be transplanted, such as the brain, implantation would be intended to be permanent. Immune rejection is the most severe problem, especially if cells are derived from nonhuman animals (e.g., cows or pigs). Although the problems of rejection of xenotransplants are substantial, great progress has been made in understanding the host response and modulating it so as to improve long-term graft acceptance. Immune rejection could also be avoided by encapsulation, so that cells are physically protected from host immune cells. Most promising is the prospect of genetically modifying cells so that they are "invisible" to the host immune system. Alternatively, the patient's own cells could be used in ex vivo gene therapy, but such customized cell therapy would be much more expensive than using "off-the-shelf" cell lines, and the time involved in preparing the cells would prevent this method from being used in diseases where treatment is needed urgently.

The cell types that could be used in cell-based therapies are those that can act as vehicles for a variety of gene products (such as myoblasts and keratinocytes) or those intended to directly replace or restore damaged tissues (such as neurons and chondrocytes). In the latter case various forms of stem cells could be used. Recent advances in stem cell biology, such as the isolation and characterization of human embryonic stem cells, neural stem cells, and mesenchymal stem cells, have brought therapy based on these cell types closer to reality.

Because of the large expansion of the cell population needed in culture, any cell type used in cell therapy must avoid the shortening of telomeres that limits the proliferative potential of somatic cells. Many forms of stem cells are normally telomerase positive, but cells that are not telomerase positive will require genetic modification to prevent telomere shortening. This could be done by introduction of the telomerase reverse transcriptase gene, thereby producing "telomerized" cells. A concern about the use of telomerized cells is that they might have a propensity to undergo neoplastic conversion, but experiments on transplantation of telomerized cells in experimental animals have shown that they produce normal tissue. Another method that has been proposed is to take advantage of the fact that nuclear transfer, the passage of a nucleus and its progeny through the environment of the fertilized egg and early embryo, can restore telomere length when this process is used on cells with short telomeres (senescent cells).

It is important to realize that the same goal (restoration of healthy tissue and prevention of further damage) can potentially be achieved by two forms of cell therapy. In the first, gene products are delivered from transplanted cells and act to affect the behavior of host cells; in the second,

the transplanted cells themselves replace the function of the host tissue. Both strategies would be applicable to the treatment and prevention of age-related diseases (see Table 1).

A full treatment of the possible uses of stem cells in human medicine is beyond the scope of this entry. Also not covered are other important topics within the fields of tissue engineering and regenerative medicine, such as the concept of growing or constructing entire organs in vitro, as a source of organs for transplantation, or the production of transgenic "humanized" animals (principally pigs) as a source of organs. In addition, some important molecular therapies are not covered, such as the use of gene therapy in cancer treatment, and possible therapies that use stimulation of the immune system to provide a protective response against the accumulation of damaged molecules, such as β-amyloid in Alzheimer's disease.

Since the beginning of gene therapy as a concept, it has been repeatedly predicted that the use of gene and cell therapy will have a major impact on human medicine, and the fact that no forms of these therapies are yet routine could be viewed as a failure of this technology. However, it must be remembered that most of the great advances in medicine did not find a place in everyday clinical practice for many years after their discovery. More than fifteen years passed between the discovery of penicillin and its routine use in treatment of infectious diseases. There is every reason to believe that gene and cell therapies will play significant roles in treatment of chronic diseases in the elderly, but therapies that aim to alter human aging and change maximal life span are unlikely in the foreseeable future.

PETER HORNSBY

See also AGE-RELATED DISEASES; CELLULAR AGING: TELOMERES; GENETICS; MOLECULAR BIOLOGY OF AGING; MUTATION.

BIBLIOGRAPHY

ANDERSON, W. F. "Human Gene Therapy." *Nature* 392 supp. (1998): 25–30.

BARTKE, A.; BROWN-BORG, H. M.; BODE, A. M.; CARLSON, J.; HUNTER, W. S.; and BRONSON, R. T. "Does Growth Hormone Prevent or Accelerate Aging?" *Experimental Gerontology* 33 (1998): 675–687.

BREVIG, T.; HOLGERSSON, J.; and WIDNER, H. "Xenotransplantation for CNS Repair: Immunological Barriers and Strategies to Overcome Them." *Trends in Neuroscience* 23 (2000): 337–344.

DENG, S., and BRAYMAN, K. L. "Gene Therapy Strategies to Facilitate Organ Transplantation." *Molecular Medicine Today* 5 1999): 400–405.

GAGE, F. H. "Cell Therapy." *Nature* 392 supp. (1998): 18–24.

HARLEY, C. B. "Human Aging and Telomeres." *Ciba Foundation Symposium* 211 (1997): 129–139.

HORNSBY, P. J. "Cell Transplantation and Aging." *Generations* 24 (2000): 54–57.

KENYON, C. "Ponce d'Elegans: Genetic Quest for the Fountain of Youth." *Cell* 84 (1996): 501–504.

KIRKWOOD, T. B. L., and ROSE, M. R. "Evolution of Senescence: Late Survival Sacrificed for Reproduction." *Philosophical Transactions of the Royal Society of London* B332 (1991): 15–24.

LANGER, R., and VACANTI, J. P. "Tissue Engineering." *Science* 260 (1993): 920–926.

MARTIN, G. M. "Genetics and the Pathobiology of Ageing." *Philosophical Transactions of the Royal Society of London* B352 (1997): 1773–1780.

OZAWA, C. R.; SPRINGER, M. L.; and BLAU, H. M. "Ex Vivo Gene Therapy Using Myoblasts and Regulatable Retroviral Vectors." In *Gene Therapy: Therapeutic Mechanisms and Strategies*. Edited by N. S. Templeton and D. D. Lasic. New York: Marcel Dekker, 2000. Pages 61–80.

TEMPLETON, N. S., and LASIC, D. D. "New Directions in Liposome Gene Delivery." *Molecular Biotechnology* 11 (1999): 175–180.

VERMA, I. M., and SOMIA, N. "Gene Therapy—Promises, Problems and Prospects." *Nature* 389 (1997): 239–242.

MORTALITY

Genes are the ultimate time travelers. They transcend the bounds of time by hitching a ride in sexually reproducing species such as humans, but then discard the human body later in life as if it was a used car that had passed its warranty period. Once immortality became a fundamental property of deoxyribonucleic acid (DNA), at some time in the distant history of life on earth, the carriers of these genetic codebooks for constructing living organisms, including humans and other sexually reproducing species, became disposable. The timing with which death occurs—both for individuals, as measured by their lifespan, and collectively for populations, as mea-

sured by life expectancy—defines the concept of mortality.

Although it is not possible to know with certainty when any single individual will die, it is known with surprising accuracy when death occurs for members of a population when viewed as a group. In humans and a large number of other species, scientists have demonstrated that the risk of death is highest just after birth, declines to its lowest point near the time of sexual maturation (puberty), and then increases exponentially until extreme old age.

Why is this age pattern of death so common among sexually reproducing species? Early in life, death rates are high because newborns are subject to mortality risks from infectious and parasitic diseases, predation, and congenital malformations. Puberty is the time of lowest mortality because, from an evolutionary perspective, this is the moment at which the investment in the next generation has reached its maximum. This implies that the body design of humans and other living things are constructed with the ultimate goal of reproduction in mind (e.g., the passage of genes from one generation to the next), so this time of life is the most highly protected of all times in the life span. Following puberty, the risk of death from intrinsic (aging-related) causes increases exponentially because of a combination of wear and tear to the physical components of the body; accumulated damage to DNA, cells, tissues, and organs, highly efficient but nevertheless imperfect maintenance and repair mechanisms; and because of the presence of lethal inherited genes that "leak" into the gene pool of every generation.

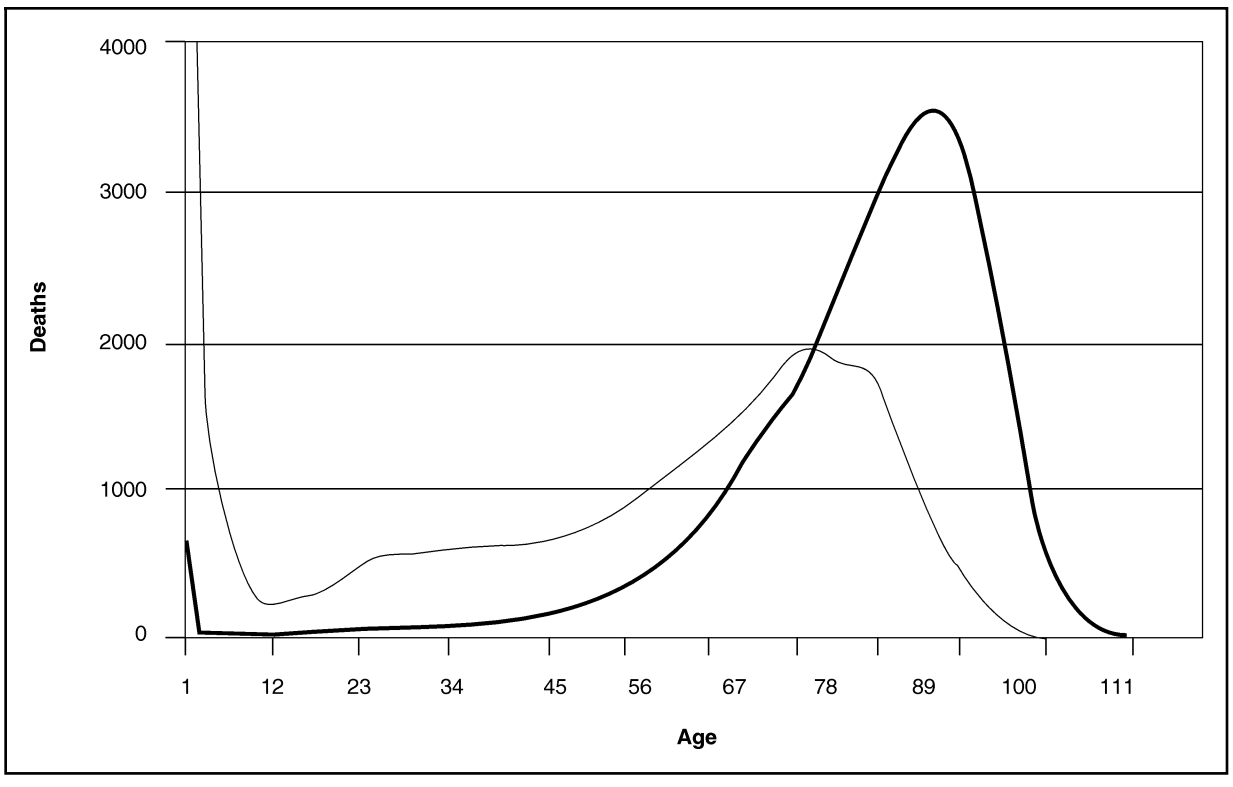
Scientists have demonstrated that the rate of increase in the death rate following puberty is often calibrated to the length of each species' reproductive window, which is the average duration of time that elapses between puberty and menopause. In other words, animals like mice that experience puberty within weeks after birth tend to age much more rapidly and live considerably shorter lives than sea turtles, which do not experience puberty until about fifty years after birth. As a result of these differences in the rate of aging across species, one day in the life of a human is, in terms of percentage of life span, equivalent to about one week in the life of a dog and one month in the life of a mouse.

Death is an event that can and does happen at every conceivable age in a genetically diverse population. The death rate (also referred to as the mortality rate) for a population may be calculated in its simplest form as the number of deaths that occur in a given year divided by the population at risk of death, the product of which is then multiplied by a standard number (such as one thousand) to give the statistic more intuitive meaning. For example, in the United States in 1995 there were 2.3 million deaths and 262.8 million people alive in the middle of that year. This means that the crude death rate for the United States in 1995 was 8.8 deaths per thousand people [$(2.3 / 262.8) \times 1{,}000 = 8.8$]. Death rates may also be calculated for people of various age groups or by single-year-of-age, and are often used to estimate the life expectancy of a population.

The various ages at which death occurs provides useful information about the longevity attributes of a population. For example, if one were to imagine a hypothetical group or cohort of one hundred thousand babies born in any given calendar year, and one applied to those babies throughout their lives the death rates that prevailed at every age in that year, it would be possible to plot on a graph the hypothetical ages at which all of the babies would have died. This is known as the distribution of death for a population. Although the distribution of death in 1900 was characterized by high mortality early in life, for those who lived beyond the perilous early years, the modal age at death for females was about 73 years of age (see Figure 1). A comparable distribution of death was observed for males in that year.

The opposite of the distribution of death is a plot of the number of people that are expected to survive from one year to the next. This is known as a survival curve. The survival curve is another useful tool for examining age patterns of death and survival in a population because it provides summary statistics that are easy to interpret and understand. For example, from the survival curve for U.S. females born in 1900 it may be determined that, based on the death rates that prevailed in that year, 58 percent would have been expected to survive to the age of fifty (see Figure 2). By contrast, an estimated 95 percent of the female babies born in the United States in the year 2000 are expected to survive to at least their fiftieth birthday. This demonstrates the dramatic improvements in survival that occurred at younger ages during the twentieth century. In 1900 in the United States the survival curve for

Figure 1
Deaths/Age



SOURCE: Author

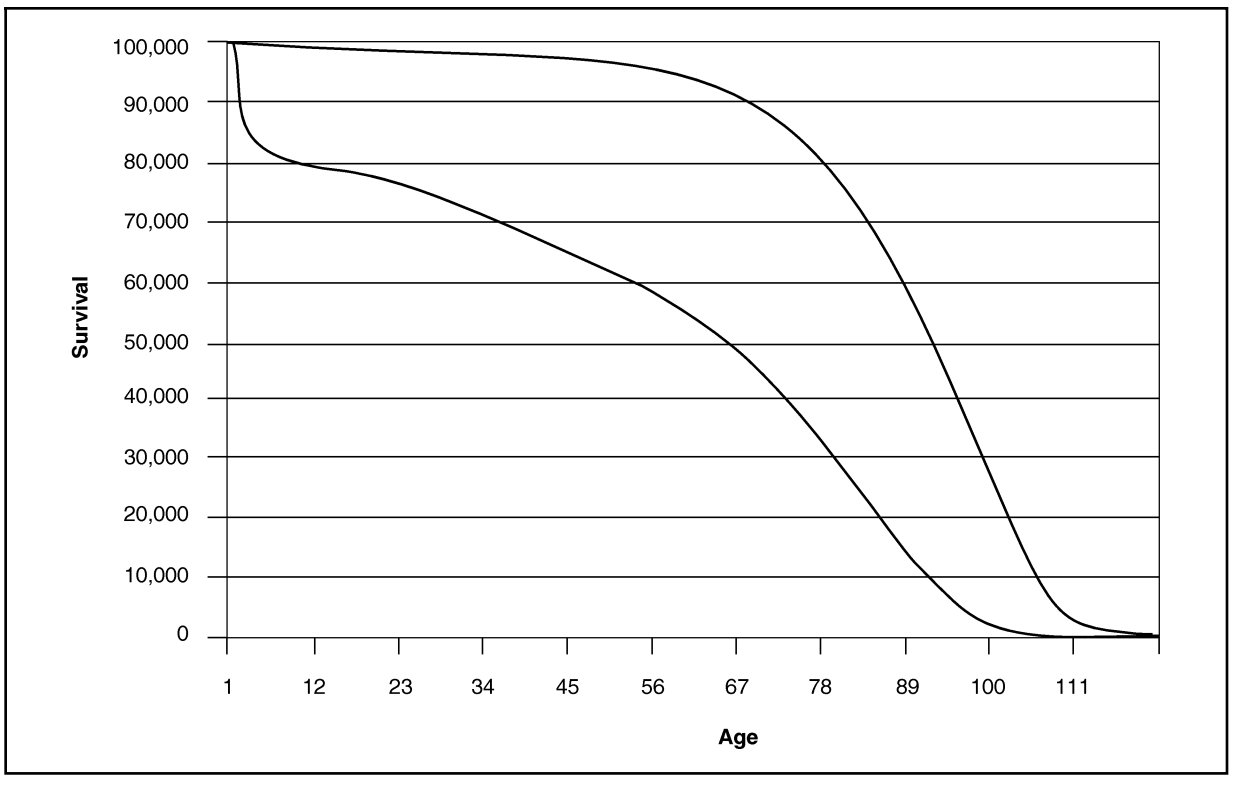
females illustrates that the median age at death (the age at which 50 percent of the babies born in that year will still be alive) was fifty-eight years of age. By the year 2000 the median age at death for females in the United States was eighty-three years. As shown in Figure 2, based on death rates observed in the U.S. in 2000, an estimated 86 percent of all the female babies born will survive at least to their sixty-fifth birthday—a dramatic improvement that occurred during the twentieth century. Both curves provide actuaries, demographers, and other scientists with valuable information that can be used to compare the same population across time, or different populations during the same time period.

The Gompertz Equation and its relationship to mortality

In 1825 an English actuary by the name of Benjamin Gompertz made an important discovery. Gompertz's job as an actuary for an insurance company was to calculate the risk of death for people of different ages in order to determine how much to charge for life insurance. (The exact same kinds of calculations are made by actuaries today.) Using data from various parts of England, where he lived, Gompertz discovered that the risk of death increased in a predictable fashion with age. His calculations led him to conclude that the death rate doubled about every ten years between the ages of twenty and sixty, which was the primary age range for people purchasing insurance annuities at that time. The mathematical formula Gompertz used to predict this exponential rise in mortality after age twenty has become known colloquially as the *Gompertz equation,* and it has remained an integral part of mortality computations conducted by actuaries and demographers ever since the early nineteenth century.

What made Gompertz's discovery so interesting was not just the fact that he devised a for-

Figure 2
Survival/Age



SOURCE: Author

mula that accurately portrayed the dying-out process of humans, but that he and others believed that the same formula could be used to characterize death rates for other species. In fact, for more than a hundred years following Gompertz's discovery, numerous investigators from a wide range of scientific disciplines speculated that the Gompertz formula described a fundamental principle of death for all living things, a principle that became known as the Universal Law of Mortality. Recently, scientists have used death statistics for such species as humans, mice, and dogs to demonstrate that there is evidence to support the idea that age patterns of death occur in a consistent way across species, despite the fact that there is a wide variation in the observed lifespans of different species. In other words, there is scientific evidence to suggest that Gompertz was right—there appears to be a nearly universal age pattern to the dying out of living things.

The biology of life span

Why do people and other living things endure as long as they do? Why aren't we immortal? The answer to the most basic question of why we age is still an unsolved problem in biology, as the late famous biologist Sir Peter Medawar said in 1951. However, scientists are quickly closing in on at least some of the possible reasons why aging occurs. One of the most prominent theories of aging today is known as the free-radical hypothesis. During the process of metabolizing food and water and operating the machinery of life in a toxic world, damaging substances known as free radicals are generated. Although the human body has a highly efficient mechanism to protect itself from these damaging substances, it is not perfect. It is this lack of perfection that leads to accumulated damage to the DNA contained within the nucleus and the mitochondria (energy factories) of most cells. The level of damage moves up the scale of biological organization from DNA to cells, tissues, organs, organ systems,

and ultimately to the whole organism—contributing to a degradation in the functioning of biological systems and an increased susceptibility to the diseases now associated with aging. Even though the damage that occurs to DNA is itself repaired with near perfection, it is the lack of perfection that is the basis for the free-radical hypothesis of aging.

There are a number of other prominent theories about the mechanisms of aging. Among them are the wear-and-tear theories and the discovery of an attribute of nuclear DNA known as the *telomere*. If the human body is viewed as a living machine with pulleys, pumps, levers, and hinges, much like that of a man-made mechanical device, it is evident that such machines cannot be operated indefinitely because of wear and tear. There are changes that occur in most human biological systems with the passage of time, including the loss of bone and muscle mass, increased brittleness of the circulatory system, and a degradation of the immune and reproductive systems.

Telomeres are the end caps of nuclear DNA, and they are known to shorten in length with each cell division. When they become short enough, the cell experiences a phenomenon known as *programmed cell death,* or *apoptosis*. An enzyme referred to as *telomerase* is known to be present in larger quantities in cells that are protected from aging, such as eggs, sperm, and stem cells, but there is no evidence so far to suggest that adding telomerase to other cells in the body would extend length of life. Although some scientists believe that this is one of the major biological mechanisms that contributes to aging, most people tend to die well before telomere shortening poses a serious problem for the whole organism.

Mortality in the twentieth and twenty-first centuries

During the twentieth century, humanity witnessed the most dramatic declines in death rates and increases in life expectancy at birth than at any other time in history. Based on prevailing death rates in 1900, male and female babies born at that time were expected to live to 46.4 and 49.0 years, respectively. Now that the twentieth century has passed, it is known that babies born in the United States in 1900 fared a little better than predicted at the time because of unanticipated declines in death rates that occurred at every age throughout the century. There were three main forces that led to these declines in mortality. The first, which occurred early in the century, was a rapid decline in the risk of death among infants and children. The combination of improved sanitation, refrigeration, the more widespread use and distribution of clean drinking water, and the development of controlled indoor living and working environments led to rapid declines in the risk of waterborne and airborne infectious and parasitic diseases (IPDs). Infants and children benefitted the most from these developments because their immature immune systems placed them at a higher risk of death from IPDs. Examples of some of the IPDs that waned early in the twentieth century include diphtheria, tuberculosis, smallpox, and cholera. The second force that led to declining death rates was the more widespread use of hospitals for childbirth, which contributed to declines in both maternal and infant mortality. The third factor was the introduction of antibiotics in the middle of the century, which has saved people of all ages from a wide range of bacterial infectious diseases. The fourth factor, which led to declining death rates at middle and older ages in the latter third of the twentieth century, occurred as a combination of improved lifestyles, advances in surgical procedures, the development of pharmaceuticals, and a host of other advances in the biomedical sciences. In this case, death rates from such chronic degenerative diseases as heart disease and some cancers were observed to have declined during this period. As evidence for the magnitude of the changes in mortality that occurred throughout the twentieth century, consider the fact that life expectancy at birth rose by thirty years during this time, which was an increase of magnitude and speed that exceeded that observed during the previous 100,000 years.

There is considerable speculation among scientists about the future of human longevity. Some believe that medical progress will continue into the future at a pace that is even faster than the remarkable gains made in recent decades. Such advances will certainly include new surgical procedures and pharmaceuticals to combat the consequences of aging-related diseases, but advances are also expected in genetic engineering and in research involving embryonic stem cells. Even more speculative, but certainly within the realm of possibility, are longevity gains that could arise from efforts to combat the aging process itself. Although there is reason to be optimis-

tic that death rates will continue to decline in the future, some scientists have demonstrated that the rise in life expectancy will probably be much slower in the twenty-first century than it was during the twentieth century. This is because it is far more difficult to add decades to the lives of people who have already lived seventy years or more than it was, early in the twentieth century, to add decades to the lives of children saved from dying of infectious diseases. However, under any condition, humanity is embarking on a fascinating new journey into the science of aging that will undoubtedly change modern notions about aging and death.

S. JAY OLSHANSKY

See also LIFE EXPECTANCY; LIFE SPAN EXTENSION; LONGEVITY: REPRODUCTION; LONGEVITY: SELECTION; LONGEVITY: SOCIAL ASPECTS; THEORIES OF BIOLOGICAL AGING.

BIBLIOGRAPHY

CARNES, B. A.; OLSHANSKY, S. J.; and GRAHN, D. "Continuing the Search for a Law of Mortality." *Population and Development Review* 22 (1996): 231–264.

GOMPERTZ, B. "On the Nature of the Function Expressive of the Law of Human Mortality and on a New Mode of Determining Life Contingencies." *Philosophical Transactions of the Royal Society of London* 115 (1825): 513–585.

KIRKWOOD, T. B. L. "Comparative Life Spans of Species: Why Do Species Have the Life Spans They Do?" *American Journal of Clinical Nutrition* 55 (1992): 1191S–1195S.

MAKEHAM, W. "On the Law of Mortality and the Construction of Annuity Tables." *Journal of the Institute of Actuaries* 13 (1860): 325–358.

MEDAWAR, P. B. *An Unsolved Problem in Biology*. London: Lewis, 1952.

OLSHANSKY, S. J., and CARNES, B. A. *The Quest for Immortality: Science at the Frontiers of Aging*. New York: Norton Press, 2001.

OLSHANSKY, S. J.; CARNES, B. A.; and CASSEL, C. "In Search of Methuselah: Estimating the Upper Limits to Human Longevity." *Science* 250 (1990): 634–640.

OLSHANSKY, S. J.; CARNES, B. A.; and DESESQUELLES, A. "Prospects for Human Longevity." *Science* (2001): 1491–1492.

SHRYOCK, H., and SIEGEL, J. "Mortality." Chapter X in *The Methods and Materials of Demography*. Academic Press, 1976.

U.S. Bureau of the Census. *Statistical Abstract of the United States*. Washington, D.C.: U.S. Government Printing Office, 2000.

MOTIVATION

Research within the psychology of aging has increased our understanding of old (and very old) age with regard to changes in intellectual functioning, everyday competence, and social relationships, as well as sources of well-being (see Baltes and Mayer, 1999). At the same time, the role of motivational processes in aging has become increasingly important.

Approaches to the study of motivation

The study of motivation focuses on the question of why people initiate, terminate, or persist in specific actions. Given this broad scope, the field of motivation has been characterized as the "cornerstone in the science of human behavior" (Ryan, 1998, p. 114). Despite a variety of theoretical approaches, research has come to increasingly emphasize the importance of goals as directors of human action. Accordingly, research has focused on desired outcomes and how they serve as incentives; on how goals direct action; how pursuit is regulated; and how needs are related to higher-order goals. It has also looked at control-related beliefs for goal attainment, such as an individual's ability to attain desired outcomes through appropriate action. An additional research focus has been on the role of emotions in motivating thought and action.

Arousal theory offers another perspective by focusing on psychophysiological states characterized by varying degrees of excitation, activation, or energy mobilization. It has been maintained that high levels of arousal are a prerequisite for the experience of at least some emotions, and that they are embedded in many motivated acts. On the other hand, any goal-directed activity has an intrinsic emotional component; so motivational and emotional processes are intertwined and exert a powerful influence on cognitive processing, as well as being affected by cognition. Even more, as Buck (1999, p. 303) has put it, "each is involved in both of the others," whereby motivation and emotion are seen "as the two sides of the same coin," i.e., the motivational-emotional system.

Developmental perspectives on motivation

For developmental psychologists the central question is why people pursue particular goals and how goal-pursuit might be related to age or life stage. Most studies, however, have been limited to childhood or early adolescence. Some suggest the relative stability of certain motives, such as the achievement motive, from that time on (McClelland, 1985). Others claim that there is a systematic reorganization of motives across adulthood, with goals related to self-verification and self-worth becoming increasingly salient (Carstensen, 1998). Beyond the question of which needs and goals instigate action at various ages, one can also distinguish various types of motivation to allow for further developmental differentiation. These motivating factors can be broken down into two general areas: (1) goal pursuit being controlled by internal vs. external forces, and (2) the temporal orientation of goals.

Control-related issues. A distinction can be made as to whether goal-directed activity emanates from the self or is brought about by (or perceived to be brought about by) forces external to the self. People of all ages have a strong desire for autonomy and feelings of control, yet the transition into old age is accompanied by increased constraints on control. In particular, rather than supporting autonomy, the social world of elderly people contributes remarkably to decrements in control. Following a "dependency-support script" (Baltes and Wahl, 1992), others—in particular those who take care of the elderly—tend to reward dependency and ignore autonomy, thereby stifling the efforts of elderly persons to control their lives themselves and undermining self-determination. Since, however, goal pursuits controlled by internal reasons have been shown to be predictive of almost all indicators of positive well-being, attempts to prevent loss of control have a long history in the psychology of aging. Only recently has it become acknowledged that elderly people, rather than adhering to illusions of control and engaging in fruitless efforts at control, exhibit a shift in regulatory strategies from primary control (directed at the external world) to secondary control (directed at the inner world of the individual). This shift may account for the so-called picture of contentment and well-being amidst threat and loss often ascribed to old age.

Time-related issues. The second way of distinguishing action goals is by their temporal orientation; that is, whether they are related to preparedness for the future or to satisfaction in the present. From this perspective, the notion of perceived time left in life deserves special attention, for the subjective assessment of time is considered to play a critical role in the ranking and execution of all goal-directed processes. Evidence has shown that elderly persons, more than other age groups, seem to focus on the here and now. Additionally, anticipated endings and limited resources have been shown to make elderly people much more selective with regard to where and when to invest their energies, and to make them much more reflexive concerning the optimization of means of attaining goals (as outlined in the model of Selective Optimization with Compensation; SOC-model).

The temporal ordering of action goals may also be examined using developmental tasks as a key concept. Developmental tasks are seen to be jointly produced by the process of biological aging; the demands, constraints, and opportunities provided by the external world; and the desires and strivings that characterize each individual's motivational system. These tasks provide individuals with a mental image of the normative course of development, thereby serving as sources for goal setting and as organizers of self-regulation. In addition, normative life transitions bring about relevant experiences, which might force psychological reorganization and induce changes in the motivational system, although little is known about these processes.

Arousal-related issues. Arousal theory makes plain the relevance of biological functioning to many motivational and emotional phenomena. In more general terms, one might refer again to the developmental-interactionist theory proposed by Buck (1999), which underscores the biological basis of higher level (e.g., social or moral) affects and elaborates how these became interrelated over the course of individual development. One of the most robust findings concerns the general slowing of the aging organism, together with a decline in sensory functioning. Thus, by emphasizing the older adults' lowered levels of vigilance, alertness, and speed of information-processing, it is expected that an individual will have less interaction with his or her environment. This is reflected in decreased emotional intensity (although decline does not occur when low arousal feelings like contentment are studied), among other things. More important, however, is that these biological changes might also have implications for the allocation of ener-

gy to goal-directed activities. For example, a decline in energy might foster in elderly people diminished feelings of control and a self-ascribed inability to attain goals. From this point of view, affective and cognitive processes again seem to interact in producing particular motivational states in old age.

Social motivation and self-esteem in old age

Among the basic motivational processes, the need for interpersonal relationships, for positive self-regard, and for meaning in life serve as powerful forces in old and very old age. This is evidenced in various self-regulation processes, and even in the construction of autobiographical narratives, i.e., how people make stories about particular episodes and experiences in their lives.

Interest in social motivation was originally nurtured by research on social support, defined as those interpersonal transactions that involve aid, affirmation, or affect. Although research has mostly lacked a developmental focus, it now seems clear that aid (i.e., instrumental rather than emotional or appraisal support) is the crucial issue for elderly people and is most predictive of their well-being.

Another social perspective considers elderly people not as needy recipients, but rather as providers of social support. Altruistic behaviors in old age are assumed to foster feelings of competence and self-worth and to provide a sense of meaning to one's life, while at the same time they might serve to distract elderly people from current troubles or to ensure the presence of others. A different perspective, known as *social emotional selectivity theory,* has as its core proposition that the elderly may have fewer social relationships, but that they compensate by selecting relationships in which they can be meaningfully understood, share intimacy, and express emotions. This means that elderly people are seen to be driven more by emotional motives aimed at self-verification or affect regulation rather than by information-seeking motives (e.g., aimed at getting to know new people or at reducing unfamiliarity in social relationships).

Finally, the need for self-esteem represents a pervasive motivation across the entire life span. Evidence on how people, irrespective of their ages, ward off threats to their self-views (e.g., by defensive responses, selective comparisons, and/or strategic self-presentation) is compelling. There is nothing special about elderly people in this regard, unless one assumes that their experiences of loss are to be equated with threats to self-esteem. It is not well understood, however, how loss encountered in later life is construed by elderly people: do these losses threaten self-esteem, or are they seen as universal concomitants of the natural course of aging? Under what conditions do loss experiences induce unpleasant feelings of uniqueness and attack feelings of self-worth? Obviously, one pathway to understand affect and motivation in elderly persons is to study their (own) subjective implicit theories of aging.

SIGRUN-HEIDE FILIPP

See also CONTROL, PERCEIVED; EMOTION; INTELLIGENCE; LIFE-SPAN THEORY OF CONTROL; SOCIAL COGNITION; SOCIAL SUPPORT.

BIBLIOGRAPHY

BALTES, P. B., and MAYER, K. U., eds. *The Berlin Aging Study. Aging from 70 to 100*. Cambridge, U.K.: Cambridge University Press, 1999.

BALTES, M. M., and WAHL, H.-W. "The Dependency-Support Script in Institutions: Generalization to Community Settings." *Psychology and Aging* 7 (1992): 409–418.

BALTES, P. B., and LINDENBERGER, U. "Emergence of a Powerful Connection Between Sensory and Cognitive Functions across the Adult Life Span: A New Window to the Study of Cognitive Aging?" *Psychology and Aging* 12 (1997): 12–21.

BALTES, P. B., and BALTES, M. M. "Psychological Perspectives on Successful Aging: The Model of Selective Optimization with Compensation." In *Successful Aging: Perspectives from the Behavioral Sciences*. Edited by P. B. Baltes and M. M. Baltes. Cambridge, U.K.: Cambridge University Press, 1990. Pages 1–34.

BAUMEISTER, R. F., and NEWMAN, L. S. "How Stories Make Sense of Personal Experiences: Motives that Shape Autobiographical Narratives." *Personality and Social Psychology Bulletin* 20 (1994): 676–690.

BRANDTSTÄDTER, J. "Coping with Discrepancies between Aspirations and Achievements in Adult Development: A Dual-Process Model." In *Life Crisis and Experiences of Loss in Adulthood*. Edited by L. Montada, S. H. Filipp, and M. Lerner. Hillsdale, N.J.: Erlbaum, 1992. Pages 301–319.

BUCK, R. "The Biological Affects: A Typology." *Psychological Review* 109: 301–336.

CARSTENSEN, L. L. "A Life-Span Approach to Social Motivation." In *Motivation and Self-Regulation Across the Life Span*. Edited by J. Heckhausen, and C. S. Dweck. Cambridge, U.K.: University of Cambridge Press, 1998. Pages 341–364.

DIENER, E.; SUH, E.; LUCAS, M.;and SMITH, H. L. "Subjective Well-Being: Three Decades of Progress." *Psychological Bulletin* 125 (1999): 276–302.

FILIPP, S.-H. "Motivation and Emotion." In *Handbook of the Psychology of Aging*, 5th ed. Edited by K.W. Schaie and J. Birren. New York: Academic Press, 1996. Pages 218–235.

GOLLWITZER, P. M., and BARGH, J. A. eds. *The Psychology of Action: Linking Cognition and Motivation to Behavior*. New York: Guilford, 1996.

HECKHAUSEN, J., and SCHULZ, R. "A Life-Span Theory of Control." *Psychological Review* 102 (1995): 284–304.

HECKHAUSEN, J. *Developmental Regulation in Adulthood. Age-Normative and Socio-Structural Constraints as Adaptive Challenges*. Cambridge, U.K.: Cambridge University Press, 1999.

MCCLELLAND, D. C. *Human Motivation*. Dallas: Scott, Foresman, 1985.

MIDLARSKY, E. "Helping As Coping." *Review of Personality and Social Psychology* 12 (1991): 238–264.

RYAN, R. M. "Commentary: Human Psychological Needs and the Issues of Volition, Control, and Outcome Focus." In *Motivation an Self-Regulation across the Life Span*. Edited by J. Heckhausen and C. S. Dweck. Cambridge, U.K.: University of Cambridge Press, 1998.

SCHULZ, R. "Commentary: Motivation and Self-Regulation in Adult Development." In *Motivation an Self-Regulation across the Life Span*. Edited by J. Heckhausen, and C. S. Dweck. Cambridge, U.K.: University of Cambridge Press, 1998. Pages 424–436.

MOTOR PERFORMANCE

Research in motor control of aging humans has been centered around determining how motor performance is influenced by age, and around efforts to unravel the mechanisms that contribute to declines in motor performance. Changes are often characterized by slower and more variable movements, specifically slower initiation of movement, slower movement durations, declines in coordination of movement, reduced force production, coactivation of antagonist muscles during movement, and increased variability of movements (i.e., movements become inconsistent or varied from one use to the next). Specific examples of tasks that are linked to dimensions of motor control include goal-directed movements such as pointing, reaching and grasping, and aiming.

Movement time

The slowing of movement in older adults can be seen in everyday tasks such as reaching and grasping, point-to-point movements (discrete goal-directed aiming movements with a defined beginning and end), and continuous movements (cyclical movements, such as circles, with no defined beginning and end). *Movement time* (MT) provides an assessment of the speed of task execution. Movement time is defined as the time from the initiation of a particular movement to the termination of the movement. Movement times in older adults are substantially slower than young adults, ranging from 20 to 70 percent slower, depending on the complexity of the task. A variety of tasks have been assessed, including movements of the finger, hand, arm, and trunk.

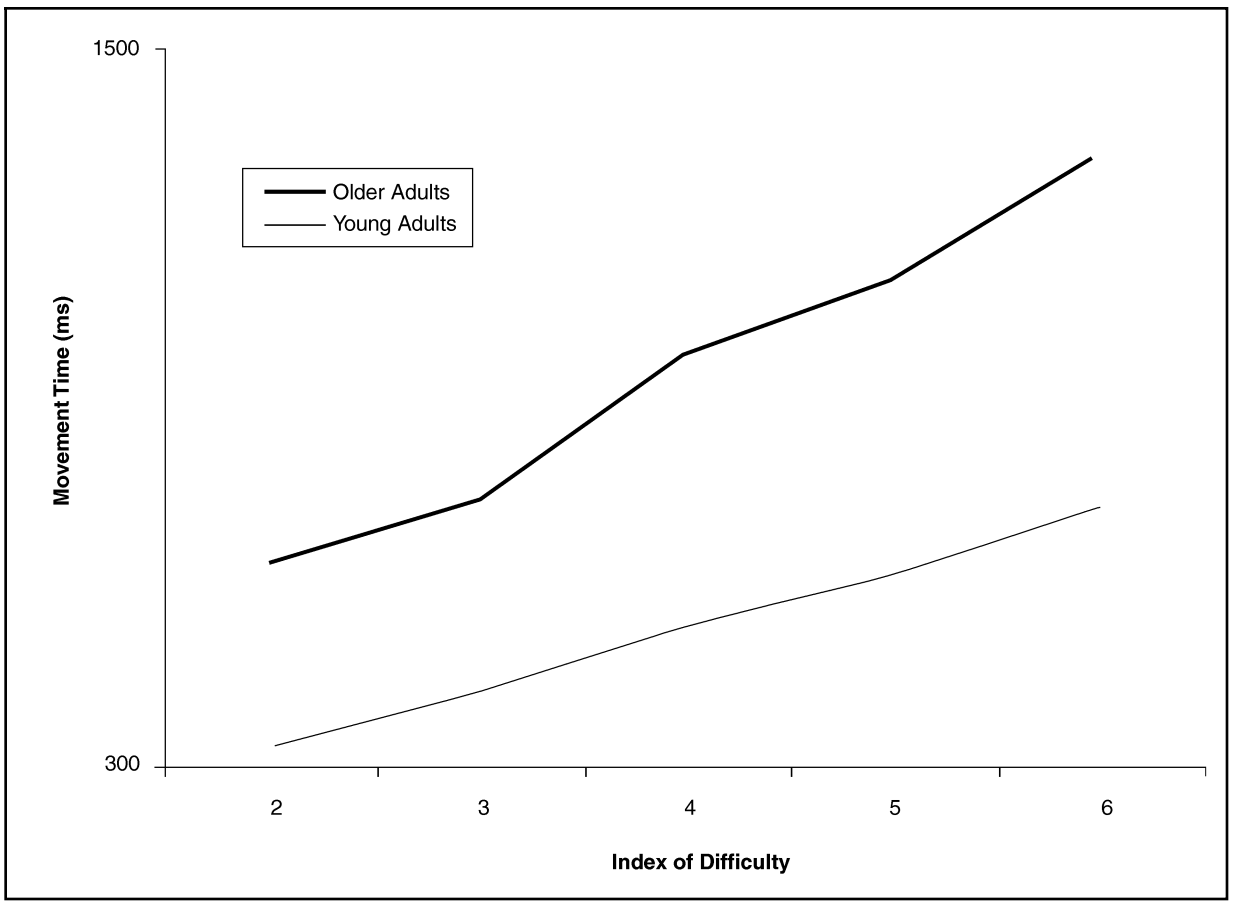
Fitts' Law (Fitts) describes increases in MT as a function of task complexity (see Figure 1). Movement accuracy is manipulated by increasing the distance traveled to a target or increasing the size of the target, and tasks can be analyzed through an Index of Difficulty (ID). For both young and older adults, MT increases linearly as ID increases. However, older adults are slower than young adults at the lowest levels of difficulty, and MT increases at a greater rate as difficulty increases.

Movement-time measures are important in assessing movement slowing, however they do not provide explicit insight on the underlying mechanisms of slowing or on specific changes in control. Research has therefore focused on movement decomposition in an effort to identify particular movement characteristics that contribute to movement slowing, allowing researchers to assess fundamental changes associated with movement slowing in older adults.

Kinematic analysis

Kinematic analysis documents the specific features of a motion, specifically linear and angular displacement, velocity, and acceleration of goal-directed movements. *Young controls* portray bell-

Figure 1
Fitts' Law: Movement times (ms) for young and older adult subjects as index of difficulty increases.



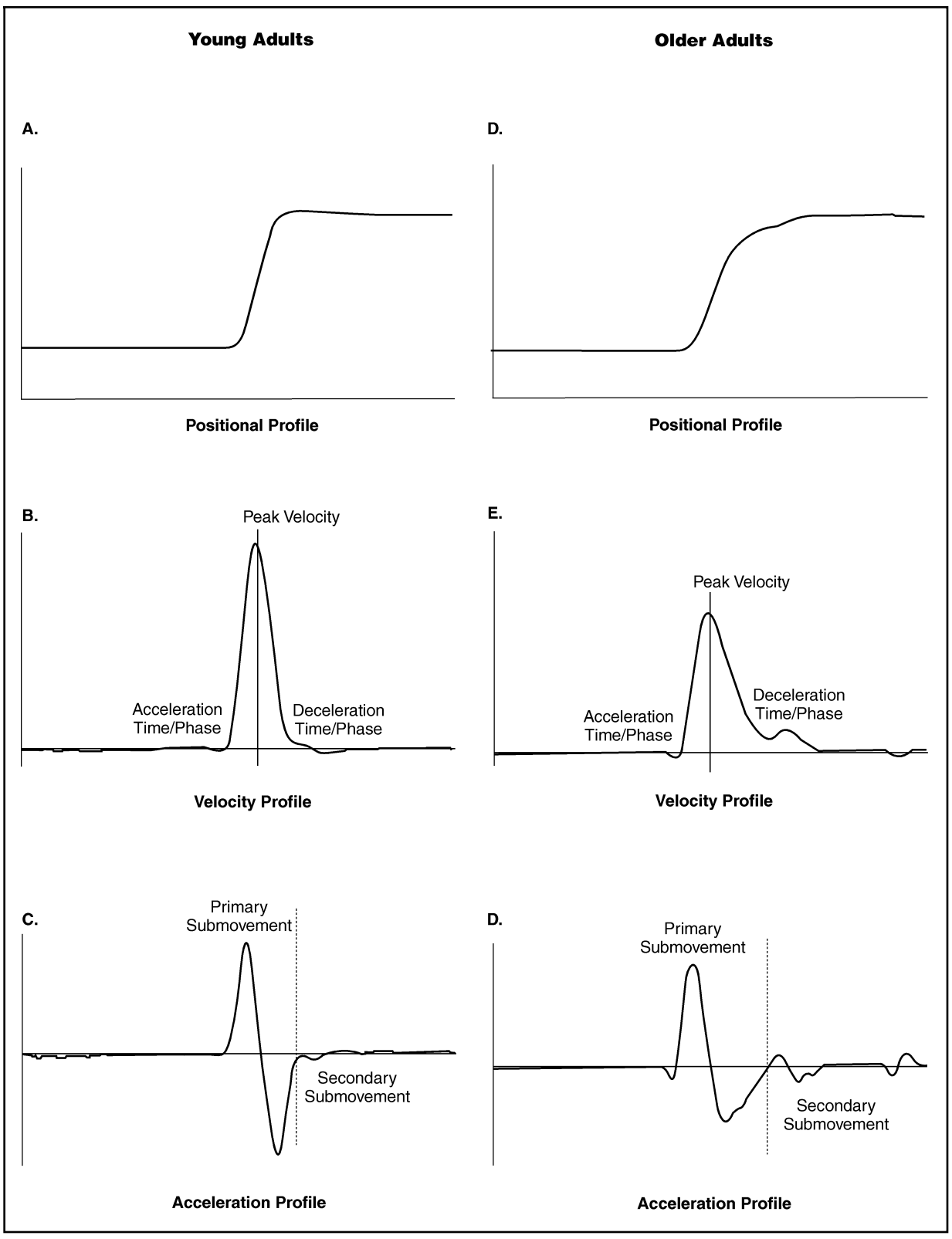
SOURCE: Ketcham, C. J.; Seidler, R. D.; Van Gemmert, A. W. A.; and Stelmach, G. E. (in Press) "Age Related Kinematic Differences as Influenced by Task Difficulty, Target-Size, and Movement Amplitude." *Journal of Gerontology: Psychological Sciences.*

shaped velocity profiles in accurate point-to-point movements (see Figure 2B). Specifically, the ratio between the acceleration and deceleration phases of a movement is approximately 1.0. The acceleration phase coincides with the portion of a movement before peak velocity, and the deceleration phase, consequently, is the portion of a movement after peak velocity (see Figure 2B; 2E). Older adults demonstrate shorter acceleration phases and prolonged deceleration phases, thus portraying asymmetric or skewed velocity profiles. This suggests that it is the terminal, or deceleration, portion of movement that primarily contributes to slower movement outputs. Furthermore, older adults consistently produce lower peak velocity and acceleration amplitudes compared to young adults, which also contributes to slower movements.

Movement subparsing

Kinematic profiles may be examined to provide additional analyses of possible sources of slower movements. The *movement optimization model* (Meyer) divides the velocity and acceleration profiles into primary and secondary submovements. The primary submovement represents the ballistic, or prepared, portion of movement, whereas the secondary submovement represents the feedback, or corrective, portion of movement control (see Figure 2C; 2F). Adjustments to the microstructure of the movement indicate how movement control changes with task constraints. The primary submovement is shortened in older adults, requiring them to make more secondary, corrective submovements to reach a target (see Figure 2F). Older adults are

Figure 2
Kinematic and Submovement Parsing: Young and older adult position, velocity, and acceleration profiles. For a complete caption, please see the section "Figure Legend" at the end of this essay.



known to decrease the distance traveled in the primary submovement and increase the number of corrective submovements in a variety of tasks. The shortening of the primary submovement may be a consequence of bodily changes and/or decrements in processing capacity and efficiency. Specific causes may include the inability to prepare and organize movement effectively, reduced proprioception, abnormal muscle activation patterns, increased reliance on vision, and the inability to produce or scale forces efficiently.

Force production

To produce movement, force must be generated by the muscles driving the body segment involved in a movement. These forces must be scaled to increase velocity; but, perhaps more importantly, the timing of muscle activation must synchronize with multiple other muscles and subsystems of the motor-control system. Research has shown that older adults have reductions in force production and regulation across a range of tasks, which limits their ability to make fast, accurate movements. Properties that may contribute to such changes are loss in muscle mass and a reorganization of motor units. However, it has further been shown in tasks in which accuracy constraints are relaxed that older adults are able to produce similar forces as young controls produce. This suggests that while muscle loss and motor unit reorganization may lead to decreases in force production, it is most likely not the limiting factor in tasks such as reaching and grasping and point-to-point movements, in which force output is submaximal. Therefore, there must be other mechanisms that contribute to force-control deficits in the presence of accuracy constraints in older adults. A possibility is that the fine ramping of force production is compromised in the reorganization of motor units, which are essential in fine motor tasks such as reaching and grasping and point-to-point movements.

In precision grip tasks, older adults produce excessive force in an effort to keep the grasped object from slipping. Again, older adults, while able to produce sufficient and even excessive force, are unable to effectively modulate and time force output. This is amplified when grip surfaces are slippery—in such instances older adults substantially increase grip forces beyond the necessary level to keep the object from falling. This suggests that it is peripheral feedback-mechanism decrements such as proprioception or tactile feedback, and/or processing capacity, that are compromised with advanced age and limit performance of older adults in these fine motor tasks.

Movement variability and coordination

Older adults also exhibit heightened movement variability in kinematic and endpoint measures. Variability has been documented in such measures as movement trajectory, peak velocity, movement duration, ratio of acceleration and deceleration phases, and force control. Compensation for movement variability may result in behavioral outputs that are a consequence of, rather than a mechanism of, movement variability and/or slowing. Seidler-Dobrin et al. (1998) found that older adults coactivate the agonist and antagonist muscles during movement, leading to altered muscle activation patterns, which consequently contributes to increased variability. Older adults also exhibited longer deceleration phases of movements. Coordination of multiple joint segments involves very complex control. Studies of handwriting, bimanual coordination, and multijoint coordination have found that older adults lose fine motor coordination and have increased *normalized jerk,* which is a measure of movement smoothness. This is manifested in decreased peak acceleration, deformations of desired movements at lower speeds, and bimanual coordination declines at lower speeds.

Visual monitoring

In the motor-control literature on older adults, many of the behavior decrements discussed thus far are linked to physical and cognitive declines. It has been suggested by several researchers that visual guidance of movement may partially, if not completely, compensate for many of the changes that occur with age when accuracy is required. Visual monitoring of a movement may compensate for sensorimotor information lost during the movement due to decrements in this information at the peripheral or central level. Since feedback information takes additional time to process and integrate, movements are typically slow and more variable. Furthermore, older adults in the absence of vision (when it is occluded) increase MTs and variability, suggesting that the visual monitoring of movements is important to the speed and accuracy of movement performance. In the absence of

vision, older adults produce shorter primary submovements compared to young controls, even with ample practice. This suggests that older adults are reliant on visual feedback to control their movements. Researchers have suggested that this dependence is a consequence of one or more limitations in processing, planning, force production and regulation, and proprioception.

Conclusions

Motor-control declines that occur in older adults lead to slow and variable movement outputs. However, the underlying mechanisms that contribute to these outcomes are not well understood. These deficits do not add up linearly to give a complete picture of motor performance decrements plotted as a function of age. This complex problem leaves motor-control researchers with a variety of questions to ask. It is important, both while reading the literature and while conducting research, to keep in mind that the human motor system is quite complex. The individual components of the puzzle measured by researchers allow them to focus on determining what the primary contributors are to any deficit, since many of the sensorimotor processes are interdependent.

Figure legend

Figure 2 concerns the principles of kinematic and submovement parsing, illustrating young and older adult position, velocity, and acceleration profiles. Each of the six panels covers specific profiles: A) Young adults' positional data; B) Young adults' velocity profile, including acceleration and deceleration phases/times; C) Young adults' acceleration profiles, including primary and secondary submovement parsing; D) Older adults' positional data; E) Older adults' velocity profile, including acceleration and deceleration phases/times; F) Older adults' acceleration profiles, including primary and secondary submovement parsing. This illustration was adapted from: Ketcham, C. J.; Seidler, R. D.; Van Gemmert, A. W. A.; and Stelmach, G. E. (in Press) "Age Related Kinematic Differences as Influenced by Task Difficulty, Target-Size, and Movement Amplitude." *Journal of Gerontology: Psychological Sciences*.

CAROLINE J. KETCHAM
GEORGE E. STELMACH

See also BRAIN; PHYSIOLOGICAL CHANGES, ORGAN SYSTEMS: SKELETAL MUSCLE; REACTION TIME.

BIBLIOGRAPHY

BELLGROVE, M. A.; PHILLIPS, J. G.; BRADSHAW, J. L.; and GALLUCI, R. M. "Response (Re)programming in Aging: A Kinematic Analysis." *Journal of Gerontology* 53A, no. 3 (1998): M222–M227.

BROWN, S. H. "Control of Simple Arm Movements in the Elderly." In *Changes in Sensory Motor Behavior in Aging*, 114. Edited by A. M. Fernandez and N. Teasdale. Amsterdam: Elsevier Science BV, 1996.

BRUCE, S. A.; NEWTON, D.; and WOLEDGE, R. C. "Effect of Age on Voluntary Force and Cross-Sectional Area of Human Adductor Pollicis Muscle." *Quarterly Journal of Experimental Psychology* 74 (1989): 359–362.

COLE, K. J.; ROTELLA, D. L.; and HARPER, J. G. "Mechanisms for Age-Related Changes of Fingertip Forces During Precision Gripping and Lifting in Adults." *The Journal of Neuroscience* 19, no. 8 (1999): 3238–3247.

COOKE, J. D.; BROWN, S. H.; and CUNNINGHAM, D. A. "Kinematics of Arm Movements in Elderly Humans." *Neurobiology of Aging* 10 (1989): 159–165.

DARLING, W. G.; COOKE, J. D.; and BROWN, S. H. "Control of Simple Arm Movements in Elderly Humans." *Neurobiology of Aging* 10 (1989): 149–157.

ERIM, Z.; BEG, M. F.; BURKE, D. T.; and DE LUCA, C. J. "Effects of Aging on Motor-Unit Control Properties." *Journal of Neurophysiology* 82 (1999): 2081–2091.

FITTS, P. M. "The Information Capacity of the Human Motor System in Controlling the Amplitude of Movement." *Journal of Experimental Psychology* 47 (1954): 381–391.

KETCHAM, C. J.; SEIDLER, R. D.; VAN GEMMERT, A. W. A.; and STELMACH, G. E. (in Press) "Age Related Kinematic Differences as Influenced by Task Difficulty, Target-Size, and Movement Amplitude." *Journal of Gerontology: Psychological Sciences*.

MEYER, D. E.; ABRAMS, R. A.; KORNBLUM, S.; WRIGHT, C. E.; and SMITH, J. E. K. "Optimality in Human Motor Performance: Ideal Control of Rapid Aimed Movements." *Psychological Review* 95 (1988): 340–370.

PRATT, J.; CHASTEEN, A. L.; and ABRAMS, R. A. "Rapid Aimed Limb Movements: Age Differences and Practice Effects in Component Submovements." *Psychology and Aging* 9, no. 2 (1994): 325–334.

SEIDLER-DOBRIN, R. D., and STELMACH, G. E. "Persistence in Visual Feedback Control by the Elderly." *Experimental Brain Research* 119 (1998): 467–474.

SEIDLER-DOBRIN, R. D.; HE, J.; and STELMACH, G. E. "Coactivation to Reduce Variability in the Elderly." *Motor Control* 2 (1998): 314–330.

WALKER, N.; PHILBIN, D. A.; and FISK, A. D. "Age-Related Differences in Movement Control: Adjusting Submovement Structure to Optimize Performance." *Journal of Gerontology* 52B, no. 1 (1997): P40–P52.

WELFORD, A. T. "Between Bodily Changes and Performance: Some Possible Reasons for Slowing with Age." *Experimental Aging Research* 10, no. 2 (1984): 73–88.

MULTIDISCIPLINARY TEAM

Many seniors enjoy good health and independence well into their ninth and tenth decades. However, some develop illnesses and functional impairments that require intensive or prolonged health care and supportive services at home, in hospitals, or in long-term care facilities. Family, peers, friends, volunteers, and other caregivers provide assistance and support, and in Western countries most seniors can access physicians and other primary-care practitioners who provide the first point of contact with health and social support services. When health issues are complicated and require specialized knowledge or resources not available to the primary-care team, seniors may be referred to specialist practitioners or to specialized multidisciplinary geriatric teams in the community, in hospitals, or in long-term care facilities. Such referrals may result in a brief intermittent contact, or there may be prolonged involvement with such specialists. In some cases, specialized teams assume primary-care responsibility, either for a defined period or indefinitely.

The skills and knowledge of many health disciplines are needed to conduct a comprehensive multidimensional assessment of the physical, mental, emotional, functional, and social status of a frail older person. The composition of teams vary, therefore, depending upon the population the team serves and the needs of a particular individual. A nurse, a physician, one or more rehabilitation therapists, and a social worker—each having specialized knowledge in gerontology—constitute a prototypical *core team,* although in practice the composition of teams may vary. Other professionals, such as counselors, nutritionists, speech and language pathologists, pharmacists, spiritual-pastoral caregivers, psychologists, other medical specialists, case managers, coordinators, and others may also be included in the core team, or they may be consulted on an ad hoc basis, reflecting the nature of the clientele referred to the team or the particular needs of an individual client.

Historically, the practice of many health professionals has been characterized by unidisciplinary thinking, and individualistic and sometimes competitive behaviors have emphasized the roles and boundaries of each discipline. However, care of older persons with complex and interactive health, social, and functional needs is best achieved when the knowledge and skills of various health disciplines are shared and integrated. Multidisciplinary, collaborative health care practice is an effective means to plan, coordinate, and implement care of frail older persons. Family members and caregivers should be participants in this process, although they may not be present at all meetings of the multidisciplinary team. Their contribution to the assessment process, to problem solving, and to identifying and selecting appropriate goals and acceptable outcomes is vital.

Health professionals providing senior care require strong discipline-specific knowledge, as well as an understanding of and respect for the contribution of other health disciplines and the ability to function well in interprofessional teams. Education programs increasingly recognize the need for preparing students for new models of professional practice. Interprofessional education affords students and practitioners from various disciplines an opportunity to learn about common issues in gerontology and the care of older people. Interdisciplinary education and education in teamwork provides theoretic and practice-based learning to prepare for working as a member of a health care team.

The term *multidisciplinary* also describes team interaction within a multiprofessional team. Other team processes include *interdisciplinary* and *transdisciplinary* teamwork. Multidisciplinary team process implies that team members practice relatively independently with respect to goal setting and treatments. Members of multidisciplinary teams may meet regularly or communicate in other ways, but their lack of common goals and their autonomous practice can result in lack

of coordination and conflict over priorities and decision making.

Teams that adopt an interdisciplinary *modus operandi* evidence a stronger focus on integration of activities to meet shared goals. Team members contribute assessment data and convene to synthesize information, to identify issues, and to plan to meet goals that are shared by the team and the older person. Each subsequent treatment or rehabilitative intervention by a team member is related to achievement of overall goals. Both interdisciplinary and transdisciplinary teamwork require considerable educational preparation of team members. They must agree on leadership, team process, priority setting, and methods to resolve conflicts.

The term *transdisciplinary* has been used to characterize a further evolution of teamwork that is highly collaborative and in which role boundaries are often blurred and skills transferred across professional boundaries. The terms *cross-disciplinary* and *multiskilled* have been applied to teams where members extend their skills well beyond the boundaries of their parent discipline. For example, a social worker may collect medical histories or a rehabilitation therapist may record the social and occupational history of patients.

Teamwork theorists have recognized four stages of team development: forming, storming, norming, and performing. In the first stage, the team develops its identity and an understanding of its purpose in a wider context. In the second stage—often an unsettling period for team members—they search for ways of working together that reflect common values and an understanding of the role of the team. In the norming phase, team members develop a shared understanding and commitment to their task, and improved communication within and outside the team develop. In the final stage (performing), a mature, effective team develops that is capable of fulfilling the task for which it was created.

While common principles underlie effective teamwork, similar teams—even within the same health care organization—often function differently. The culture of teams derives from and reflects the values and history of the parent organization, as well as the professional and personal backgrounds of founding members and team leaders. Team membership changes over time as new members are recruited, and a process of education and acculturation to the team is necessary. A common terminology for problems and for goal setting that incorporates functional and psychosocial problems, as well as medical diagnoses, is helpful and facilitates communication within and among teams. Other professionals and health care teams may be involved simultaneously or sequentially in the care of an older person, and timely communication among all those involved in care of the older person and his or her family is important.

Effective team work—that is, teamwork utilizing the resources of a multiprofessional team to achieve optimal results for older persons and their families while using available human and other resources prudently—provides a continuing challenge for health care organizations and health professionals to critically examine current practices and to study and evaluate innovative ways of working together.

DUNCAN ROBERTSON

See also ASSESSMENT; CASE MANAGEMENT; FRAILTY; GERIATRIC ASSESSMENT UNIT; GERIATRIC MEDICINE; GERONTOLOGICAL NURSING; OCCUPATIONAL THERAPY; PHYSICAL THERAPY; REHABILITATION; SOCIAL WORK.

BIBLIOGRAPHY

CASTO, R, M., and JULIA, M. C. *Interprofessional Care and Collaborative Practice: Commission on Interprofessional Education and Practice*. Pacific Grove, Calif.: Brooks/Cole Pub. Co. 1994.

GARNER, H. G., and ORELOVE, F. P. *Teamwork in Human Services: Models and Applications Across the Life Span*. Newton, Mass.: Butterworth Heinemann, 1994.

MANION, J.; LORIMER, W.; and LEANDER, W. J. *Team-Based Health Care Organizations: Blueprint for Success*. Gaithersburg, Mass.: Aspen Pub. Inc., 1966.

OVRETVEIT, J.; MATHIAS, P.; and THOMPSON, T., eds. *Interprofessional Working for Health and Social Care*. Basingstoke, U.K.: Macmillan Press Ltd., 1977.

MULTIPLE SYSTEM ATROPHY

Multiple system atrophy is a group of disorders that share common clinical features, which include Parkinsonism, problems with balance (ataxia), and dysfunction of the autonomic nervous system. It is a sporadic neurodegenerative disease of adult onset. Its cause remains unknown.

Parkinsonism is a part of the constellation of symptoms, hence multiple system atrophy also falls within the rubric of disorders called *Parkinson-plus syndromes*. In addition to multiple system atrophy, Parkinson-plus syndromes include progressive supranuclear palsy and corticobasal ganglionic degeneration. Some also consider Lewy-body disease to be one these syndromes. The Parkinson-plus syndromes are distinct from idiopathic Parkinson's disease because of certain aspects of clinical presentations, but more importantly, are differentiated by clinical response to treatment with L-dopa and related drugs, and neuropathology. In early stages, Parkinson-plus syndromes can be difficult to distinguish from idiopathic Parkinson's disease. However, patients with idiopathic Parkinson's disease have significant improvement of symptoms with dopaminergic drugs, while patients with Parkinson-plus syndrome have, at best, a modest response, so that a diagnosis of Parkinson-plus syndrome is often first considered only when patients show an atypically modest response to treatment. Within the context of Parkinson-plus syndromes, multiple system atrophy is a distinct entity because of its clinical features and neuropathological expression.

In 1900, Déjérine and Thomas coined the term *olivopontocerebellar atrophy* to describe a disorder in which the predominant clinical feature was ataxia, but also included parkinsonism and autonomic dysfunction. In 1960, Shy and Drager described patients in whom there was predominant autonomic dysfunction manifested primarily by a sudden fall in the blood pressure on standing (orthostatic hypotension). These patients also had parkinsonism, and to a lesser degree, ataxia. The disorder has been called *Shy-Drager Syndrome*. In the 1960s, Adams and his colleagues described a group of patients with predominant parkinsonism who also had autonomic failure and, to a lesser degree, ataxia. They termed this disorder *striatonigral degeneration*.

The neuropathological description of these disorders shows changes in various structures, predominantly the basal ganglia, cerebellum, and certain brainstem nuclei. Because of the common features, both clinically and neuropathologically, Graham and Oppenheimer suggested that these three sporadic, adult-onset, neurodegenerative disorders be considered as one diagnostic entity, namely *multiple system atrophy*. This grouping of patients with sporadic olivopontocerebellar atrophy, striatonigral degeneration, and Shy-Drager Syndrome as one entity was further strengthened by the observation that all these disorders had a common neuropathological feature, namely intracytoplasmic inclusion bodies (a collection of abnormal molecules) in the oligodendrocytes, which are cells that provide structural and functional support for the brain cells (neurons).

Clinical features

Four features are present in idiopathic Parkinson's disease: slowing of movement (bradykinesia), tremor, muscle rigidity, and a tendency to fall. The four together mean that Parkinson's disease can be diagnosed. When three or fewer are present, the combination is referred to as *parkinsonism*.

Parkinsonism occurs, to some degree, in the majority of patients with multiple system atrophy. This is more prominent in striatonigral degeneration type of multiple system atrophy. Slowing of movement (bradykinesia) and rigidity are more common, while tremor, which is more common in idiopathic Parkinson's disease, is less prominent in multiple system atrophy. Furthermore, like idiopathic Parkinson's disease, these patients also display gait disturbance, which is independent of ataxia. In contrast to idiopathic Parkinson's disease, the parkinsonian symptoms in these patients respond poorly to dopaminergic agents.

Ataxia

Ataxia of the limbs generally occurs first, predominantly in patients with olivopontocerebellar-type of multiple system atrophy. This leads to gait disturbance. Ataxia in these patients is of cerebellar origin and this can progress to other cerebellar signs, which include dysarthria (speech impairment), and myoclonus (jerking movement of muscles). Abnormalities of eye movements of the cerebellar origin also occur, such as nystagmus (involuntary movements of the eyeball). Examination of the eye movements is important in terms of diagnosis because supranuclear vertical gaze abnormalities, that is, inability to move eyes voluntarily, particularly downward, would be consistent with a diagnosis of progressive supranuclear palsy rather than multiple system atrophy.

Autonomic dysfunction

Autonomic dysfunction occurs in a significant number of patients with multiple system atrophy and is more prominent in patients with Shy-Drager Syndrome. Clinical manifestations of autonomic dysfunction include orthostatic hypotension, gastrointestinal disturbance (i.e., constipation or fecal incontinence), urinary disturbance including urinary retention, urinary incontinence, and impotence. In addition to this, there is impairment in sweating. Postural hypotension in which there is a drop in the systolic blood pressure of 20 mm or more upon standing can cause significant disability in these patients. Some of the symptoms include lightheadedness, although loss of consciousness can also occur leading to morbidity in these patients. In terms of gastrointestinal symptoms, constipation is more common, however, dysphagia (inability to swallow) may become prominent as the disease progresses. While urinary incontinence and retention may occur, impotence is another significant autonomic dysfunction, particularly in men, which occurs in approximately 95 percent of patients at some point of the disease process.

Other general neurological findings in these patients may include upper motor neuron findings, including brisk deep tendon reflexes (such as knee jerk reflex) and extensor plantar responses (that is, up-going toe on stroking the sole of the foot. Normal response is for the toe to go down or remain in neutral position). These findings may occur in up to two-thirds of patients with multiple system atrophy, but are not a common feature of idiopathic Parkinson's disease.

Cognitive function

The majority of patients with multiple system atrophy displays a mild form of cognitive impairment reflecting frontal-subcortical system dysfunction. This is predominantly manifested by disturbances in attention, mild problems with memory, visuospatial dysfunction, and executive dysfunction.

Natural history

The age range for onset of multiple system atrophy is between 33.3 years to 75.6 years with a mean age of onset of this disease at 52.5 years. The male to female ratio ranges from 1.1:1 to 1.9:1. Mean survival time ranges from 5.5 to 9.5 years.

Treatment

The parkinsonian features in multiple system atrophy respond poorly or, at best, have modest response to dopaminergic agents. Anticholinergic agents and amantadine sometimes give mild benefit. The cerebellar signs in multiple system atrophy do not respond to any medical treatment. For postural hypotension, a high salt diet, head up-tilt of the bed at night, and elastic support stockings or tights could be used. Other agents that help postural hypotension include ephedrine fludrocortisone and octreotide. Urinary bladder dysfunction can be helped with oxybutynin, as well as intermittent catheterization. Some patients have respiratory failure such as respiratory stridor, which may require tracheostomy (a tube inserted in the wind-pipe to help a person breath) if indicated. Some patients have dysphagia, which may require gastrostomy (a tube inserted in the stomach through which nutrition is given). In general, the medical treatment of multiple system atrophy is disappointing. Physical therapy, occupational therapy, speech therapy, and other measures for safety are of paramount importance.

SULTAN DARVESH

See also BRAIN; DEMENTIA; DEMETIA WITH LEWY BODIES; FAINTING; PARKINSONISM.

BIBLIOGRAPHY

ADAMS, R. D., VAN BOGAERT, L.; and VANDER EECKEN, H. "Striato-nigral Degeneration." *Journal of Neuropathology and Experimental Neurology* 23 (1964): 584–608.

DÉJÉINE, J., and THOMAS, A. A. "L'atrophie olivo-ponto-cérébelleuse." *Nouveau Inconog. Salpetriere* 13 (1900): 330–370.

GRAHAM, J. G., and OPPENHEIMER, D. R. "Orthostatic Hypotension and Nicotine Sensitivity in a Case of Multiple System Atrophy." *Journal of Neurology, Neurosurgery and Psychiatry* 32 (1969): 28–34.

NAKAZATO, Y.; YAMAZAKI, H.; HIRATO, J.; ISHIDA, Y.; and YAMAGUCHI, H. "Oligodendroglial Microtubular Tangles in Olivopontocerebellar Atrophy." *Journal of Neuropathology and Experimental Neurology* 49 (1990): 521–530.

QUINN, N. P., and WENNING, G. K. "Multiple System Atrophy." *Advances in Neurology* 69 (1996): 413–419.

SHY, G. M., and DRAGER, G. A. "A Neurologic Syndrome Associated with Orthostatic Hypo-

tension." *Archives of Neurology* 2 (1960): 511–527.

WENNING, G. K.; BEN SHIOMO, Y.; MAGALHAES, M.; DANIEL, S. E.; and QUINN, N. P. "Clinical Features and Natural History of Multiple System Atrophy: An Analysis of 100 Cases." *Brain* 117 (1994): 835–845.

MUTATION

There is ample evidence that mutations are causally related to cancer, a prominent age-related disease. Since the 1950s the accumulation of spontaneous mutations in the DNA of organs and tissues has been hypothesized to underlie aging itself (e.g., Failla, 1958). What are mutations, and why are they there? First, it is necessary to distinguish DNA mutations from DNA damage. DNA damage consists of chemical alterations in DNA structure, leading to a structure that can no longer serve as a substrate for faithful replication or transcription. DNA damage cannot be copied to end up in daughter cells. DNA mutations are heritable changes in a DNA sequence of an organism, which can be part of a gene, a gene regulatory region, or some noncoding part of the genome. Mutations are usually introduced as a consequence of misreplication or misrepair, for example, due to the presence of DNA damage. Hence, DNA damage can lead to mutations when it is not correctly repaired. Mutations can vary from point mutations, involving single or very few base pairs to large deletions, insertions, duplications, and inversions. In organisms with multiple chromosomes, DNA from one chromosome can be joined to another and the actual chromosome number can be affected.

Mutations are inevitable. Indeed, they fuel the survival of cells and organisms in times of stress. They are the substrate for evolution, which gave rise to different life forms. In both prokaryotic and eukaryotic cells mutation rate can be greatly increased, causing many cells to die but also giving rise to cells with the necessary attributes to survive and expand. Cancer cells, for example, can undergo mutations in genes that control the mutation rate (for example, genes involved in DNA repair). Such "mutator phenotypes" allow them to accelerate the acquisition of novel attributes (e.g., drug resistance, tissue invasivity) through gene mutation. While in such cases mutations are detrimental for the host, they are beneficial for the cell. In most cases, mutations will have adverse effects on both the host and the cell. In the somatic cells of multicellular organisms, however, mutations usually have adverse effects.

Gross chromosomal alterations

The earliest and still the most popular way to look at mutations is by cytogenetic means. This necessarily precludes the detection of mutational events smaller than a few million base pairs and also limits the target tissue to cells in metaphase, usually white blood cells. A noteworthy exception to this latter limitation is the original work of the late Howard Curtis (1963), who with coworkers examined mouse liver parenchymal cell metaphase plates after partial hepatectomy and found considerably higher numbers of cells with abnormal chromosomes in old, compared with young, animals (i.e., from about 10 percent of the cells in mice four to five months old to 75 percent in mice older than twelve months). Later, large structural changes in DNA were observed to increase with donor age in white blood cells of human individuals, from about 2–4 percent of the cells having chromosomal aberrations in young individuals to about six times higher in the elderly. The recent use of more advanced methods, such as chromosome painting, have confirmed the increase in cytogenetic damage with age in both human and mouse. In both human and mouse lymphocytes the increase in chromosome aberrations appeared to be exponential.

Mutations detected in selectable marker genes

With the development of tests based on selectable endogenous marker genes, it became possible to assess mutation frequencies at these loci in T-cells from human and animal donors (for a review see Vijg, 2000). Using the hypoxanthine phosphoribosyl transferase (HPRT) locus test, investigators have shown that mutation frequencies at this locus increase with donor age. For example, results obtained with this assay suggest that mutation frequencies in humans increase with age from about 2×10^{-6} in young individuals to about 1×10^{-5} in middle aged and old individuals. In mice mutation frequencies have been reported from about 5×10^{-6} in young animals to about 3×10^{-5} in middle aged mice (Dempsey et al., 1993). However, in both mice and humans these values could be underestimates, due to the loss of HPRT mutants in vivo or in vitro. Indeed,

results from Grist et al. (1992), who assayed the HLA locus (using immunoselection for mutationally lost HLA antigen) in human lymphocytes, indicate mutant frequencies two to three times higher. Values higher than HPRT were also found with other assays involving selectable target genes. The discrepancy has been explained in terms of the inability of the HPRT test to detect mitotic recombination events (HPRT is X-linked) and a relatively strong in vivo selection against mutants.

In mice subjected to caloric restriction, the only intervention demonstrated to increase life span (Masoro, 1993), HPRT mutation frequencies were found to increase with age at a significantly slower rate than in the animals that fed at will. Dempsey et al. (1993) studied both types of animals for twelve months. They saw an age-associated accumulation of mutations in the mice that fed at will, but not in the mice that experienced calorie restriction. Their conclusion was that the great majority of endogenous mutations are related to diet. However, it is not clear if this effect of diet is the result of intake of multiple exogenous mutagens or is related to the metabolism of food.

The results of Dempsey et al. suggest that the level of accumulated somatic mutations reflects biological rather than chronological age. This conclusion was further strengthened by Odagiri et al. (1998), who demonstrated accelerated accumulation of mutations in peripheral blood lymphocytes of so-called senescence-accelerated mice (SAM). Although the SAM model is not generally accepted as a mouse model of accelerated aging, these findings nevertheless demonstrate a link between somatic mutation rate and physiological decline. Interestingly, the HPRT test has been used on tubular epithelial cells of kidney tissue from human donors two to ninety-four years old. The mutation frequencies found were much higher than the values for blood lymphocytes and also increased with age (Martin et al., 1996). The high mutation frequency in the kidney cells could reflect a relatively slow turnover as compared to T-cells.

Mutations in transgenic mouse reporter genes

With the development of transgenic mouse models harboring chromosomally integrated reporter genes, it became possible to directly test the hypothesis that somatic mutations in a neutral (with no function) gene accumulate with age in various organs and tissues (Gossen and Vijg, 1993). Using one of these models, harboring the lacI gene as a target, Lee et al. (1994) were the first to demonstrate an age-related increase in mutation frequency in spleen from about 3×10^{-5} in mice of a few weeks old to $1\text{-}2 \times 10^{-4}$ in 24-month-old animals. Subsequent results from other laboratories indicated age-related increases in mutation frequency in some, but not all, organs. Dollé et al. (1997), for example, demonstrated that mutation frequencies at a lacZ transgene increase with age in the liver, while such an increase was virtually absent in the brain. The increased susceptibility to spontaneous mutagenesis of liver versus brain corresponds to observed higher frequency of focal pathological lesions in the mouse liver as compared with the brain (Bronson, 1990). More recently, the pattern of organ specificity in age-related mutation accumulation was expanded with the observation of age-related increases in mutation frequencies in spleen, heart, and small intestine, but not in testes (Dollé et al., 2000).

Essentially the same results obtained by Dollé et al. (1997) were found by Ono et al. (2000). These investigators used the original mouse model of Gossen et al. (1989), harboring the same transgene. They also observed an age-related increase of mutation frequency in the liver, heart, and spleen, but virtually no increase in the brain and testes. Dollé et al. (1997; 2000) also observed striking organ specificity with respect to the mutational spectra of the old animals. While in the small intestine and the brain virtually only point mutations accumulated (the small increase in the brain was almost totally due to point mutations), in the liver and especially in the heart large deletion mutations were a prominent part of the spectrum (Dollé et al., 1997).

In interpreting these data it should be noted that the observed increases were modest (varying from less than twofold, to more than fourfold) and appeared to level off at middle age (Lee et al., 1994; Dollé et al., 1997). The relatively small age-related increase of mutant frequencies can be interpreted as evidence against a major role for somatic mutations in aging (Warner and Johnson, 1997). However, although transgenic reporter genes do not suffer from a selection bias (as is the case with most selectable endogenous targets), it still provides an underestimate of the real mutation load and its adverse effects. Homologous (mitotic) recombination, for example,

leading to deletion of entire reporter gene copies is a frequent mutational event and goes undetected in the transgenic assays. Most of the transgenic models also do not account for mutational hot spots, and such important functional end points as cell death are missed. Indeed, to put the results on mutant frequencies of different organs and tissues at various age levels into context, it will be necessary also to assess cell proliferation and cell death. Most important, it will be necessary to determine at some point the critical level of cellular mutation loads in terms of physiological consequences. The question is whether the mutation loads observed in a tissue at old age have physiological consequences. A glimpse of an answer can possibly be obtained from another type of model system.

Models for genome instability

Evidence that mutation accumulation does play a role in the functional decline and increased incidence of disease associated with aging can be derived from the work with mouse models having genetically engineered defects in genome stability systems. For example, cells in highly proliferating organs of telomerase-null mice (knockout or defective mice) showed erosion of telomeres, resulting in high levels of genetic instability (fusion and loss of chromosomes), accompanied by increased programmed cell death and a compromised capacity for cell renewal in spleen and bone marrow. In a subsequent study of third-generation telomerase-null mice, shortened life span was found to be accompanied by reduced capacity to respond to stresses, such as wound healing, and by an increased incidence of spontaneous malignancies (Rudolph et al., 1999). The results of these studies underscore that in proliferative organs (highly proliferating cells in organs of telomerase defective mice) the early initiation of genetic instability due to telomere erosion can greatly accelerate age-related loss of cell viability and increased tumor formation.

Other examples of genome stability mutants that point to accelerated aging are mouse models with inactivated genes involved in double-strand break repair. These animals prematurely exhibit symptoms of age-related degeneration in liver, skin, and bone (Vogel et al., 1999). Hence, it appears that genetic defects promoting genomic rearrangements are associated with symptoms of accelerated aging (for a review see Vijg, 2000). This would be in keeping with the results of studies involving patients with Werner syndrome. This genetic disease, caused by a heritable mutation in a single gene (the WRN gene), is characterized by the accelerated occurrence of certain aspects of the senescent phenotype, including cancer. The WRN gene contains both a helicase and an exonuclease function and is thought to play a role in suppressing genomic instability. Indeed, cultured somatic cells from patients with Werner syndrome display an increased rate of somatic mutations and a variety of cytogenetic abnormalities, such as deletions and translocations (Fukuchi et al., 1989). This high level of genomic instability could be the cause of the severe limitation of in vitro life span demonstrated in these cells. Other so-called progeroid syndromes, such ataxia telangiectasia and Bloom syndrome show increased genomic instability (for a review, see Turker and Martin, 1999).

Summary and future prospects

In summary, there is now conclusive evidence that mutations accumulate with age in most organs and tissues of the mouse and in white blood cells of mice and humans. A considerable fraction of this loss of stability of the nuclear genome consists of genome rearrangements. Genome rearrangements in the form of illegitimate recombinations are likely to be due to misrepair and misannealing of double-strand breaks or other DNA lesions opposite one another on the two DNA strands. In view of the elevated occurrence of this type of mutation in white blood cells of patients with segmental progeroid syndromes, it is tempting to speculate that if mutations contribute to the adverse effects associated with aging, genome rearrangements play a major role. Indeed, it is unlikely that randomly induced point mutations will have a major effect on cell functioning. Cellular systems are robust, and insensitive to many mutations. However, sizable genome rearrangements, even a relatively small number, could seriously affect normal regulation, through gene dosage or position effects. A dosage effect is another standard term in biology and means that an additional copy of the gene (or additional copies) will increase the amount of proteins that are produced. (And the other way around, i.e., when one of your two copies of gene X is deleted you may produce less of protein X). In actively proliferating cell compartments one of the predicted effects would be hyperplasia,

neoplasia, and tissue atrophy. Hyperplasia is like neoplasia, but a forestage. In many cases (perhaps most) it stays with that and a tumor never results. Atrophy simply means a reduction in mass because of cell loss. In postmitotic cells it could affect a variety of functional pathways leading to a mosaic of cells at different stages and finally to cell death.

Future research in the area of mutation accumulation as a possible cause of aging is likely to focus on two topics. First, more and more emphasis is now given to mouse models genetically manipulated to have defects in genome stability systems. As outlined above, many of these mice also show signs of accelerated aging. By using so-called knock-in models in which natural genes are replaced by genes with subtle alterations rendering them less effective, it should be possible to generate models with overall less effective genome preservation systems without the total absence of one important gene function. If aging is caused by mutation accumulation, it is likely that such mice will mimic the aging phenotype more fully than single-gene knockouts.

Second, a more recent approach, made possible by the completion of the Human Genome Project, is to analyze all genome instability genes for polymorphic variation in different populations of elderly individuals. Gene variants, alone or in combination with others, can then be studied for association with natural differences in life span, functional decline, and age-related disease among elderly persons. Studies of individuals over one hundred years old have provided evidence that genes may play an increasingly prominent role in the ability to achieve older and older age beyond average life expectancy (Perls et al., 1998). It is possible that a combination of optimal genome stability genotypes contributes to the longevity in centenarians.

JAN VIJG

See also ACCELERATED AGING: ANIMAL MODELS; ACCELERATED AGING: HUMAN PROGEROID SYNDROMES; CELLULAR AGING: CELL DEATH; GENETICS; LONGEVITY: REPRODUCTION; LONGEVITY: SELECTION; NUTRITION: CALORIC RESTRICTION; STRESS; THEORIES OF BIOLOGICAL AGING.

BIBLIOGRAPHY

BRONSON, R. T. "Rate of Occurrence of Lesions in 20 Inbred and Hybrid Genotypes of Rats and Mice Sacrificed at 6 Month Intervals During the First Years of Life." In *Genetics of Aging,* Vol. 2. Edited by D. E. Harrison. Caldwell, N.J.: Telford Press, 1990. Pages 280–358.

CURTIS, H. J. "Biological Mechanisms Underlying the Aging Process." *Science* 141 (1963): 686–694.

DEMPSEY, J. L.; PFEIFFER, M.; and MORLEY, A. A. "Effect of Dietary Restriction on in Vivo Somatic Mutation in Mice." *Mutation Research* 291 (1993): 141–145.

DOLLÉ, M. E. T.; GIESE, H.; HOPKINS, C. L.; MARTUS, H. J.; HAUSDORFF, J. M.; and VIJG, J. "Rapid Accumulation of Genome Rearrangements in Liver but not in Brain of Old Mice." *Nature Genetics* 17 (1997): 431–434.

DOLLÉ, M. E. T.; SNYDER, W. K.; GOSSEN, J. A.; LOHMAN, P. H. M.; and VIJG, J. "Distinct Spectra of Somatic Mutations Accumulated with Age in Mouse Heart and Small Intestine." *Proceedings of the National Academy of Sciences of the United States of America* 97 (2000): 8403–8408.

FAILLA, G. "The Aging Process and Carcinogenesis." *Annals of the New York Academy of Science* 71 (1958): 1124–1135.

FUKUCHI, K.; MARTIN, G. M.; and MONNAT, R. J., JR. "Mutator Phenotype of Werner Syndrome is Characterized by Extensive Deletions." *Proceedings of the National Academy of Sciences of the United States of America* 86 (1989): 5893–5897.

GOSSEN, J. A.; DE LEEUW, W. J. F.; TAN, C. H. T.; LOHMAN, P. H. M.; BERENDS, F.; KNOOK, D. L.; ZWARTHOFF, E. C., and VIJG, J. "Efficient Rescue of Integrated Shuttle Vectors from Transgenic Mice: A Model for Studying Gene Mutations in Vivo." *Proceedings of the National Academy of Sciences of the United States of America* 86 (1989): 7971–7975.

GOSSEN, J. A., and VIJG, J. "Transgenic Mice as Model Systems for Studying Gene Mutations In Vivo." *Trends in Genetics* 9 (1993): 27–31.

GRIST, S. A.; MCCARRON, M.; KUTLACA, A.; TURNER, D. R.; and MORLEY, A. A. "In Vivo Human Somatic Mutation: Frequency and Spectrum with Age." *Mutation Research* 266 (1992): 189–196.

LEE, A. T.; DESIMONE, C.; CERAMI, A.; and BUCALA, R. "Comparative Analysis of DNA Mutations in lacI Transgenic Mice with Age." *Federation of American Societies for Experimental Biology Journal* 8 (1994): 545–550.

LOEB, L. A. "Endogenous Carcinogenesis: Molecular Oncology into the Twenty-First Century—Presidential Address." *Cancer Research* 49 (1989): 5489–5496.

MARTIN, G. M.; OGBURN, C. E.; COLGIN, L. M.; GOWN, A. M.; EDLAND, S. D., and MONNAT, R. J., JR. "Somatic Mutations are Frequent and Increase with Age in Human Kidney Epithelial Cells." *Human Molecular Genetics* 5 (1996): 215–221.

MASORO, E. J. "Dietary Restriction and Aging." *Journal of the American Geriatrics Society* 41 (1993): 994–999.

ODAGIRI, Y.; UCHIDA, H.; HOSOKAWA, M.; TAKEMOTO, K.; MORLEY, A. A.; and TAKEDA, T. "Accelerated Accumulation of Somatic Mutations in the Senescence-Accelerated Mouse." *Nature Genetics* 19, no. 2 (1998): 116–117.

ONO, T.; IKEHATA, H.; NAKAMURA, S.; SAITO, Y.; HOSOI, Y.; TAKAI, Y.; YAMADA, S.; ONODERA, J.; and YAMAMOTO, K. "Age-Associated Increase of Spontaneous Mutant Frequency and Molecular Nature of Mutation in Newborn and Old lacZ-Transgenic Mouse." *Mutation Research* 447 (2000): 165–177.

PERLS, T. T.; BUBRICK, E.; WAGER, C. G.; VIJG, J.; and KRUGLYAK, L. "Siblings of Centenarians Live Longer." *Lancet* 351 (1998): 1560.

RUDOLPH, K. L.; CHANG, S.; LEE, H. W.; BLASCO, M.; GOTTLIEB, G. J.; GREIDER, C.; and DEPINHO, R. A. "Longevity, Stress Response, and Cancer in Aging Telomerase-Deficient Mice." *Cell* 96 (1999): 701–712.

TURKER, M. S., and MARTIN, G. M. "Genetics of Human Disease, Longevity and Aging." In *Principles of Geriatric Medicine and Gerontology,* 4th ed. Edited by W. R. Hazzard, J. P. Blass, W. H. Ettinger, Jr., J. B. Halter, and J. G. Ouslander. New York: McGraw-Hill, 1999.

VIJG J. "Somatic Mutations and Aging: A Re-Evaluation.". *Mutation Research* 447 (2000): 117–135.

VOGEL, H.,; LIM, D. S.; KARSENTY, G.; FINEGOLD, M.; and HASTY, P. "Deletion of Ku86 Causes Early Onset of Senescence in Mice." *Proceedings of the National Academy of Sciences of the United States of America* 96 (1999): 10770–10775.

WARNER, H. R., and JOHNSON, T. E. "Parsing Age, Mutations and Time." *Nature Genetics* 17 (1997): 368–370.

N

NARRATIVE

Narrative can be situated within the range of speech acts that comprise ordinary communication. At one end, there are relatively brief communications, such as token conversational responses like "umm" or "uh-huh" or short descriptive statements like "I've felt that way all my life." At the other end, where narrative is situated, are more extended and complex commentaries, such as full-blown life stories or the frames of reference that researchers themselves use to analyze narrative material (Linde; Gubrium and Holstein; McAdams; Riessman). Harvey Sacks, a pioneer of conversation analysis, characterized narrative or storytelling as an extended turn at talk or a relatively lengthy speech act (see Silverman).

A distinguishing feature of research on ordinary communication is that it centers on naturally occurring speech, as it is conveyed in subjects' own words. For example, if the subject is the aging World War II veteran, the veteran's own responses to the war experience is of central concern, not, for example, contemporary front-line journalists' accounts of the soldier's experience or a spouse's reports about her husband's thoughts and feelings in the course of battle. What others say about the subject's experience, how they describe the subject's world, and the explanations they offer for his or her sentiments and conduct are of secondary interest.

The subject is not always a single category of individual. The focus of attention may center on narratives of any and all who subsequently commented on the war experience, which would include the soldier himself, significant others, and journalists' remarks, among those whose narratives served to communicate what it was like to be in and survive the war. The subject might be extended to include the narratives of veterans of other wars, such as the Korean and Vietnam wars, perhaps aiming to document comparatively how public sentiments surrounding war affect the way soldiers communicate their identities and fighting aims (see Hynes). Whoever the subject is and however extended this is categorically, the goal of narrative analysis is to focus attention on subjects' own accounts.

The growing significance of narrative

The acceptance of narrative analysis as an approach to understanding experience has grown significantly. The social sciences, in particular, have undergone a resurgence of interest in life stories. Narrative analysis is now once again an important investigatory and research genre. One stream of early work in the area—tellingly called the "own story" approach—produced rich and detailed depictions of individuals' social lives. A leading example is sociologist Clifford Shaw's presentation of "a delinquent boy's own story" in his book *The Jack-Roller,* which portrayed the subject, Stanley, and his delinquent career, in Stanley's own words. To Shaw and others working in this vein, statistical profiles, professional assessments, and other "outsider" reports were no substitute for the deep understanding one gained from a narrative approach, a perspective now being extensively revisited.

The widespread contemporary interest in life stories followed a fallow period, from the

1950s through the 1970s, in which the leading research paradigms eschewed narrative. Narrative analysis was figured to be too "subjective," emphasizing that term's association with being biased. The view was that only neutral outsiders could be objective in describing personal experience, which by the same token required "objective" research procedures. This led to the proliferation of positivistic, quantitative techniques in these decades, which stressed measurement and statistical analysis, not the extended story-like accounts favored by narrative researchers.

The resurgence of interest in narrative, which began in the 1980s, stemmed in part from the disappointingly thin representations of experience produced by positivistic methods. While surveys of experience of all kinds, from quality of life to political sentiments, provided information about the distribution of attitudes and opinions, they offered little understanding of how these operated in subjects' lives. The desire for richer detail reminded researchers of the promises of early work on narrative material, once again centering attention on the subject's "own words" and "own story," as communicated by those whose experiences were under consideration. At the outset of the twenty-first century, narrative analyses of all kinds are being conducted across the social sciences and overlapping fruitfully with literary, linguistic, and historical studies (Holstein and Gubrium; Josselson and Lieblich; Rosenwald and Ochberg).

The structure of stories

The key argument that experience comes to us by way of narrative suggests that experience can be viewed as structured along the same lines that stories are. For example, when we are asked about what may have happened to us over a particular span of time, we are likely to respond with an unfolding story, not just a list of events. A listing is simply a series of happenings, which may or may not be organized chronologically. A story, in contrast, can have myriad internal linkages and thus considerable overall organizational complexity. These linkages supply both the meaningful connections between events and the horizons of meaning that comprise the varied worlds of lived experience.

Stories and their events are narratively structured in at least three ways—through characterization, by formulating events into plots, and by discerning an overall theme or point. In responding to a question about what one has experienced, one can, respectively, describe who was involved and how, detail the temporal organization of events, and make a point, for example, of what it all led to or explain why things developed as they did. For instance, as far as characterization is concerned, the dramatis personae of the story of one's caregiving experience for a demented parent may be limited to the caregiver and the care receiver, with all events described as unfolding around them. The point being made about the experience might be that, overall, it was an important learning experience and strengthened the caregiver's resolve as a person. In contrast, such a story might be told in terms of a huge cast of characters, ranging from the caregiver and care receiver themselves, to professionals, neighbors, friends, and both close and distant relatives, and whose plot links up with the point that if it had not been for the help and support of others, the caregiver would not have survived the ordeal.

While the actual experience of caregiving might be similar in any two cases, their respective characterizations, the plots, and the points subsequently conveyed, can make for distinct forms of knowledge. In practice, we respond as much, if not more, to the stories told about experience as to the experience in its own right. The argument that experience comes to us in the form of stories is important because the organization of stories, separate from what actually happened, bears significantly on how we respond to the events in question. The relevance of studying stories follows directly from this, as their organization brings the researcher face-to-face with the experience's communicative realities.

Each of the three ways of structuring a story can be further divided into subcategories, into forms of characterization, kinds of plots, and types of themes. Vladimir Propp was an important pioneer in distinguishing the underlying plot structure of the folk tale, for example, an approach that other narrative researchers have since developed extensively into additional structures and categorizations (see Polkinghorne). Moreover, the three ways of structuring a story may be narratively related in different ways. For example, emphasis might be placed on characterization, with the plot and the point given relatively minor roles, or conversely the point and plot might be highlighted with little character de-

velopment. This, too, affects how we respond to the experiences being described.

Applications to aging

One of the earliest applications of a narrative approach in gerontology was clinical and focused on the life review (Butler and Lewis). Psychiatrist Robert Butler determined that in old age, individuals were likely sooner or later to take stock of their lives in relation to their impending death. The process of coming to terms with the past in relation to the present was called the *life review* and was seen to have a positive psychological function. Butler advised professional caregivers and service providers to encourage life reviews—narrative reconstructions of a lifetime of experience—as a way of producing overall meaning at life's end. However, the life review approach is controversial because it focuses on the individual and fails to take account of the circumstances of the reconstructions, which may prove to have negative consequences for the life reviewer (Kenyan and Randall).

Anthropologist Sharon R. Kaufman's study of personal narrative and identity in old age has made a significant contribution to the formulation of an area of research now called *narrative gerontology* (Kenyon, Clark, and de Vries). Kaufman's book *The Ageless Self* shows that older people are narratively active in conveying the contours of their lives through stories. The plots and themes are not governed by old age itself for Kaufman's respondents, nor by this generation's major historical experiences, such as having lived through the Great Depression and World War II. Significantly, Kaufman's respondents construct the stories of their lives on separate terms, many of them centered on personal values (but see Ruth and Öberg for contrasting results).

Sociologist Jaber F. Gubrium's study of the life narratives of nursing home residents takes this approach into an institutional setting. Gubrium's research focused on the quality of care and of life in the nursing home; he was interested, in particular, in how the residents themselves communicated these qualities. Rather than asking exclusively about the qualities, he raised questions about them in relation to the residents' life stories. The rationale for this was that residents don't leave a lifetime of experiences behind when they check into nursing homes. Interestingly enough, the qualities of life and of care in the nursing homes studied had strikingly distinct meanings. No particular degree of quality of life or of quality of care seemed to matter as much as what the nursing home experience meant in the context of life as a whole. The "same" quality of care, in other words, had different meanings for residents with contrasting life stories.

There are many other new applications in place in gerontology. Researchers have been studying the way that emotional experience is narratively conveyed across the life course. Others are researching the character of storytelling in therapeutic encounters in old age. Some are revisiting the life review approach in nursing practice and in adult education, as well as examining life stories against a variety of historical events (see Birren et al). Studies combining narrative approaches with more traditional, field-based research also are showing considerable promise. Researchers are examining how characterization, plots, and themes are mediated by the social settings in which they are conveyed, such as in focus groups, formal care organizations, and distinct residential environments (see Rowles and Schoenberg). A new technique known as *guided autobiography* is extending the study of narrative to include the researchers and interviewers as co-storytellers, as those who elicit life stories are taken to be in narrative collaboration with their subjects (Kenyon). Across the board, the research horizon for narrative studies in aging is vibrant and expanding.

JABER F. GUBRIUM
JAMES A. HOLSTEIN

See also LIFE REVIEW; QUALITATIVE RESEARCH.

BIBLIOGRAPHY

BIRREN, J. E.; KENYON, G. M.; RUTH, J.-E.; SCHROOTS, J. J. F.; and SVENSSON, T., eds. *Aging and Biography*. New York: Springer, 1996.

BUTLER, R. N., and LEWIS, M. *Aging and Mental Health*. St. Louis, Mo.: C. V. Mosby Co., 1977.

GUBRIUM, J. F. *Speaking of Life: Horizons of Meaning for Nursing Home Residents*. Hawthorne, N.Y.: Aldine de Gruyter, 1993.

GUBRIUM, J. F., and HOLSTEIN, J. A. *The New Language of Qualitative Method*. New York: Oxford University Press, 1997.

HOLSTEIN, J. A., and GUBRIUM, J. F. *The Self We Live By: Narrative Identity in a Postmodern World*. New York: Oxford University Press, 2000.

HYNES, S. *The Soldiers' Tale: Bearing Witness to Modern War*. New York: Penguin, 1997.

JOSSELSON, R., and LIEBLICH, A. *The Narrative Study of Lives*. Thousand Oaks, Calif.: Sage, 1993.

KAUFMAN, S. R. *The Ageless Self: Sources of Meaning in Late Life*. Madison, Wis.: University of Wisconsin Press, 1986.

KENYON, G. M. "Guided Autobiography." In *Qualitative Gerontology*. Edited by Graham D. Rowles and Nancy Schoenberg. New York: Springer, 2001.

KENYON, G. M. and RANDALL, W. L. *Restorying Our Lives: Personal Growth Through Autobiographical Reflection*. Westport, Conn.: Praeger, 1997.

KENYON, G. M.; PHILLIP, C.; and DE VRIES, B., eds. *Narrative Gerontology: Theory, Research, and Practice*. New York: Springer, 2001.

LINDE, C. *Life Stories: The Creation of Coherence*. New York: Oxford University Press, 1993.

MCADAMS, D. P. *The Stories We Live By*. New York: Guilford Press, 1993.

POLKINGHORNE, D. E. *Narrative Knowing and the Human Sciences*. Albany, N.Y.: SUNY Press, 1988.

PROPP, V. *The Morphology of the Folk Tale*. (1928). Reprint, Austin: University of Texas Press, 1968.

RIESSMAN, C. K. *Narrative Analysis*. Thousand Oaks, Calif.: Sage, 1993.

ROSENWALD, G. C., and OCHBERG, R. L., eds. *Storied Lives*. New Haven, Conn.: Yale University Press, 1992.

ROWLES, G. D., and SCHOENBERG, N., eds. *Qualitative Gerontology,* 2d ed. New York: Springer, 2001.

RUTH, J.-E., and ÖBERG, P. "Ways of Life: Old Age in a Life History Perspective." In *Aging and Biography*. Edited by James E. Birren, Gary M. Kenyon, Jan-Erik Ruth, Johannes J. F. Schroots, and Torbjorn Svensson. New York: Springer, 1996. Pages 167–186.

SACKS, H. *Lectures on Conversation, V. I & II*. Oxford, U.K.: Blackwell, 1992.

SHAW, C. R. *The Jack-Roller: A Delinquent Boy's Own Story*. (1930). Reprint, Chicago: University of Chicago Press, 1966.

SILVERMAN, D. *Harvey Sacks: Social Science and Conversation Analysis*. London: Sage, 1998.

THE NATIONAL INSTITUTE ON AGING/NATIONAL INSTITUTES OF HEALTH

The present challenge of research on aging is to maintain or even accelerate the trend of declining disability and disease rates in the context of the anticipated rise in the number of older people. Demographic projections show that the U.S. population will begin to age rapidly after 2011, the year the first baby boomers turn sixty-five. Between 2000 and the year 2030, the number of people over sixty-five likely will double, reaching 70.3 million and comprising a larger proportion of the entire population, up from 13 percent in 2000 to 20 percent in 2030.

Of great interest is the explosive growth anticipated among those most at risk for disease and disability, people age eighty-five and older. Their ranks are expected to grow from 4.3 million in 2000 to at least 19.4 million in 2050. The racial and ethnic makeup of the older population will change dramatically as well, possibly bringing with it even greater racial and ethnic disparities in health among a more diverse population of Americans. These demographic factors threaten to increase the burden of age-related disease and conditions on individuals, families, and society.

In this new millennium, the National Institute of Aging's (NIA's) research portfolio is aimed primarily at increasing "health span," the years of healthy, active life expectancy. NIA is one of twenty-seven Institutes and Centers of the National Institutes of Health (NIH), established by authority of the U.S. Congress in 1974. The specific missions of the NIA are the following:

- To support and conduct high-quality research on the biochemical, genetic, and physiological mechanisms of aging in humans and animal models; on the structure and function of the aging nervous system; on social and behavioral aspects of aging processes and the place of older people in society; and on the pathophysiology, diagnosis, treatment, and prevention of age-related disease, degenerative conditions, and disabilities. It is the primary federal agency responsible for Alzheimer's Disease (AD) research.
- To train and develop highly skilled research scientists.
- To develop and maintain state-of-the-art resources to accelerate research progress.
- To communicate with the public and disseminate information on health and research advances, and to give new directions for research. (See www.nia.nih.gov.)

Since its inception, NIA has grown significantly, in part because of the recognition by the federal government and Congress of the importance of research on aging. NIA's funding since 1996 increased from $324 million to over $785 million in 2001. About 10 percent of its budget goes to an intramural program that conducts basic and clinical research on aging in several scientific laboratories that are maintained by NIA (www.nia.nih.gov/research/intramural).

More than 85 percent of NIA's budget goes to support extramural research and training activities at educational and research institutions throughout the United States and in other countries. The extramural program helps to set the national scientific agenda for research on aging, and funds research and training at universities, hospitals, medical centers, and other public and private organizations in the United States (www.nia.nih.gov/research/extramural).

The extramural group focuses on four program areas. The Biology of Aging Program emphasizes research on the biochemical, genetic, cellular, and physiological mechanisms of aging, and has revolutionized scientific understanding of cellular and molecular changes occurring throughout the aging process. The Behavioral and Social Research Program focuses on the behavioral (e.g., cognition) and social (e.g., retirement) changes related to aging, and on older people's impact on society as well as society's impact on older persons. The Geriatrics Program focuses on age-related diseases, degenerative conditions, and disabilities. The Neuroscience and Neuropsychology of Aging Program facilitates research on the structure and function of the aging nervous system, including the brain–behavior relationship. Much of NIA's research on AD is located in this program.

Although each intramural and extramural program has a unique focus, the NIA has increasingly fostered research that is integrated across all programs. Research initiatives on genetics, on cognition, and on long-term care are examples of these crosscutting emphases. The NIA also collaborates with other NIH Institutes and Centers on research related to cardiovascular disease, cancer, neurological diseases, osteoporosis, osteoarthritis, diabetes, HIV/AIDS, behavior and health, and alternative and complementary medicine as they relate to an aging population. The NIA supports efforts by the National Academy of Sciences/National Research Council to investigate broad societal issues, such as race and ethnicity, the aging mind, and elder abuse and neglect. NIA also invests in research and infrastructure-building centers throughout the United States that are devoted to AD, minority health and minority scholars, the translation of research into practice, and applied geriatric research, among others.

To guide its future direction, the NIA has created a strategic plan for the years 2001–2005 to guide research across the life span. This research agenda is based upon scientific knowledge in gerontology and geriatrics and on opportunities to eliminate gaps in this knowledge base. Research goals include the following:

To improve health and quality of life of older persons, NIA sponsors and conducts research focusing upon developing strategies for maintaining health and function, understanding the dramatic and continuing decline in disability rates among older people, and preventing or reducing the incidence of age-related diseases, including AD. In addition to investigator-initiated research, NIA continues to support several major studies investigating cognitive, physical, sensory, and behavioral functioning. These include (1) the Roybal Centers, which translate basic behavioral and social research into practical interventions to promote independence and productivity in later life; (2) the Advanced Cognitive Training for Independent and Vital Elders (ACTIVE) clinical trials, which investigate whether targeted behavioral interventions can improve and sustain memory, reasoning skills, or speed of cognitive processing in older adults; (3) the Women's Health and Aging Study, which provides a detailed understanding of the causes and course of physical disability for older women; and (4) the Resources for Enhancing Alzheimer's Caregiver Health (REACH) study, which investigates the impact of caregiving upon the health and functioning of family caregivers of AD patients in order to lessen the profound burdens of caregiving.

To understand the healthy aging process, ongoing NIA-sponsored research is working toward unlocking the secrets of aging, health, and longevity by examining the influences of biological, environmental, psychological, and social factors. As part of this goal, NIA supports basic and applied research aimed toward understanding behavioral and biological changes that occur with normal brain aging and with neurodegenerative

disorders such as AD. The highly successful and visible Alzheimer's Disease Centers program is a national resource to gain insight into the causes and treatment of this disabling and prevalent condition. NIA also actively supports research on age-related changes in movement, perception, sensory function (e.g., taste, smell, vision, hearing); changes in sleep physiology and circadian rhythms in the elderly and in AD patients; the effects of stress on immune function; behavior in the elderly; and how personality and cognition change with age. NIA funds the Nathan Shock Centers to facilitate research on the basic biology of aging through their research resource cores that support specialized research technologies. NIA also supports Demography Centers, which focus on trends in mortality, biodemography, and longevity. These Centers are at the forefront of developing needed data and training for understanding population aging. As a national resource, NIA sustains research infrastructure activities through large longitudinal data collection efforts, such as the Health and Retirement Study and the National Long-Term Care Survey, both of which are providing insights into the antecedents and consequences of retirement, economic, and health circumstances of people as they age.

To reduce health disparities among older persons and populations, NIA sponsors research to improve active life expectancy and health status for older minority individuals. Efforts to understand health differences associated with race, ethnicity, gender, environment, socioeconomic status, geography, and culture can inform policy debates on health disparities. NIA has made reducing health disparities a major priority and is committed to supporting basic research, clinical studies, and infrastructure-building for special populations. Notable projects include (1) the Honolulu-Asian Aging Study, a longitudinal epidemiological investigation of older Japanese-American men in Hawaii; (2) the Mexican Health and Aging Study, which investigates the paradoxical health advantages of foreign-born Hispanics who seem to be healthier than U.S.-born Hispanics; and (3) the Washington Heights-Inwood Columbia Aging Project study, the Indianapolis-Nigeria project, and the Chicago Health and Aging Project, all examining the differences in dementia rates and severity among and between African, African-American, Hispanic, and white populations. NIA also sponsors the Resource Centers for Minority Aging Research to create infrastructure for research on minority health. In addition, many large-scale studies (e.g., the previously mentioned Health and Retirement Study) oversample minority populations to assure adequate examination of the health of these groups. Finally, research by independent scholars addressing health disparities is highly encouraged by each NIA program.

To enhance resources to support high-quality research, NIA maintains a strong commitment to developing and maintaining an infrastructure to support future research, program management, and information dissemination. This includes resources to train a skilled research workforce, provide necessary equipment and research resources, and disseminate information to the scientific community and to the public. To that end, NIA supports training programs for degree-granting institutions and individuals enrolled in these programs, thus enabling the production of skilled researchers. These institutions are also encouraged to establish and improve programs for identifying, recruiting, and training women and men, including minorities and individuals with disabilities, for careers in aging-related biomedical and social science. In addition, NIA provides research institutions with essential physical resources, including colonies of animal species (such as genetically altered animals) necessary for research on aging processes and specific age-related diseases. Resources for cell and tissue cultures, DNA resources for genetics, and imaging technologies for exploring the body are also supported by NIA. Further, the NIA sponsors information technologies to provide broad access to archived data vital to researchers and policymakers, and to ensure protection of anonymity and confidentiality of participants in research.

Through the research of NIA-sponsored scientists, significant strides have been made since 1990 to address major health concerns of older people. This research has helped to shift the paradigm from the supposition that degeneration of body systems and cognition is a normal consequence of aging. Instead, research on aging has promoted the view that aging is a process in which health, learning, and development can be, and should be, expected to continue throughout the life span. The NIA strives to highlight progress, emphasize scientific opportunities for additional research, and set the research agenda on aging into the twenty-first century. With the help of research on aging, the world's population can

anticipate a longer, more productive, and more healthful lifespan.

SIDNEY M. STAHL
KIMBERLY M. FIRTH

See also MEDICALIZATION OF AGING.

NEUROBIOLOGY

Although research initiatives on normal aging of the human brain are still in their infancy, experimental studies have revealed a discrete spectrum of structural, physiological, and neuropsychological alterations that accompany the senescent changes that occur in other organ systems. While neuronal atrophy is the most consistent and pervasive change associated with the aging process, investigations have documented the presence of additional abnormalities in neuronal and non-neuronal (glial cell) morphological parameters, as well as enhanced vulnerability of specific neuronal and glial subtypes to cellular injury. Regional glial-cell activation is seen during brain aging, particularly within subcortical white-matter structures. During this phase of senescence, there is an increase in the size, number, and structural protein complement of astrocytes, a class of glial cells that support neuronal survival and function by secreting growth factors and providing additional molecular cues.

Neuronal loss initially occurs only within a few selected brain structures, such as the hippocampus. Degenerative changes also exhibit regional and cell-type-specific predilections. These progressive alterations include swelling of neuronal pre-synaptic (axonal) terminals, loss of axonal integrity, deterioration of neuronal post-synaptic (dendritic) arbors and synaptic loss, widespread accumulation of age-related pigments due to progressive oxidative damage, and the presence of large cytoplasmic inclusions, vacuoles, and granules containing polysaccharide moieties. Ultrastructural studies of these latter granular deposits have revealed the presence of fibrillar material resembling degenerated membrane-like structures that contain unbranched polysaccharide chains covalently linked to specific proteins.

Separate studies on human pathological materials and using mouse model systems have also shown that aging is associated with dramatic, regional profiles of dendritic growth and regression. These dynamic changes represent compensatory responses of healthy, surviving neurons to selective patterns of neuronal atrophy, biochemical alterations, and adjacent neuronal and glial cell loss that, collectively, impair normal cellular maintenance functions. Specific forms of synaptic plasticity (i.e., hippocampal long-term potentiation) are also compromised in the aging brain.

Experimental mouse strains have been utilized to examine the biological basis of brain aging, and such strains now serve as model systems to examine the potential applications of pharmacological- and gene-based therapeutic strategies. Specific inbred mouse strains, termed *senescence-accelerated mice* (SAM), exhibit apparently normal neural development, but later in life display the neuropathological profiles seen in human aging. These animal models provide the necessary experimental reagents to examine longitudinal changes, individual variations, and neurobehavioral correlates associated with the aging process. Both SAMP-8 and SAMP-10 mice display impairments in shock-motivated simple avoidance and in conditional-avoidance T-maze tasks, but there is an absence of clear deficits using more complex behavioral paradigms. Autoimmune mouse strains have been utilized to demonstrated the presence of age-related increases in brain-reactive antibodies that are also linked to deficits in avoidance-learning paradigms. These findings are consistent with an immunological model of aging, and may help to explain the presence of chronic inflammatory responses in pathological specimens from Alzheimer's disease patients.

The reactive increases in astrocyte size and cell numbers, as well as inflammatory changes, seen in the aging brain have been associated with increased levels of expression of the astrocyte markers S100β and glial fibrillary acidic protein (GFAP), and of the cytokine interleukin-6 (IL-6). Genetically-altered (transgenic) mice with IL-6 targeted to astrocytes exhibit neurodegenerative changes similar to those present during brain aging, whereas transgenic mice with IL-6 targeted to neurons, S100β targeted to astrocytes, or mice with genetic ablation of GFAP show neuropathological and/or behavioral changes unlike those found in the senescent brain.

Age-associated pathological changes in the brain are also thought to result from the cumulative effects of oxidative damage. Oxidative stress

results in the formation of very reactive superoxide radicals. These unstable molecular species are catalyzed to hydrogen peroxide by the enzyme superoxide dismutase (SOD), and are eventually cleared by catalase or selenoglutathione peroxidase. Two competing theories suggest that elevations in SOD may either protect against oxidative damage and retard brain aging, or induce an imbalance in antioxidant enzymes and foster the enhanced production of hydroxyl radicals and ensuing oxidative damage. Various studies have suggested that levels of SOD1 and SOD2 may either be increased, decreased, or remain unchanged within the aging brain. Studies using SOD1 transgenic and gene deletion (knockout) mice suggest that SOD may be neuroprotective, and that deficiency of the enzyme may increase neuronal vulnerability to environmental stressors. The enzyme monoamine oxidase (MAO) normally produces hydrogen peroxide as a by-product of oxidative degradation of biogenic amines, which are central molecular effectors of neural communications. MAO-B levels are increased during brain aging and are thought to contribute to neurodegeneration through enhanced production of hydrogen peroxide. Selective atrophy of a specific subclass (dopamine-containing) neurons in a distinct brain region is, in fact, present in MAO-B transgenic mice. Elevated levels of corticosteroids are also found during brain senescence, and are linked to enhanced astrocyte reactivity, diminished elaboration of dendritic arbors, and ensuing neurodegeneration within the hippocampus. Growth-hormone transgenic mice exhibit accelerated brain aging as assessed by the finding of impairments of a variety of structural and neurochemical parameters.

There are also age-related deficits in a variety of neurobehavioral systems that are associated with linear declines in oxygen consumption in focal brain regions, such as the neocortex and the left thalamus. Prominent impairments in memory occur, but display significant subsystem dissociations.

Deficits in episodic, or working, memories, defined as autobiographical memories for context-specific events, are present at relatively early stages of aging, whereas alterations in semantic memories, representing general knowledge and other linguistic skills, become obvious only at later stages of senescence. Within the area of working memory, a central executive subsystem appears particularly vulnerable to age-associated impairments. Significant deficits in free recall are partially ameliorated with cued recall, however, and essentially disappear with the application of simple recognition tasks. Although older individuals display better visual than verbal memory functions, significant abnormalities in memories for faces, for abstract objects, and for the spatial location of objects also occurs. Procedural memories, however, which are required to perform skilled motor or cognitive acts, remain intact. With aging, reductions in visual acuity and contrast sensitivity are seen, mediated primarily by changes in central, rather than peripheral, connections. There are also progressive impairments in the ability to attend to objects in the visual field, particularly in the presence of visual distractors, indicating age-associated difficulties in ignoring irrelevant stimulus information.

Functional neuroimaging studies suggest that older and younger individuals utilize different brain regions and associated cognitive strategies to perform similar neurobehavioral tasks. This observation may reflect compensatory functional reorganization in older subjects, particularly in their utilization of alternate physiological interactions between the frontal lobes. In performing diverse visual processing tasks, older individuals display the requisite activation of ventral visual processing pathways, which mediate facial and object perception, and dorsal pathways, which mediate spatial perception. However, when compared to younger subjects, older individuals exhibit additional activation of the prefrontal cortices and the left temporal cortex, as well as stronger feedback influences from the frontal to the occipital lobes. With aging, there are reductions in performance of visual search tasks. In this paradigm, younger subjects show increased activation of the posterior visual cortex, whereas older individuals display enhanced bilateral activation of the prefrontal cortices. Older individuals also exhibit reductions in the accuracy of short-term facial recognition. In this task, both younger and older subjects show bilateral occipitotemporal and prefrontal cortical activation, whereas older individuals exhibit greater activation of the left dorsolateral prefrontal and occipitoparietal cortices, coupled with failure of hippocampal activation at short delay intervals.

The altered profiles of left prefrontal (semantic encoding) and parietal (short-term memory storage retrieval) cortical activation in older individuals appears to reflect the greater need

for stimulus elaboration and an increased demand on storage capacity in the aging brain. By contrast, older subjects also show reductions in long-term facial recognition, representing a failure of stimulus encoding due to an inability to activate the prefrontal cortices and the hippocampus during stimulus encoding. Thus, for this task, older individuals display a failure to engage the appropriate cognitive processing networks, as well as an inability to recruit additional networks to compensate for these deficits. Interestingly, in episodic encoding and retrieval of word pairs, a cued recall task, older subjects display reductions in brain activation within the encoding network, but also display markedly enhanced right/left prefrontal cortical interactions and additional activation of the prefrontal cortex and other brain regions.

Aging is therefore associated with a spectrum of alterations in neuropsychological skills that reflect complex changes in the fidelity of the requisite cognitive-processing networks, differential impairments of specific complementary neural subsystems, and compensatory changes in regional patterns of activation and interregional communications. These alterations represent sophisticated biological adaptations designed to facilitate optimal neural network communications. At the cellular and molecular level, age-associated deficits in brain and cognitive functioning may thus reflect the cumulative structural and metabolic consequences of senescence, coupled with the more recent finding of a global loss of gene silencing. This novel molecular mechanism normally functions to sculpt patterns of gene expression in differentiated cells, including neurons. Progressive loss of gene silencing in association with aging may lead to alterations in the functional stability, and in the viability, of these essential cellular mediators of neural communications.

MARK FREDERICK MEHLER

See also BRAIN, MEMORY; NEUROCHEMISTRY; NEURODEGENERATIVE DISEASES; NEUROENDOCRINE SYSTEM; NEUROTRANSMITTERS; PLASTICITY.

BIBLIOGRAPHY

EUSTACHE, F.; RIOUX, P.; DESGRANGES, B.; MARCHAL, G.; PETIT-TABOUE, M.-C.; DARY, M.; LECHEVALIER, B.; and BARON, J.-C. "Healthy Aging, Memory Subsystems, and Regional Cerebral Oxygen Consumption." *Neuropsychologia* 33 (1995): 867–887.

GRADY, C. L. "Brain Imaging and Age-Related Changes in Cognition." *Experimental Gerontology* 33 (1998): 661–673.

GUARENTE, L., and KENYON, C. "Genetic Pathways that Regulate Ageing in Model Organisms." *Nature* 408 (2000): 255–262.

INGRAM, D. K., and JUCKER, M. "Developing Mouse Models of Aging: A Consideration of Strain Differences in Age-Related Behavioral and Neural Parameters." *Neurobiology of Aging* 20 (1999): 137–145.

JUCKER, M., and INGRAM, D. K. "Murine Models of Brain Aging and Age-Related Neurodegenerative Diseases." *Behavioural Brain Research* 85 (1997): 1–25.

SHIMADA, A. "Age-Dependent Cerebral Atrophy and Cognitive Dysfunction in SAMP 10 Mice." *Neurobiology of Aging* 20 (1999): 125–136.

TAKEDA, T. "Senescence-Accelerated Mouse (SAM): A Biogerontological Resource in Aging Research." *Neurobiology of Aging* 20 (1999): 105–110.

TOUSSAINT, O.; REMACLE, J.; CLARK, B. F. C.; GONOS, E. S.; FRANCHESCHI, C.; and KIRKWOOD, T. B. L. "Biology of Ageing" *BioEssays* 22 (2000): 954–956.

NEUROCHEMISTRY

None of the billions of nerve cells, or neurons, in the human brain functions alone. To process information, neurons must form circuits and must communicate with each other rapidly and with great precision. Within a neuron, the electrical impulses that carry information are propagated by rapid changes in membrane potential that arise from the controlled opening and closing of ion channels. These pores in the cell membrane permit the controlled passage of positive or negative ions between the interior and exterior of the cell, and thereby the conduction of electrical impulses along the cell's processes. Additional mechanisms are required at *synapses* (neuron junctions) to pass signals from one neuron to another. Although a few neurons form *electrical synapses*, where electrical signals are conducted directly from one neuron to the other through specialized ion channels (gap junctions), most neurons in the mature nervous system communicate via *chemical synapses*. At chemical synapses, electrical activity in a presynaptic neuron causes the release of a chemical messenger, a *neurotransmitter,* which diffuses across the narrow

synaptic cleft to bind to neurotransmitter receptors on the postsynaptic neuron and elicit changes in the electrical activity of that neuron.

Neurochemistry of synaptic transmission

Multiple neurochemical processes are involved in the synthesis, packaging, and release of neurotransmitters, and in the production and function of neurotransmitter receptors. Significantly, each of these biochemical steps represents a point of potential regulation of synaptic function and a site of possible age-related changes.

Most neurons produce and release one of several small molecules that serve as neurotransmitters, including acetylcholine, biogenic amines (dopamine, norepinephrine, epinephrine, histamine, or serotonin), or amino acids (glutamate, glycine, or gamma-aminobutyric acid). Many neurons also release one or more *neuroactive peptides* (neuropeptides), which provide additional modulation of signal transmission. Low levels of neuronal activity often result in release of only the small-molecule transmitter, whereas higher levels of activity result in the corelease of neuropeptides. Release of the neuropeptides may cease at very high levels of activity, however, since peptides must be delivered from the cell body and are replenished slowly. In contrast, synthesis and packaging of other neurotransmitters occurs more rapidly because the necessary synthetic enzymes are present within the cytoplasm in the region of the synapse. The release of neurotransmitters depends upon an increase in intracellular calcium that occurs with the depolarization (decrease in membrane potential) associated with the arrival of action potentials, regenerative waves of electrical activity that are the basis for signaling along neronal processes. Increased calcium leads to modification of vesicle-binding proteins, which facilitate the fusion of vesicles, membrane-bound packages in the cytoplasm, with the cell membrane and subsequent release of the vesicles' contents into the extracellular space.

After release, all neurotransmitters bind to neurotransmitter receptors and initiate changes in the postsynaptic neuron. It is the biochemical properties of the receptor protein, rather than that of the neurotransmitter itself, that determine the response of the postsynaptic cell. Each neurotransmitter binds to a different receptor, although multiple receptor types exist for several neurotransmitters, with each receptor initiating a different response in the target neuron. Functionally, neurotransmitter receptors fall into two groups, based on the mechanisms by which they alter the electrical activity of a neuron. *Ionotropic receptors* include an ion channel as part of their structure, and binding of the neurotransmitter results in immediate opening of that ion channel. *Metabotropic receptors* influence ion channels indirectly through activation of one of several *second-messenger pathways*. The three second-messenger systems that have been identified so far are similarly organized in that each includes a ligand-binding receptor domain coupled to a transducer that regulates the activity of an effector enzyme. The enzyme produces a second messenger that acts directly on one or more target proteins or activates additional, secondary effector enzymes. In addition to regulating ion channels, second-messenger systems may influence a variety of intracellular processes and elicit long-lasting changes in stimulated neurons.

Once a neurotransmitter has activated its receptors, it must be removed or destroyed rapidly in order to permit transmission of subsequent signals. Some neurotransmitters, regardless of type, simply diffuse from the synaptic cleft. Small-molecule neurotransmitters are also taken back up by presynaptic and postsynaptic neurons and by neighboring cells. One neurotransmitter, acetylcholine (ACh), is broken down rapidly by a membrane-bound enzyme in the region of the synapse. Neuroactive peptides are eliminated only by diffusion from the synaptic cleft and by proteolysis (degradation) by extracellular enzymes; thus they tend to have more sustained effects than small-molecule neurotransmitters.

Effects of age on the neurochemistry of synapses

Normal aging appears to result in significant but restricted neurochemical changes in synapses. Each of the many steps involved in neurotransmission may be altered in some neurons, but it does not appear that there are global changes in the neurochemistry of all synapses. Studies of neurotransmitter synthesis are difficult because most of the synthetic enzymes are unstable and difficult to measure; however, synthesis of ACh has been demonstrated to diminish with age in some brain regions, including the cerebral cortex. Levels of other neurotransmitters (e.g., dopamine) also appear to decline late in life, also in a regionally specific manner. Age-

related changes in neurotransmitter receptors have been studied by direct assay of the proteins and by analysis of the binding of labeled neurotransmitters to sections of the brain. Receptors for the neuropeptides and for some amino acid neurotransmitters appear to be relatively resistant to age-related changes. In contrast, ACh, dopamine, and serotonin receptors decline with age in several regions of the brain. Even for synapses at which both neurotransmitter levels and neurotransmitter receptors are maintained, changes in second-messenger systems may produce age-related declines in synaptic function. Such changes may account for an age-dependent loss of *plasticity*—that is, a decline in the ability of synaptic stimulation to produce the sustained biochemical changes in postsynaptic neurons that underlie learning and memory.

Functional consequences of age-related neurochemical changes

It is difficult to link age-related changes in the neurochemistry of synapses to specific changes in cognitive function. Neurochemical studies of experimental animals are easier to perform and better controlled than those using postmortem human brain tissue, but they are not readily related to cognitive changes in humans. Despite such difficulties, however, there is accumulating evidence that age-related declines in transmission at cholinergic, serotonergic, and dopaminergic synapses contribute to changes in motor function, mood, and memory, respectively. Recent developments in functional brain imaging have provided significant advances in studies of the neurochemistry of synapses, changes in the aging brain, and their relationship to cognitive function. Radioactive ligands for specific neurotransmitter receptors, which can be imaged in living subjects using positron emission tomography (PET), permit investigators to visualize the activity of specific types of synapses in discrete regions of the brain. This approach permits direct comparisons of synaptic function in the brains of individuals of different ages and allows investigators to link neurochemical differences to differences in cognitive function.

DAVID R. RIDDLE

See also BRAIN; NEURODEGENERATIVE DISEASES; NEUROTRANSMITTERS; PLASTICITY.

BIBLIOGRAPHY

DEKOSKY, S. T., and PALMER, A. M. "Neurochemistry of Aging." In *Clinical Neurology of Aging*. Edited by M. L. Albert and J. E. Knoefel. New York: Oxford, University Press. 1994. Pages 79–101.

MELTZER, C. C. "Neuropharmacology and Receptor Studies in the Elderly." *Journal of Geriatric Psychiatry and Neurology* 12 (1999): 137–149.

SCHWARTZ, J. H. "Neurotransmitters." In *Principles of Neural Science*. Edited by E. R. Kandel, J. H. Schwartz, and T. M. Jessell. New York: McGraw-Hill, 2000. Pages 280–297.

STRONG, R. "Neurochemical Changes in the Aging Human Brain: Implications for Behavioral Impairment and Neurodegenerative Disease." *Geriatrics* 53 (1998): S9–S12.

NEURODEGENERATIVE DISEASES

Neurodegenerative diseases represent a diverse spectrum of chronic neurological disorders, of possible genetic etiology, that are associated with the progressive loss of motor, sensory, and perceptual functions and associated cognitive and behavioral deficits. These disorders are characterized by disease-selective profiles of adult-onset neuronal cell loss within areas of the cerebral cortex, basal ganglia, cerebellum, brain stem, and motor systems. The biological underpinnings of these complex clinicopathological entities have remained obscure.

Research on pathological aging has focused mainly on defining the causes of cell death during adult life, and has favored the cumulative cellular-damage hypothesis. However, more recent studies have suggested the existence of a final common pathway for pathological cell death in these disorders. In this scenario, individual environmental stressors that normally do not promote cell death act upon precursors of vulnerable neuronal subpopulations that exist in a precarious abnormal steady state. These observations are compatible with the increasing evidence that neurodegenerative diseases may represent fundamental disorders of neural development, characterized by novel biological responses to subtle developmental abnormalities that alter the cellular homeostasis of neuronal biosynthetic pathways without causing obvious gross developmental deficits.

In support of this developmental model of disease pathogenesis, genes that are mutated in

neurodegenerative diseases code for proteins that are expressed throughout the periods of neural induction, patterning of the neural tube, and progressive stages of neurogenesis and neuronal maturation. Numerous molecular genetic studies further suggest that the nonmutated form of these disease genes normally mediate a broad range of fundamental neurodevelopmental events. The protein products of these disease genes can interact with additional protein partners that help to orchestrate many of these essential neural maturational processes.

Additional investigations have shown that pathogenic mutations compromise only a subset of these protein-protein interactions. Further, although transgenic mice harboring pathogenic mutations for human neurodegenerative diseases do not display the obvious deficits in patterning or neurogenesis that are observed with the corresponding gene deletion models, they do exhibit subtle but progressive molecular, physiological, and structural abnormalities that predate the occurrence of a neurological phenotype and evidence of irreversible cellular injury. These pathogenic mutations are also associated with the presence of abnormal profiles of activation of selective cellular genes, and these pathologic events can prevent the proper integration and transmission of neural network signals within vulnerable neuronal subpopulations.

Finally, specific gene alleles that alter the probability of acquiring an individual neurodegenerative disease, or that modify the clinical course of the disease (e.g., apolipoprotein E [ApoE]), can influence the fidelity of cellular signaling within large plasma-membrane-associated macromolecular complexes that are normally deployed to mediate later aspects of neuronal maturation. Targeted loss of these disease-modifier genes can cause neurodegeneration, but it does not promote the occurrence of classical neurodevelopmental abnormalities, because they are not the primary activators of these neuronal differentiation pathways. These cumulative observations suggest that the normal functions of neurodegenerative disease genes may be to orchestrate progressive developmental events associated with the elaboration and maintenance of regional specialized neuronal cell types.

Although Mendelian inheritance has been observed in many neurodegenerative disorders, maternal inheritance can be documented in a subgroup of late-onset mitochondrial diseases that affect both brain and neuromuscular functions. These diseases, known as encephalomyopathies, are associated with mutations in mitochondrial genes that code for components of respiratory chain subunits involved in cellular energy metabolism. In conditions such as Alzheimer's disease and Parkinson's Disease, less than 10 percent of cases display clear genetic inheritance. In these diseases, mutations of several genes that lead to similar clinicopathological profiles have been identified.

By contrast, in Huntington's disease, a clear family history can be identified in essentially all cases. Huntington's disease is the prototype of a subgroup of neurodegenerative diseases that exhibit errors in DNA replication associated with the expansion of repeating triplet sets of nucleic acid residues (*trinucleotide repeats*) in the proximal end of the mutant gene, resulting in selective patterns of neurodegeneration. Autosomal dominant disorders within this disease subgroup include Huntington's disease and several forms of hereditary gait instability (e.g., spinocerebellar ataxia, types 1–3 and 6–8). In these disorders, heterozygotes are as severely affected as homozygotes, and the genetic abnormality is thought to endow the mutant protein with novel cytotoxic (toxic to cells) properties. By contrast, in Friedreich's ataxia, an autosomal recessive disorder, disease manifestations are caused by abnormalities in production of the mutant protein, resulting in a loss of the normal cellular function of the involved protein.

There is also a separate category of nongenetic neurodegenerative diseases, as exemplified by the disorder known as *Purkinje cell degeneration*. In this prominent example of a remote effect of systemic cancer (paraneoplastic disorder), the abnormal production of antibodies to a cytoplasmic protein (cdr2) that normally sequesters an important cell-cycle regulatory protein (Myc) within the cytoplasm of mature cerebellar Purkinje neurons results in unopposed Myc nuclear translocation and inappropriate cell cycle reentry, culminating in neuronal cell death.

Although Alzheimer's disease most often presents clinically in the later decades of life, early-onset inherited forms are now widely recognized. The pathological hallmarks of this disease are the presence of neurofibrillary tangles and senile plaques. Neurofibrillary tangles (NFTs) are composed of aggregates of hyperphosphorylated forms of a microtubular protein

called *tau*. By contrast, senile plaques (SPs) consist of accumulations of several protein species, including β-amyloid (beta-amyloid), in association with a local inflammatory reaction. The role of NFTs and SPs in the occurrence of neurodegeneration is presently unclear. With disease progression, neurons are lost in areas of the hippocampus, entorhinal cortex, and in neocortical-association areas. The genes that code for three transmembrane proteins—β-amyloid precursor protein and presenilin 1 and 2—have been linked to early-onset familial forms of Alzheimer's disease. Mutations in each of these disease genes results in the increased cellular production of a specific form of a cellular protein (β-amyloid 1-42) which is toxic to neurons. β-amyloid precursor protein and the presenilins appear to be important components of developmental pathways involved in neuronal survival and maturation.

Recently, primary mutations in tau have been associated with the presence of neurofibrillary tangles and chromosome 17–linked autosomal dominant forms of frontotemporal dementia. This disorder is characterized by the occurrence of behavioral abnormalities in the absence of memory loss, and progressive dementia associated with the types of motor slowness and rigidity often seen in Parkinson's disease. Pathologically, tau-immunoreactive inclusions are present in neurons and glial cells (non-neuronal) without the concurrent appearance of senile plaques.

The second most common neurodegenerative disease after Alzheimer's disease is Parkinson's disease. This disorder is characterized by the presence of resting tremor, motor slowness, and rigidity. Pathologically, there is loss of cells in the substantia nigra layer of the midbrain, depletion of the neurotransmitter *dopamine,* and the characteristic presence of Lewy bodies (cytoplasmic inclusions found predominantly within neurons of the substantia nigra). Mutations in several genes have been identified in familial forms of Parkinson's disease. In a related disorder, diffuse Lewy body disease, Lewy bodies are widely expressed within cortical neuronal subpopulations.

Significant clinical and pathological overlap is seen among individual neurodegenerative diseases, particularly between Alzheimer's disease and Parkinson's disease. Parkinson's disease is associated with a high incidence of dementia, and neuropathological studies have documented the occurrence of Lewy bodies, senile plaques, neurofibrillary tangles and the concurrent presence of α-synuclein (alpha-synuclein) and β-amyloid expression. Multiple-system atrophy is a disorder characterized by the presence of autonomic, cerebellar, and extrapyramidal motor signs and symptoms in association with striatonigral and olivopontocerebellar atrophy. In this disorder, α-synuclein immunoreactive neuronal and glial cytoplasmic inclusions occur, establishing links between this neurological condition and both Lewy body disease and Parkinson's disease.

At least eight neurodegenerative diseases are represented within the subclass of trinucleotide repeat disorders, as previously defined. These neurodegenerative diseases are characterized by autosomal dominant or X-linked patterns of inheritance, correlation of the number of trinucleotide repeats with the age of onset and the severity of the disorder, and the presence of *anticipation,* defined as the tendency for successive generations to exhibit an earlier age of onset. Recent studies suggest that disease pathogenesis involves the preferential ability of mutant proteins to undergo abnormal cleavage by cellular proteases (caspases) to form nuclear and cytoplasmic aggregates, which can impair the actions of important cellular proteins. This mechanism causes alterations in the availability of key developmental and transcriptional regulatory molecules, resulting in subthreshold developmental abnormalities in precursors of vulnerable neuronal subpopulations that later undergo regional cell death. Huntington's disease is an autosomal dominant disorder characterized by behavioral disturbances, dementia, and abnormal limb movements (chorea) in association with a gradient of neuronal cell loss in the neostriatum and the cerebral cortex.

Several subtypes of autosomal dominant spinocerebellar ataxias, characterized by a partially overlapping spectrum of neurological impairments, have been defined by identification of the relevant mutant genes. The protein products, termed *ataxins,* all have expanded polyglutamine residues. The regional and neuronal selectivity that defines each disease subtype is correlated with the degree of accumulation of abnormal intranuclear fragments of the individual ataxin proteins. By contrast, Friedreich's ataxia, the most common hereditary ataxia, is an autosomal recessive disorder characterized by early age of onset, gait instability, speech impairment,

motor disability, sensory loss, skeletal deformities, and cardiac dysfunction. This myriad of clinical signs is associated with neuropathological involvement of the long tracts of the dorsal columns of the spinal cord, the peripheral nerves, and the pyramidal motor system. Mutation of the gene product, *frataxin,* a mitochondrial protein, results in altered iron metabolism and a severe cellular energy deficit caused by impairments in components of the respiratory chain that predispose to late-onset cell death in selected regions of the nervous system that express the disease gene.

Neurodegenerative diseases also affect different components of the central and peripheral motor pathways, resulting in upper motor-neuron signs (spasticity, weakness and increased deep-tendon reflexes) and lower motor signs (muscle atrophy and weakness). Amyotrophic lateral sclerosis, the most common form of motor-neuron disorder, is defined by relentless progression of weakness and atrophy of muscles innervated by brain-stem and spinal-cord neurons, with conspicuous sparing of those muscles that regulate eye movements and bowel and bladder function. Pathologically, there is widespread death of motor neurons preceded by cellular shrinkage and axonal swelling. Less than 10 percent of cases are familial, and of these approximately 10 to 20 percent have mutations of the superoxide dismutase type 1 gene, which encodes a molecule involved in the regulation of free radical formation. Genetic studies suggest that the gene mutation exhibits selective toxicity for motor neurons.

Spinal and bulbar muscular atrophy (Kennedy's syndrome) is an X-linked disorder of midlife characterized by progressive proximal limb weakness and atrophy associated with extensive loss of androgen-responsive motor neurons. Kennedy's syndrome is one of the trinucleotide repeat disorders.

Hereditary spastic paraparesis may be inherited as autosomal dominant, autosomal recessive, or X-linked conditions that target upper motor neurons, with resulting progressive symmetric leg weakness and spasticity. Both autosomal dominant and recessive forms of the disorder are caused by mutations in genes that code for members of a specific class of proteins, termed *AAA proteins*. The protein *spastin* is responsible for dominant forms of the disorder, and *paraplegin* for recessive forms. Another AAA protein, torsin A, is mutated in a distinctive neurodegenerative disorder resulting in an early-onset movement disorder, *torsion dystonia,* which is characterized by the presence of abnormal, intermittent motor postures. By contrast, X-linked forms of hereditary spastic paraparesis are caused by mutations in specific genes that can also cause mental retardation or a rare form of dysmyelinating disorder related to multiple sclerosis, termed Pelizaeus-Merzbacher disease.

Finally, there are a series of early-onset autosomal recessive disorders that predominantly affect the lower motor neurons, termed *spinal muscular atrophies,* that are associated with progressive muscular weakness and atrophy. The vast majority of patients with spinal muscular atrophy have deletions of the survival motor-neuron gene, whereas mutations in two other genes have also been shown to cause spinal muscular atrophy: neuronal apoptosis inhibitory protein and neuromuscular degeneration, which is involved in early stages of DNA damage repair.

MARK F. MEHLER

See also ALZHEIMER'S DISEASE; BRAIN; DEMENTIA; DEMENTIA WITH LEWY BODIES; DNA DAMAGE AND REPAIR; GENETICS; NEUROCHEMISTRY; NEUROENDOCRINE SYSTEM; PARKINSONISM; PATHOLOGY OF AGING, HUMAN.

BIBLIOGRAPHY

CUMMINGS, C. J.; ORR, H. T.; and ZOGHBI, H. Y. "Progress in Pathogenesis Studies of Spinocerebellar Ataxia Type 1." *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* 354 (1999): 1079–1081.

GOEDERT, M. "Filamentous Nerve Cell Inclusions in Neurodegenerative Diseases: Tauopathies and α-Synucleinopathies." *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* 354 (1999): 1101–1118.

JONES, A. L. "The Localization and Interactions of Huntingtin." *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* 354 (1999): 1021–1027.

MARTIN, J. B. "Molecular Basis of the Neurodegenerative Disorders." *The New England Journal of Medicine* 340 (1999): 1970–1980.

MEHLER, M. F., and GOKHAN, S. "Mechanisms Underlying Neural Cell Death in Neurodegenerative Diseases: Alterations of a Developmentally-Mediated Cellular Rheostat." *Trends in Neurosciences* 23 (2000): 599–605.

PRICE, D. L.; TANZI, R. E.; BORCHELT, D. R.; and SISODIA, S. S. "Alzheimer's Disease: Genetic

Studies and Transgenic Models." *Annual Review of Genetics* 32 (1998): 461–493.

ROSS, C. A.; WOOD, J. D.; SCHILLING, G.; PETERS, M. F.; NUCIFORA, F. C.; COOPER, J. K.; SHARP, A. H.; MARGOLIS, R. L.; and BORCHELT, D. R. "Polyglutamine Pathogenesis." *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* 354 (1999): 1005–1011.

SATHASIVAM, K.; HOBBS, C.; MANGIARINI, L.; MAHAL, A.; TURMAINE, M.; DOHERTY, P.; DAVIES, S. W.; and BATES, G. P. "Transgenic Models of Huntington's Disease." *Philosophical Transactions of the Royal Society of London B* 354 (1999): 963–969.

VAN GASSEN, G.; ANNAERT, W.; and VAN BROECKHOVEN, C. "Binding Partners of Alzheimer's Disease Proteins: Are They Physiologically Relevant." *Neurobiology of Disease* 7 (2000): 135–151.

WONG, P. C.; ROTHSTEIN, J. D.; and PRICE, D. L. "The Genetic and Molecular Mechanisms of Motor Neuron Disease." *Current Opinions in Neurobiology* 8 (1998): 791–799.

NEUROENDOCRINE SYSTEM

A substantial volume of scientific evidence has been accumulated demonstrating that biological aging is associated with functional deficits at the cellular, tissue, organ, and system levels. Although several theories have been proposed to explain these changes, as well as the increased risk of disease with age, no single explanation has adequately accounted for the diversity of physiological changes associated with age. The concept that deficiencies in the neuroendocrine system contribute to aging evolved from studies indicating that (1) the endocrine system has an important role in developmental processes, (2) hormones have an important trophic and integrative role in maintaining tissue function, and (3) hormone deficiency results in deterioration of tissue function.

The neuroendocrine system is composed of the hypothalamus and pituitary gland and is under the influence of neurotransmitters and neuropeptides that regulate hypothalamic releasing and hypothalamic release inhibiting hormones secreted into the blood vessels that connect the hypothalamus and pituitary gland. The release of these hypothalamic hormones influences the secretion of anterior pituitary hormones that subsequently regulate tissue function. The hypothalamus and pituitary gland have the capacity to detect *humoral secretions* (hormones secreted) from target tissues and adjust hormone production to maintain an optimal internal "milieu" appropriate for normal function. It is well-established that the neuroendocrine system has a critical role in integrating biological responses and influencing: (1) cellular protein synthesis and general metabolism through the release of growth hormone and thyroid-stimulating hormone (TSH), respectively, (2) reproductive function through the release of luteinizing hormone (LH), follicle-stimulating hormone (FSH), prolactin, and oxytocin, and (3) plasma electrolytes and responses to stress through regulation of the hormones vasopressin (antidiuretic hormone, or ADH) and adrenocorticotropin (ACTH). In addition, the hypothalamus also has an important role in the integration of parasympathetic and sympathetic nervous system activity, and can thereby influence a wide variety of functions, including heart rate, blood pressure, vascular responses, and glucose metabolism. The hypothalamus has been implicated in the regulation of biological rhythms by its interactions with hypothalamic nuclei. More recently, the regulation of fat metabolism and food intake has been shown to be regulated through the hypothalamus by its response to the protein, leptin, and its synthesis of neuropeptide Y. It should be noted that the classification of hormones and their primary function presented here is an overly simplistic view of the neuroendocrine system, since critical interactions occur among these hormones that contribute to the coordinated regulation of cellular and tissue function.

Although the specific etiology of age-related changes in the neuroendocrine system is unknown, it has been proposed that cellular and molecular alterations in specific subpopulations of neurons within the hypothalamus and pituitary, and/or supporting structures within the brain, contribute to the decrease in tissue function. Some of the alterations may be related to loss of neurons or synapses, genetic errors, and/or the production of free radicals, all of which lead to progressive aberrations in neurons and contribute to neuroendocrine aging. As a result, the neuroendocrine theory of aging is unique when compared to other theories of aging in that the neuroendocrine alterations are, in many cases, not considered the primary causative factors of biological aging, but rather are considered to be mediators of aging that are initiated by cellular changes in specific subpopulations of neurons or systems that closely interact with hypothalamic neurons.

Three classic examples of age-associated changes in neuroendocrine regulation, and the resulting consequences for tissue function, help emphasize the importance of this system in the development of the aging phenotype. First, with increasing age there is a decline in growth-hormone secretion that results in a decrease in insulin-like growth factor-1 (IGF-1) production in the liver and other tissues. The loss of these anabolic hormones contributes to the general decline in cellular protein synthesis, skeletal muscle mass, immune function, and cognitive ability in rodents, nonhuman primates, and humans. The decrease in growth-hormone release from the pituitary gland results from impaired release of growth-hormone-releasing hormone and increased release of somatostatin (an inhibitor of growth hormone) from hypothalamic neurons. Second, decreased secretion of gonadotropin-releasing hormone (GnRH) from hypothalamic neurons results in a decline in luteinizing hormone. This is the primary factor in the loss of reproductive cycles in the female rodent, and, in conjunction with the loss of ovarian follicles, contributes to the decline in estrogen levels in women. These latter changes result in atrophy of secondary reproductive tissues and have been implicated in the post-menopausal loss of bone and cognitive function. Decreased GnRH secretion in the male also contributes to a decrease in LH and androgen levels and to the corresponding loss of skeletal muscle mass and reproductive function. Finally, increased secretion of ACTH and the adrenal hormone, cortisol, in response to stress have been reported to contribute to atrophy and/or loss of neurons, as well as age-related decline in cognitive function. These latter findings have contributed to the hypothesis that increased levels of glucocorticoids contribute to brain aging.

Although other mechanisms are possible, the alterations in the secretion of hypothalamic hormones with age have been traced to deficiencies in the secretion of brain neurotransmitters. For example, the activity of dopamine and norepinephrine decreases with age, and both acute and chronic procedures used to increase levels of these neurotransmitters in aged animals have been shown to restore some aspects of neuroendocrine function. Studies have shown an increase in growth hormone release and a restoration of some aspects of reproductive function in older animals in response to the L-Dopa, dopamine and norepinephrine precursor. These findings have led investigators to conclude that a decline in neurotransmitter activity is a contributing factor in the neuroendocrine decline that accompanies aging. Nevertheless, the possibility that interactions with other hypothalamic peptides, the loss of neurons, or intracellular changes within hypothalamic neurons contribute to the loss of function cannot be excluded. In fact, the inability of hypothalamic neurons to compensate for the age-related alterations in circulating levels of hormones supports the concept that the normal feedback mechanisms that occur within the hypothalamus are impaired in aged animals. Whether these altered feedback mechanisms are related to the deficiencies in neurotransmitters or result from other aberrations within the aging neuroendocrine system remain to be established. Nevertheless, deficits in the regulation of these critical hormonal systems contribute to deterioration of tissue function and undoubtedly are an important factor in age-related disease and disability.

WILLIAM E. SONNTAG

See also BRAIN; ENDOCRINE SYSTEM; LONGEVITY: REPRODUCTION.

BIBLIOGRAPHY

GRIFFIN, J. E., and OJEDA, S. R. *Textbook of Endocrine Physiology,* 3d ed. New York: Oxford University Press, 1996.

LANDFIELD, P. W. "The Role of Glucocorticoids in Brain Aging and Alzheimer's Disease: An Integrative Physiological Hypothesis." Nathan Shock Memorial Lecture 1990. *Experimental Gerontology* 29 (1994): 3–11.

SAPOLSKY, R. M. "Glucocorticoids, Stress, and Their Adverse Neurological Effects: Relevance to Aging." *Experimental Gerontology* 34 (1999): 721–732.

SONNTAG, W. E.; LYNCH, C. D.; CEFALU, W. T.; INGRAM, R. L.; BENNETT, S. A.; THORNTON, P. L.; and KHAN, A. S. "Pleiotropic Effects of Growth Hormone and Insulin-Like Growth Factor (IGF)-1 on Biological Aging: Inferences from Moderate Caloric Restricted Animals." *Journals of Gerontology: Biological Sciences* 54a (1999): 521–538.

WISE, P. M. "Neuroendocrine Modulation of the 'Menopause': Insights into the Aging Brain." *American Journal of Physiology* 277 (1999): E965–E967.

WISE, P. M.; SMITH, M. J.; DUBAL, D. B.; WILSON, M. E.; KRAJNAK, K. M.; and ROSEWELL, K. L.

"Neuroendocrine Influences and Repercussions of the Menopause." *Endocrine Reviews* 20 (1999): 243–248.

NEUROPLASTICITY

Information in the brain is transmitted from neuron to neuron through specialized connections called *synapses*. A synapse between two neurons is made up of presynaptic and postsynaptic terminals, which are separated by a synaptic cleft. The presynaptic terminal is filled with small vesicles containing chemical neurotransmitters, and the postsynaptic terminal consists of receptors specific for these neurochemicals. Neurons carry information in the form of an electrical impulse called an action potential that is initiated at the cell body and travels down the axon. At the synapse, an action potential causes the voltage-dependent release of neurotransmitter-filled vesicles, thereby converting an electrical impulse into a chemical signal. Neurotransmitters diffuse across the synaptic cleft, where they bind to receptors and generate an electrical signal in the postsynaptic neuron. The postsynaptic cell will then, in turn, fire an action potential if the sum of all its synapses reaches an electrical threshold for firing. Since a neuron can receive synapses from many different presynaptic cells, each cell is able to integrate information from varied sources before passing along the information in the form of an electrical code. The ability of neurons to modify the strength of existing synapses, as well as form new synaptic connections, is called *neuroplasticity*. It is believed that neuroplasticity may be the underlying cellular mechanism for the brain's ability to encode information during learning. In theory, this is how information is stored as memory.

Defined in this way, neuroplasticity includes changes in strength of mature synaptic connections, as well as the formation and elimination of synapses in adult and developing brains. This encompasses a vast field of research, and similar processes may also occur at peripheral synapses, where much of the pioneering studies on synaptic transmission first took place. In addition, neuroplasticity includes the regrowth (or sprouting) of new synaptic connections following central nervous system injury; following stroke, for example.

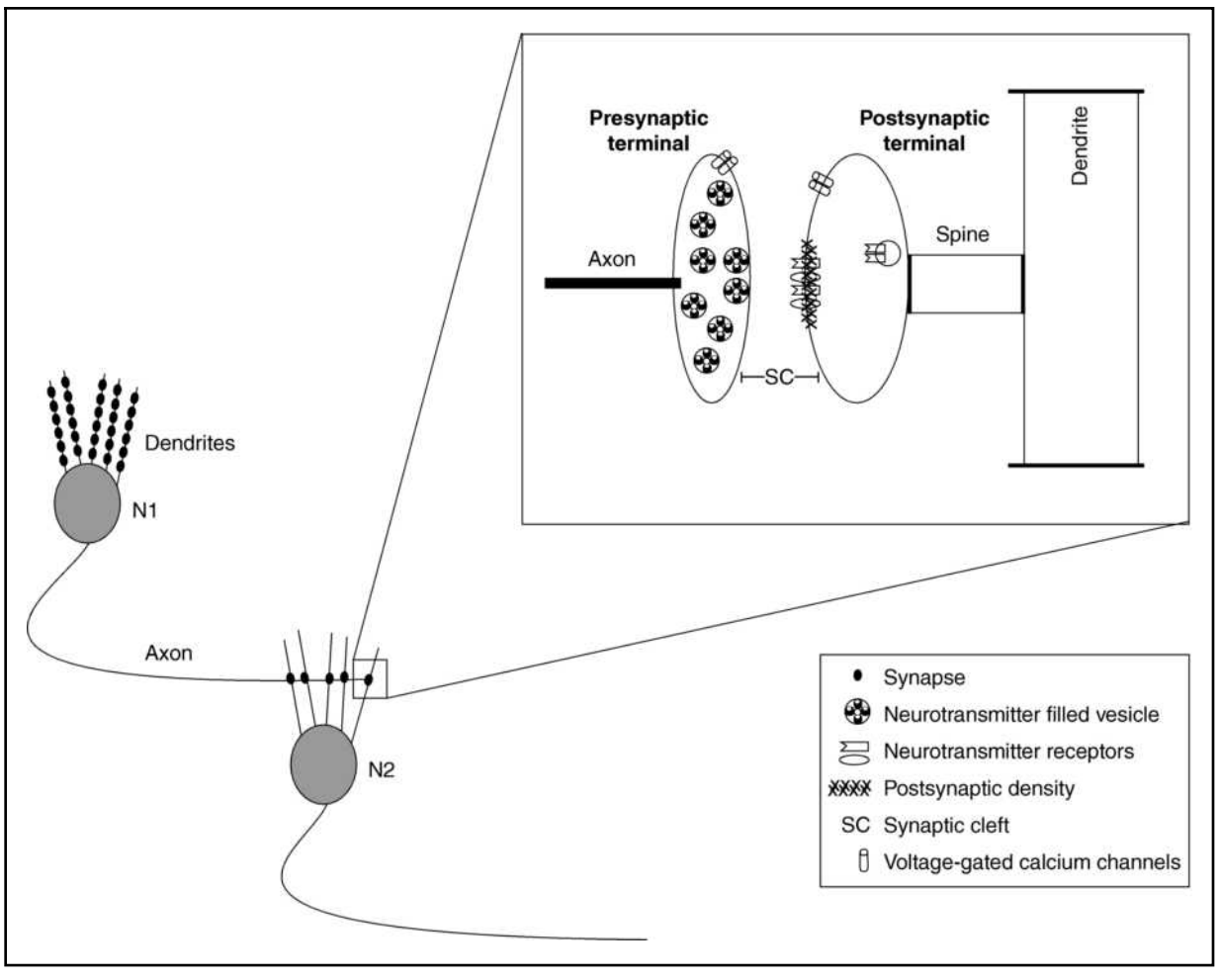
The notion that the brain can store information by modifying synaptic connections is not a new one. In fact, Santiago Ramon y Cajal (a founder of modern neuroscience) expressed this theory in 1894, three years before Charles Sherrington coined the term *synapse* to describe the connections made between neurons. In the late 1940s the neuroplasticity model was advanced by Jerzy Konorski, who used the word *plasticity* to describe "permanent functional transformations," and Donald Hebb, who ascribed testable physiologic characteristics to synaptic plasticity. However, experimental evidence that synapses are capable of long-lasting changes in synaptic strength did not come until the early 1970s, when Timothy Bliss and Terry Lomo described an increase in the synaptic strength of neurons in the mammalian hippocampus (a region of the brain critical for some forms of memory) following electrical stimulation. They termed this increase *long-lasting potentiation*, now referred to as *long-term potentiation* (LTP).

Changes in synaptic strength proved to be bidirectionally modifiable (they increase and decrease in strength) as Serena Dudek and Mark Bear first demonstrated in 1992 by recording activity-driven, long-term depression (LTD) in the hippocampus. The evidence that learning and memory are based on these long-lasting changes in synaptic strength is substantial, but still incomplete. However, defining the molecular constituents in the mechanistic pathway leading from synaptic activity to plasticity continues to strengthen the evidence linking neuroplasticity with learning and memory. In addition, resolving the molecular mechanisms underlying synaptic modification should lead to targets for clinical intervention in eliminating age-related memory loss or synaptic loss following brain damage by enhancing new synaptic connections.

Mechanisms of plasticity

Synaptic plasticity can occur at either the presynaptic or postsynaptic terminal. Modifications to the presynaptic terminal affect the release of neurotransmitters. As the action potential invades the presynaptic terminal, it activates voltage-gated calcium channels that conduct calcium ions into the presynaptic terminal. This rise in intracellular calcium triggers the exocytosis of vesicles (fusion with the plasma membrane) and thus the release of neurotransmitters. Each presynaptic terminal contains between 200 and 500 vesicles, though only a small proportion of these are ready to be released at any time. Vesicles in the presynaptic terminal

Figure 1
The synapse: Neurons maintain thousands of synapses. In this synapse schematic, the axon of neuron 1 (N1) contributes the presynaptic terminal and the postsynaptic terminal is contained on a specialization of the dendrite of neuron 2 (N2), called a synaptic spine. When an action potential is propagated down the axon of N1, the presynaptic terminal depolarizes through the activation of voltage-gated calcium channels. The rise in calcium in the presynaptic terminal will trigger the fusion of synaptic vesicles with presyaptic membrane, resulting in the release of neruotransmitters into the synaptic cleft. The neurotransmitters will bind to specific receptors located on the postsynaptic membrane that will lead to a change in the membrane potential in the dendrite that is conducted toward the cell body of N2. Synaptic plasticity, or the change in the strength of this synapse, can result from molecular changes at either the pre- or postsynaptic terminal (see text).



SOURCE: Author

move through a specific release cycle, including vesicle storage, priming for release, release, vesicle reformation, and reloading with neurotransmitter.

Factors that alter the presynapse resulting in either modification of the calcium channel conductance or modification of the vesicle cycle will yield changes in synaptic strength. One such factor is the cyclic nucleotide cAMP. An increase in cAMP presynaptically can enhance transmitter release by activating protein kinase A (PKA). PKA activation induces a decrease in a specific potassium channel conductance called a *delayed rectifier current*. Decreased delayed rectifier conductance will increase the calcium entry into the presynaptic terminal by increasing the duration

of the action potential. In addition, a rise in cAMP can activate vesicular release from presynaptic terminals that were previously dormant. Such terminals are present, but do not release neurotransmitters in response to an action potential prior to a rise in cAMP. A morphologically distinct synapse that is physiologically dormant has been termed a *silent synapse* and can be the result of deficient presynaptic release, or a deficiency of transmitter receptors expressed postsynaptically.

The postsynaptic terminal can also be modified to produce changes in synaptic efficacy. Signaling molecules in the postsynaptic compartment such as protein kinase A (PKA) and the alpha subunit of calcium/calmodulin-dependent kinase II (α-CaMKII) are thought to play major roles in synaptic plasticity. For example, when a mouse is genetically altered to express a version of α-CaMKII incapable of activation, LTP and learning are disrupted. While α-CaMKII can directly phosphorylate neurotransmitter receptors leading to an increase in conductance, it is likely to play additional roles in synaptic plasticity as well. Neurotransmitter receptors can cycle in and out of the postsynaptic membrane (in a process not unlike the presynaptic vesicles), and α-CaMKII phosphorylation of an as yet unidentified substrate could lead to the rapid insertion of more receptors. This would result in LTP of an active synapse and the unsilencing of a synapse that was not previously expressing these receptors in its membrane. As stated above, there is substantial evidence implicating long-lasting changes in synaptic strength with the formation of memory. It should be noted that synapses do not act in isolation. The neural circuits to which they belong are a result of the many thousands of synapses contained therein. Although the cellular coding of information may be encoded at synapses, memory itself is likely dependent upon the circuit(s) in which they are contained.

Plasticity, memory, and aging

As humans age, an impairment of memory occurs that is not associated with neurological damage or disease. The age of onset for this decline varies, but it is clear that this is a selective deficit and not a generalized decrease in cognitive skills. Moreover, the deficit is also apparent in animal models of aging and is manifest as a greater number of trials required to memorize a task and a decrease in memory retention that begins approximately twenty-four hours post-training. Interestingly, LTP also changes with age, typically requiring a more robust stimulus to induce and yielding a synaptic potentiation that decays more rapidly. Since aging animals and humans both maintain the ability to store memory, the fundamental mechanisms that underlie information storage may remain essentially intact. The deficit may not be a lack of ability, but rather a decline in the efficiency of storage—or an inability to maintain the neural plasticity induced during learning. Since the formation of memory is dependent on new protein synthesis, one way to address the decreased stability of memory is to identify proteins made during learning. Consistent with this, synaptic plasticity has at least two temporally distinct components: transient changes that do not require new protein synthesis, and enduring modifications (e.g., LTP and LTD) that require the production of new proteins. Identification of newly formed proteins, their site of action, and the molecular basis for their role in neural plasticity may provide insights into the maintenance of memory, and thus indicate clinical targets for the amelioration of age-related memory decline.

DAVID G. WELLS

See also BRAIN; LEARNING; MEMORY; NEUROCHEMISTRY; NEURODEGENATIVE DISEASES.

BIBLIOGRAPHY

BLISS, T. V. P., and LOMO, T. "Long-Lasting Potentiation of Synaptic Transmission in the Dentate Area of the Anaesthetized Rabbit Following Stimulation of the Perforant Path." *Journal of Physiology* (London) 232 (1973): 331–356.

COWEN, W. M., and KANDEL, E. R. "A Brief History of Synapses and Synaptic Transmission." In *Synapses*. Edited by W. M. Cowen, T. C. Sudhof and C. F. Stevens, Baltimore, Md.: The Johns Hopkins University Press, 2001. Pages 1–88.

DAVIS, H. P., and SQUIRE, L. R. "Protein Synthesis and Memory: A Review." *Psychology Bulletin* 96 (1984): 518–559.

DUDEK, S. M., and BEAR, M. F. "Homosynaptic Long-Term Depression in Area CA1 of Hippocampus and Effects of N-methyl-D-aspartate Receptor Blockade." *Proceedings of the National Academy of Science* 89 (1992): 4363–4367.

FOSTER, T. C. "Involvement of Hippocampal Synaptic Plasticity in Age-Related Memory

Decline." *Brain Research Review* 30 (1999): 236–249.

GIESE, K. P.; FEDOROV, N. B.; FILIPKOWSKI, R. K.; and SILVA, A. J. "Autophosphorylation at Thr286 of the Alpha Calcium-Calmodulin Kinase II in LTP and Learning." *Science* 279 (1998): 870–873.

HAYASHI, Y.; SHI, S.-H.; ESTEBAN, J. A.; PICCINI, A.; PONCER, J. C.; and MALINOW, R. "Driving AMPA Receptors into Synapses by LTP and CaMKII: Requirements for GluR1 and PDZ Domain Interactions." *Science* 287 (2000): 2262–2267.

MA, L.; ZABLOW, L.; KANDEL, E. R.; and SIEGELBAUM, S. A. "Cyclic AMP Induces Functional Presynaptic Boutons in Hippocampal CA3-CA1 Neuronal Cultures." *National Neuroscience* 2 (1999): 24–30.

TONG, G.; MALENKA, R. C.; and NICOLL, R. A. "Long-Term Potentiation in Cultures of Single Hippocampal Granule Cells: A Presynaptic Form of Plasticity." *Neuron* 16 (1996): 1147–1157.

NEUROPSYCHOLOGY

Neuropsychology is a scientific field concerned with understanding relationships between the human brain, behavior, and mind, and applying this understanding to the assessment, clinical management, and rehabilitation of persons with neurological disease and injury. Mind includes both conscious (that of which the person is aware) and unconscious (that of which the person is unaware) mental contents and processes, and involves both cognition (e.g., attention, perception, memory, language, thought, mental imagery) and emotion. The history of neuropsychology, within Western culture, is often traced to Hippocrates, who asserted that the brain was the organ of the intellect. Another important historical contribution, occurring at the beginning of the nineteenth century, was that of Franz Josef Gall, who believed that mind could be divided into different functions that are localized within different areas of the brain. During the middle of the nineteenth century, separate reports by physicians Paul Broca, Carl Wernicke, and Hughlings Jackson provided the first clear evidence that the sudden onset of different types of speech and language impairments was associated with damage to different areas within the left hemisphere of the brain. Throughout the twentieth century, the development of neuropsychology was most influenced by scientific discoveries within clinical neurology, psychology (particularly cognitive psychology and theory concerning the mental measurement), and, more recently, neuroscience (including such subfields as neuroanatomy, neurophysiology, and neuropharmacology). Contemporary neuropsychology can be divided into two complementary sub-fields: Experimental neuropsychology and clinical neuropsychology.

Experimental neuropsychology

Experimental neuropsychology employs a wide range of scientific methods in an attempt to understand basic brain-behavior-mind relationships. Some of these methods involve the study of non-human animals, observing behavior changes following experimental damage, electrical stimulation, or drug injection within various brain regions, and recording the electrical activity of nerve cells while the animal performs different tasks. In the study of humans, the major method has been the careful measurement of behavioral and mental changes following accidental brain injury, neurosurgery, or the unfortunate occurrence of neurological diseases that affect particular brain regions.

Within the late-twentieth and early-twenty-first centuries, a variety of technologies have been added to the methodology of experimental neuropsychology. Each of these technologies allows a noninvasive (without entering the body) or minimally invasive measurement of brain structure or physiology which can be correlated to measures of behavior, cognition, or emotion during the performance of a specified task. These technologies include: (1) Electroencephalography (EEG; fluctuations in brain electrical activity recorded from sensors placed on the scalp); (2) Event-related potentials (ERP; brain electrical in response to a sensory stimulus or preceding a voluntary movement, recorded from scalp sensors and enhanced by computer averaging); (3) Magnetoencephalography (MEG) recording, from outside the head, of the magnetic field fluctuations generated by nerve-cell activity; (4) computerized tomography (CT), which allows the visualization of brain structure by computer-assisted measures of tissue density calculated by the average absorption of X-rays; (5) magnetic resonance imaging (MRI), which makes a highly detailed visualization of brain structure through computer-assisted measures of cellular composition, calculated from rad-

iowave signal changes following a radiofrequency pulse while the head is within the field of a powerful magnet; (6) functional magnetic resonance imaging (fMRI), which involves the use of MRI technology to visualize changes in blood oxygen content that reflect the metabolic demands of active brain cells; and (7) positron emission tomography (PET), which allows measures of blood flow or metabolic activity of different brain regions, based on emitted subatomic particles from radioactively labeled substances injected into blood vessels that supply the brain.

Overall, the most confident conclusions concerning what brain regions contribute to any particular aspect of behavior, cognition, or emotion are obtained when results from several of these scientific methods converge. As technological developments have allowed increasingly fine-grained measurement of brain structure and processes, a more detailed and sophisticated understanding of human brain-behavior-mind relationships has emerged.

Clinical neuropsychology

Clinical neuropsychology is an applied discipline that uses the basic knowledge from experimental neuropsychologic research to develop reliable and valid procedures for assessing, managing, and rehabilitating persons who suffer from the behavioral, cognitive, and emotional consequences of neurological injury or disease. A variety of different tests of cognitive functions, such as memory, visual and auditory perception, language, and abstract reasoning, have been developed and shown to be sensitive to the consequences of localized brain damage or dysfunction. Although not yet as extensively developed, similar tests of emotional functions (e.g., recognition of facial or vocal emotional expression) are available.

In assessing a person with known or suspected neurological injury or disease, the clinical neuropsychologist uses several such tests to draw inferences about the functional integrity of different brain areas and systems. The pattern of strengths and deficits shown by a particular individual on these tests (as judged against performance expectations based on the study of healthy persons of similar age and educational background) can be compared to the documented patterns shown by persons with known neurological injury or disease. The clinical neuropsychologist can thus determine whether the pattern of test scores is consistent with a particular neurological diagnosis.

Neuropsychological testing plays a particularly important role in diagnosis when a given illness (e.g., Alzheimer's disease) manifests primarily by changes in cognition and emotion (rather than in clear physical abnormalities). In addition to diagnosis, neuropsychological assessment plays an important role in giving information to health care providers, patients, and family members concerning specific strengths and deficits in cognitive and emotional functions and their practical implications. Neuropsychological testing is also used in the assessment of treatment effects (e.g., experimental drugs being tested to improve memory in persons with Alzheimer's disease) or disease progression, and in guiding the rehabilitation or clinical management of cognitive, emotional, and behavioral problems.

In selecting, administering, and interpreting neuropsychological tests, several factors need to be considered. First, specific tests should be selected on the basis of whether they meet accepted psychometric criteria. These criteria include demonstrated reliability (consistency of test scores obtained by the same persons when retested with the identical test or an equivalent form) and validity (sensitivity and specificity for the consequences of brain damage or disease). There should also be available normative data (average scores of healthy persons) comparable to the age, educational background, and other characteristics of the person being examined. In addition to test reliability, sensitivity, specificity, and available normative data, the impact of various patient characteristics must be considered. One characteristic known to affect test performance is the individual's age.

Age-related neuropsychological changes

Both age-related sensory acuity changes and response slowing can influence test performance, as can the physical limitations of such prevalent illnesses as arthritis. Changes in visual and auditory acuity with aging are well documented. Such sensory changes can affect neuropsychological test performance by making it more difficult for an older individual to accurately see test stimuli or hear the examiner's instructions. Reaction time shows progressive slowing from early through late adulthood. One obvious implication is that older adults will take longer than younger adults to complete various neuropsychological testing procedures.

Response slowing may also result in lower scores on tests that assign bonus points for faster performance. This underscores the need for age-appropriate normative data to which an individual's performance can be compared. Although healthy older people are unlikely to fatigue more rapidly than younger adults during average-length (e.g., two to three hours) testing sessions, older persons in poor health are likely to fatigue quickly. It may thus be necessary to take more frequent breaks during a neuropsychological examination session when evaluating older (particularly ill or frail) adults. Performance limitations imposed by physical disabilities (e.g., arthritis) may require modifications in testing procedures (e.g., allowing the person to work on a task beyond the standard time limits). Such departures from standardized test procedures require both caution and clinical experience when interpreting performance.

Even on neuropsychological tests that do not assign bonus points for faster performance, and for which age-related sensory changes do not likely contribute, performance is often poorer for older adults than for younger adults. This is particularly true for tests of memory and for tests of abstract reasoning and complex problem solving. There is both animal and human experimental data that suggests age-associated memory changes are due to cell loss and physiologic changes within the hippocampal complex, a deep brain region known to be important for establishing longer-lasting memories. Similarly, human experimental neuropsychological data has indicated that age-associated decreases in abstract reasoning and complex problem-solving ability likely reflect cellular and physiologic changes within the frontal lobes and deep brain structures to which they are interconnected. The frontal lobes and their interconnected brain structures are known to be important for a range of complex cognitive abilities that have been collectively termed *executive functions*.

However, it should be noted that there is greater variability in neuropsychological test performance among older (versus younger) individuals, with some older adults performing within the range of average younger persons. This observation has led to controversy over whether age-group differences in neuropsychological test performance should be thought of as reflecting necessary changes in brain structure and functioning with aging or as the manifestation of subtle age-associated neurological disease processes within a subgroup of older adults. The resolution of this controversy must await future research, particularly that employing longitudinal research designs in which persons are repeatedly examined (both neuropsychologically and with sophisticated brain imaging technologies) as they age.

Neuropsychological diagnosis of dementias

Dementia is the term used to describe a clinical syndrome of progressive impairment of cognitive functions, often with accompanying changes in behavior and emotion. Many different illnesses can cause the syndrome of dementia. Accurate diagnosis of the particular illness that is likely causing dementia (e.g., Alzheimer's disease, Huntington's disease, Parkinson's disease, fronto-temporal dementia), requires the efforts of a multidisciplinary team of physicians (particularly neurologists and psychiatrists), neuropsychologists, and other health professionals (e.g., social workers). Neuropsychological assessment plays an important role in the clinical identification of the dementia syndrome and the differentiation of various dementia-causing illnesses.

Brief mental status questionnaires can provide health professionals with a quick documentation of the presence of dementia. However, such questionnaires are generally not sufficiently sensitive to detect very mild dementia, particularly in persons who had high intellectual functioning before the onset of their illness. This is due to mental status questionnaires being composed of fairly easy questions. Mental status questionnaires also lack the specificity to assist in differential diagnosis of dementia types, due to the fact that, typically, too few cognitive functions are assessed. In comparison, standardized neuropsychological tests contain a range of task difficulty. This provides for greater sensitivity to subtle or mild cognitive impairment than what is possible through the use of mental status questionnaires.

The ability of neuropsychological test batteries to examine the pattern of performance across different, reliably measured areas of cognitive functioning helps to differentiate dementias caused by particular illnesses. Different dementia-causing illnesses do not manifest with equivalent impairment across all areas of cognitive function. Thus, inspection of the pattern of per-

formance across various neuropsychological tests can be used as an aid to diagnosis. For example, research has demonstrated that Alzheimer's disease typically begins with changes in memory ability that accompany neuronal damage within the hippocampal complex. Neuropsychological tests that assess recall of novel information after a short delay have been shown to be sensitive to these early memory changes. In contrast, regions of the frontal and temporal lobes of the brain are often first affected by the fronto-temporal dementias. Tests of executive functions, including abstract reasoning, problem solving, and the ability to easily shift mental set (readiness to respond in a given manner to a stimulus), are thus most sensitive to the early cognitive changes of fronto-temporal dementia.

It can be difficult to clinically differentiate the early changes of Alzheimer's disease or other dementias from the cognitive impairment that can accompany depression in older adults. Older persons with depression may show deficits on a range of neuropsychological tests, particularly on tests requiring sustained attention or rapid performance, and on tests with pleasant or neutral (in contrast with unpleasant) content. The term *pseudodementia* was once used to describe persons with depression and cognitive impairment, reflecting the expectation that the cognitive deficits would reverse with effective treatment of the depression. This term is no longer in use because research has shown that many of these persons show a progressive dementia that does not reverse with depression treatment. Such studies have indicated the need for both caution and reassessment in attempts to differentiate cognitive deficits associated with depression from those due to Alzheimer's disease or other dementias.

ALFRED W. KASZNIAK

See also ALZHEIMER'S DISEASE; DEMENTIA; MENTAL STATUS EXAMINATION; PSYCHOLOGICAL ASSESSMENT; REACTION TIME.

BIBLIOGRAPHY

BONDI, M. W.; SALMON, D. P.; and KASZNIAK, A. W. "The Neuropsychology of Dementia." In *Neuropsychological Assessment of Neuropsychiatric Disorders,* 2d ed.. Edited by I. Grant and K. H. Adams. New York: Oxford University Press, 1996. Pages 164–199.

DUKE, L. M., and KASZNIAK, A. W. "Executive Control Functions in Degenerative Dementias: A Comparative Review." *Neuropsychology Review* 10 (2000): 75–99.

GREEN, J. *Neuropsychological Evaluation of the Older Adult: A Clinician's Guidebook*. San Diego: Academic Press, 2000.

KASZNIAK, A. W. "Techniques and Instruments for Assessment of the Elderly." In *A Guide to Psychotherapy and Aging*. Edited by S. H. Zarit and B. G. Knight. Washington, D.C.: American Psychological Association, 1996. Pages 163–219.

KASZNIAK, A. W., and NEWMAN, M. C. "Toward a Neuropsychology of Cognitive Aging." In *Psychology and the Aging Revolution: How We Adapt to Longer Life*. Edited by S. H. Qualls and N. Abeles. Washington, D.C.: American Psychological Association, 2000. Pages 43–67.

KOLB, B., and WHISHAW, I. Q. *Fundamentals of Human Neuropsychology*, 4th ed. New York: W. H. Freeman and Company, 1996.

NUSSBAUM, P. D., ed. *Handbook of Neuropsychology and Aging*. New York: Plenum, 1997.

TUOKKO, H., and HADJISTAVROPOULOS, T. *An Assessment Guide to Geriatric Neuropsychology*. Mahwah, N.J.: Lawrence Erlbaum Associates, 1998.

NEUROTRANSMITTERS

The idea that nerve cells function as independent units and form a physical contact to facilitate intercellular communication was first proposed by neurobiologists at the turn of the twentieth century. This concept, termed the *neuron theory of brain function,* is based on the knowledge that the nervous system is not made up of a contiguous labyrinth of intertwining processes but instead represents a collection of neurons, together with their axons and dendrites, that form close functional contacts to permit the transfer of information from one cell to another. The site at which the contact between two neurons is made is called the synapse; and the chemical signal that is used for mediating communication between neurons is the neurotransmitter.

For both the central and peripheral nervous system there are a relatively small number of molecules that fulfill the criteria of a neurotransmitter. These include dopamine (DA), norepinephrine (NE), epinephrine, serotonin, histamine, acetylcholine (Ach), gamma-amino butyric acid (GABA), glycine, and glutamate. During development the nervous system takes on the responsibility for controlling a variety of body functions including movement, conscious-

ness, learning and memory, and sensory processing. A fully competent nervous system is essential for maintaining the integrity of body functions in adulthood while an aging nervous system has often been coupled with an irreversible loss of global function. However, this oversimplified picture of brain aging is far from the truth. Research conducted since the early 1980s has indicated that an age-related decline in neurotransmitter function is not a global phenomenon. Instead, studies have reported that just as organisms age at different rates, so do the different neurotransmitter systems in their bodies; and that wide differences in neurotransmitter levels exist in the brain between individuals of like age. This divergence between biological and chronological old age is most obvious in the human population but is also found in aged rodents and nonhuman primates. Functional variability with age is tied closely to the variability in the biochemical and anatomical changes found in different neurotransmitter systems of the brain and is unquestionably linked to genetic and environmental factors that influence the "rate" at which we age. Thus, the degree to which age-related anatomical and biochemical changes occur in neurotransmitter systems of the brain can be described as variable at best.

When investigating age-related alterations in neurotransmitter function it is important to realize that a decline of a particular neurotransmitter does not always equate with a loss in physiological function. Previous studies have reported that age-related changes in the brain cannot be represented by simple cell loss that leads to functional decline. Rather, it is understood that the aging brain represents a composite of various adaptive and compensatory responses, which work together to maintain and repair the brain's neural networks in response to naturally occurring cell loss or neurochemical deficits that are brain region, cell type, and species specific. In addition, it is important to distinguish between changes in neurotransmitter systems that are seen in normal aging with that characteristic of the diseased state. While it was once believed that neurodegenerative diseases such as Alzheimer's and Parkinson's disease were part of an accelerated aging process it is now known that the neuropathology of the diseased brain represents extensive neuronal degeneration and cell death that goes beyond normal aging. In fact anatomical studies with sophisticated neuronal counting techniques indicate that the degree of neuron loss in the aged brain is quite low and age-related changes ascribed to neurotransmitter neurons may not affect our activities of daily living until we are well into our late seventies or eighties.

If global neurodegeneration and cell death are not characteristic of neurotransmitter neurons then what are the changes seen in neurotransmitter neurons with increased age? To answer this question we must consider that changes can occur in either the presynaptic or postsynaptic components involved in information transfer. Age-related changes in the presynaptic components can include changes in neurotransmitter synthesis, storage, synaptic release, and neurotransmitter re-uptake. Changes in postsynaptic components include changes in neurotransmitter receptors (protein complexes that bind neurotransmitters), secondary messenger systems (responsible for transfer of information into neurons), and enzymes involved in neurotransmitter degradation. The following is a brief overview of the age-related changes that have been described for the four most common neurotransmitters found in the central and peripheral nervous system.

Acetylcholine

The neurotransmitter acetylcholine is important for communication in a number of brain regions, particularly the hippocampus, striatum, and cerebral cortex. It is also the neurotransmitter used to transmit information at the neuromuscular junction. Acetylcholine is synthesized presynaptically by the enzyme choline acetyltransferase (CAT). Absolute levels of CAT and its activity decline with age, ranging from a 20 to 30 percent decline in the hippocampus and striatum and about a 10 percent decline in the cerebral cortex. Within these same anatomical regions there is evidence of some neuron cell loss, but it does not necessarily account for total decline in neurotransmitter production. It is interesting that the loss of CAT activity can be reversed or attenuated. For example, increased production of neurotrophic factors (which themselves are regulated by exercise and diet) influence CAT activity and acetylcholine production. In addition to these presynaptic changes, postsynaptic alterations have also been documented. For example, the muscarinic acetylcholine receptor, the synaptic receptor protein that binds acetylcholine, has been shown to decline by similar degrees in areas where CAT activity is also di-

minished. However, it remains to be determined whether this is the cause of the neurotransmitter deficiency or a consequence in response to presynaptic changes. Despite the fact that global neuron cell death may not underlie specificity of neurotransmitter system decline, some studies, but not all, have suggested that altered cholinergic neurotransmission may also be accompanied by a decline in the number or size (atrophy) of cholinergic neurons, including those in the nucleus basalis. The best example of a neurodegenerative disease associated with the loss of cholinergic neurons is Alzheimer's disease.

Dopamine

Dopamine is the primary neurotransmitter in the basal ganglia (i.e., striatum, substantia nigra) and to a lesser extent in the cerebral cortex. In normal aging there are presynaptic alterations including decline of dopamine in the striatum, decreased dopamine metabolites (indicated by decreased dopamine biosynthesis), as well as postsynaptic alterations including decreased dopamine receptors. As summarized in the review by Morgan and Finch, the decline in the DA content and TH activity of the substantia nigra and striatum of aged rodents is not a consistent finding across rodent species and is generally smaller than that reported for nonhuman primate and postmortem human brains. Similarly, for dopamine cell loss, while it has been reported that normal aging is not associated with a significant decline in the total number of DA neurons of the substantia nigra in aged mice, controversy exists as to the degree DA cell loss occurs in the substantia nigra of nonhuman primates and man. It is interesting that despite the fact that there are presently five different classes of dopamine receptors, the decline in the D2 receptor is the only one that has been reported to show an age-related decline across species. The reasons for this variability are yet unclear. Other age changes seen in the dopaminergic system included decreased dopamine transporter (responsible for uptake of dopamine from the synapse) and increased monoamine oxidase B (an enzyme that breaks down dopamine resulting in reduced effective synaptic levels of dopamine). The prime example of a neurogenerative disease associated with the loss of dopamine neurons is Parkinson's disease.

GABA and glutamate

GABA and glutamate are both metabolic intermediates and neurotransmitters. GABA is considered the major inhibitory neurotransmitter in the brain, whereas glutamate is considered an excitatory neurotransmitter that promotes a postsynaptic stimulatory response. In the aged brain glutamic acid decarboxylase (GAD), the enzyme that converts glutamate into GABA, falls 20–30 percent in the cortex and thalamus of postmortem human brain, and there is a decrease in GABA receptor binding sites and GAD mRNA levels in the aged rodent brain. Similarly, previous studies have reported an age-related decrease in glutamate receptors in the hippocampus of aged rats, mice, and nonhuman primates while no change in glutamate receptor binding sites has been found in postmortem human brains. Huntington's disease is the classic example of a neurodegenerative disease linked to the loss of GABA neurons in the striatum.

To summarize, while there is little doubt that degenerative changes occur in neurons of the aged brain the severity of these changes vary from person to person, and the question of cause and effect remains elusive. In addition, previous studies have shown that age-related changes in the neurotransmitter systems of the brain are not a global phenomenon of normal aging but are brain region, cell type, and species specific. Species variability is well documented in the gerontologic literature, and we must be cautious in our interpretations when comparing data across animal species or when comparing cellular changes in animals and human aging. Lastly, it is no longer possible to associate brain aging with the loss of function and structure without taking into consideration the compensatory or plastic nature of the nervous system. Rather, it is understood that the aging brain represents a composite of various adaptive and compensatory responses, which work together to maintain neurotransmitter levels in the brain and repair the brain's neural networks in response to naturally occurring cell loss or neurochemical changes that are brain region specific.

THOMAS H. MCNEILL
MICHAEL JAKOWEC

See also NEUROCHEMISTRY.

BIBLIOGRAPHY

COLLIER, T. J., and COLEMAN, P. D. "Divergence of Biological and Chronological Aging: Evi-

Nurse practitioners play an increasingly important role in providing health care in the United States. Nurse practitioner Marilyn Graham (left) prepares to give three-month-old Donovan Washington a check-up in Arlington, Texas on August 30, 2000. (AP photo Donna McWilliam.)

dence from Rodent Studies." *Neurobiology of Aging* 12 (1991): 685–693.

FINCH, C. E., and ROTH, GEORGE S. "Biochemistry of Aging." In *Basic Neurochemistry: Molecular, Cellular and Medical Aspects.* Edited by G. J. Siegel, B. W. Agranoff, R. W. Albers, S. K. Fisher, and M. D. Uhler. Philadelphia: Lippincott-Raven, 1999. Pages 614–633.

MORGAN, D. G., and FINCH, C. E. "Dopaminergic Changes in Basal Ganglia: A Generalized Phenomenon of Aging in Mammals." *Annals of the New Academy of Science* 515 (1988): 145–160.

WANG, E., and SNYDER, D. S. *Handbook of the Aging Brain,* San Diego, Calif.: Academic Press, 1998.

NORMAL AGING

See PHYSIOLOGICAL CHANGES

NURSE PRACTITIONER

Health care demands are often the driving force behind the emergence of new and modified positions within the field. In the 1960s the United States began to experience a significant reduction in the number of physicians. Coupled with increasing patient acuity (increasingly ill patients) and funding cutbacks, new types of positions as well as expansions of roles already within the system were introduced into the health care system.

Beginnings

Because of the significant demand for physicians that could not be met by medical training programs currently in place, a new position, the physician assistant (PA) was introduced into the U.S. health care system. In this role registered nurses and retired Army Medical Corps personnel took on certain medical functions. Physician assistants were trained on the medical model, and practiced medicine with a great deal of autonomy—often in geographically isolated regions—while remaining under the supervision of a licensed physician. PAs continue to flourish in the United States, with an estimated twenty-six thousand in practice as of 1996. The average PA program consists of two years of intensive training offered within a medical school curriculum.

As in the United States, Canada experienced a physician shortage in the 1970s and 1980s.

However, rather than introducing a totally new type of health care worker into the system, it was decided to expand the scope of registered nursing practice to meet the primary health care needs of Canadians. The new role was established as the nurse practitioner (NP) or expanded role nurse (ERN).

NP education did not develop within the usual university setting because of the urgent demand for NP/ERNs. Moreover, attitudes within many universities fostered skepticism about what was seen as a mixed medical and nursing role rather than a pure nursing role. Thus the NP role was initially perceived to be an extension of the registered nurse role emphasizing many of a physician's responsibilities: histories and physicals, medical diagnoses, ordering and interpreting laboratory and diagnostic tests, prescribing medications, and developing treatment plans in collaboration with a physician. As such, the NP was often compared to the PA. NP courses quickly proliferated in such subspecialties as pediatrics, occupational health, and geriatrics, and their graduates often worked in sparsely populated areas of northern Canada and the western United States that could not attract physicians.

As early as the 1940s a version of the NP, the clinical nurse specialist (CNS), was emerging in both Canada and the United States as a response to nurse educators' concerns for improving nursing care. The CNS specializes in a particular population or disease, emphasizing teaching, role modeling, nurse-to-nurse consultation, education and staff development, and research. The CNS uses specifically developed clinical expertise (e.g., in geriatrics or cardiovascular disease) to guide and mentor nursing staff in improving patient care.

Education and licensure requirements

Initially education for the NP/ERN did not require a baccalaureate nursing degree, provided the registered nurse had experience in the area. Education consisted of on-the-job training for several months, followed by graduation with a certificate or diploma. Though this preparation continues in some areas of North America, Great Britain, and Australia, general agreement now is that educational preparation should be at a master's degree at the nursing level with specific proficiencies and standards, and should focus on advanced clinical and teaching skills. Candidates are limited to registered nurses with a baccalaureate degree in nursing and clinical experience in the field of study. This arrangement clearly establishes the NP program at the graduate level.

Current roles and functions

The NP is now recognized as a registered nurse with specialized skills and knowledge in health assessment and promotion, counseling, disease prevention, and management of selected health problems. While both the PA and the NP undertake medical functions, the NP does so as a registered nurse, applying advanced nursing knowledge. In collaborative practice, NPs and physicians provide health care to a specific population of patients, sharing authority for providing care within the scope of their practice. NPs have shared competencies with physicians and other health professionals, and upon completing specific education have been delegated to perform selected medical functions.

NPs demonstrate a high degree of professional autonomy; working in environments where they are supervised employees of physicians (in a family practice office), in collaborative practices (as in a geriatric ambulatory clinic), or in solo practices (community health care drop-in centers). NPs bring additional skills to the care of patients, including provision of disease-prevention counseling, health education, and health promotion activities, as well as more time than physicians to spend talking to patients. The physician will always be the primary professional providing diagnosis and treatment in complex cases and managing patients with critical and unstable medical conditions.

Gerontological nurse practitioners (GNPs) provide elderly persons with services specifically tailored to frail individuals. Their scope of practice involves management of the patient from the community consultation, through diagnosis and treatment (emergency, outpatient, or inpatient), through home visits following discharge, including a comprehensive discharge plan. These activities have reduced hospital readmissions and costs of care, and have improved the continuity of care. Medical directives and protocols for specific problems, such as cardiac irregularities, delirium, and sudden shortness of breath, are examples of medical functions delegated to the GNP.

Future of the nurse practitioner

Though the NP role has proliferated and formalized, there is still some residual anxiety in both the nursing and the medical communities as to its exact benefits and responsibilities. Is the NP abdicating the role of the nurse, or is the NP a strategy to retain skilled nurses within the profession while providing improved care to specific patient populations and reducing costs? Is the NP position taking jobs from physicians because NPs are less costly, thus affecting physicians' employment opportunities? Regardless, as the role continues to be tested with different populations, it is being heralded as an appropriate role for registered nurses in the care and treatment of specific patient populations within a collaborative and collegial relationship with physicians and other health care professionals.

DEBORAH A. VANDEWATER

See also GERIATRIC MEDICINE; GERONTOLOGICAL NURSING.

BIBLIOGRAPHY

Canadian Nurses Association. "Out in Front—Advanced Nursing Practice." *Nursing Now: Issues and Trends in Canadian Nursing* 2 (1997): 1–4.

DUKE, S. *The Function of the Expanded Role Nurse in a Reforming Health Care System*. Halifax, Nova Scotia: Dalhousie University School of Nursing, 1998.

HUCH, M. H. "Nurse Practitioners and Physician Assistants: Are They the Same?" *Nursing Science Quarterly* 5, no. 2 (summer 1992): 52–53.

MUNDINGER, M. O. "Advanced-Practice Nursing—Good Medicine for Physicians?" *New England Journal of Medicine* 330 (1994): 211–214.

NAYLOR, M. D.; BROOTEN, D.; CAMPBELL, R.; JACOBSEN, B. S.; MEZEY, M. D.; PAULY, M. V.; and SCHWARTZ, J. S. "Comprehensive Discharge Planning and Home Follow-up of Hospitalized Elders: A Randomized Clinical Trial." *Journal of the American Medical Association* 281 (1999): 613–620.

PINELLI, J. M. "The Clinical Nurse Specialist/Nurse Practitioner: Oxymoron or Match Made in Heaven?" *Canadian Journal of Nursing Administration* 10 (1997): 85–110.

Registered Nurses' Association of Nova Scotia and College of Physicians and Surgeons of Nova Scotia. *Guidelines for Shared Competencies and Delegated Medical Functions*. Halifax, Nova Scotia: RNANS, 1997.

RUIZ, B. A.; TABLOSKI, P. A.; and FRAZIER, S. M. "The Role of Gerontological Advanced Practice Nurses in Geriatric Care." *Journal of the American Geriatrics Society* 43 (1995): 1062–1064.

NURSING HOME ADMINISTRATION

The practice of nursing home administration has been embodied in five domains of practice developed in the 1980s by the National Association of Boards of Examiners for Long Term Care Administrators: (1) organizational management, (2) personnel, (3) financial management, (4) environmental management, and (5) resident care. These five domains are updated every five years. A license issued by a state government body is required for every administrator of record in all U.S. nursing facilities. Each state sets the requirements that must be met for licensure, usually setting education requirements, an internship requirement, and examination requirements. The majority of states require that an administrator obtain a college degree and complete an internship in a nursing facility of twelve to fifty weeks in length. There is one national examination required of all who become nursing home administrators. However, reciprocity among states varies. Usually state boards or agencies will allow a person to receive a license in a new state by taking any required test on the receiving state's regulations.

Nearly one hundred colleges and universities across the Untied States offer curricula in long-term care administration. There is a national website www.longtermcareedu.com that provides state-by-state information on the requirements for licensure set by each state, how to contact the state licensure authority, and which colleges offer long-term care administration. This site provides extensive background information on nursing home administration as a profession and provides resource contacts and access to publications in the field.

About six thousand of the roughly thirty-four thousand licensed nursing home administrators in the United States belong to a professional organization, the American College of Health Care Administrators. Most nursing home administrators, through their facility, are active members in a state level association of the American Health Care Association, which has both for-

profit and nonprofit facility members. Nonprofit facilities may also belong to the American Association of Homes and Services for the Aging.

Salaries for nursing home administrators range from $40,000 to $100,000 per year. Because turnover is often high among facility administrators, there is usually an opportunity to enter the field and find a job quickly. About 70 percent of the 16,400 Medicare-certified nursing homes in the United States are owned by for-profit corporations. Typically, about 70 percent of the residents in a nursing facility pay for care through Medicaid, another 10 to 12 percent through Medicare, and the rest pay privately or through insurance.

There is a trend among nursing home administrators to move more and more easily between job assignments in assisted living facilities and life care communities. Assisted living administrators receive about the same salaries as nursing home administrators while life care communities salaries run higher, $60,000 per year and above. Current requirements for licensure in assisted living and life care communities are available on the web at www.ltcedu.com.

JAMES E. ALLEN

See also CAREERS IN AGING; LONG-TERM CARE; NURSING HOMES.

NURSING HOMES

Nursing facilities, commonly called *nursing homes,* serve a small percentage of older adults. These facilities continue to be in the public-policy spotlight because of efforts to redefine their position in the long-term care system and because of ongoing efforts to enhance the quality of care they provide to their residents. *Nursing facilities* are defined here as facilities with three or more beds that routinely provide twenty-four-hour nursing care services to sick or disabled individuals; they may be certified by Medicare or Medicaid or licensed by the state as a nursing facility, and they may be freestanding or part of a larger facility. There are four major characteristics of nursing facilities: (1) facility characteristics, (2) resident characteristics, (3) financial characteristics, and (4) administration and staffing characteristics.

Facility characteristics

A *nursing facility* (NF) is a facility that has met Medicaid certification requirements. A *skilled nursing facility* (SNF) is one that has met Medicare certification requirements. Facilities that are part of hospitals and intermediate-care facilities for the mentally retarded (ICF-MR) are not included in this discussion.

In 1998, there were about 17,000 nursing facilities containing approximately 1.8 million beds and 1.6 million elderly and disabled residents in the United States. Six states—California, Illinois, New York, Ohio, Pennsylvania, and Texas—accounted for 37 percent of all nursing-facility beds (over 640,000 beds). Texas had the most nursing-facility beds (122,365). The total number of nursing facilities (and the number of licensed beds) fell slightly between 1998 and 1999. Nationwide, there were 49.7 beds per 1,000 persons age sixty-five or older in 1999, a drop of 4.2 percent from 51.9 beds in 1998. The average size of a nursing facility in 1997 was 107 beds. For the thirty-three largest chain-owned facilities, the average number of beds per facility in 1999 was 109, which was a 5.1 percent drop from the average of 115 beds in 1998.

Data from the 1997 National Nursing Home Survey revealed that approximately 77 percent of all facilities and 84 percent of all beds are certified by both Medicare and Medicaid. In 1997 the occupancy rate in all nursing facilities was about 88 percent, which is 5 to 10 percent, less than during the early 1990s. According to Manton and Gu, "there was a large absolute decline (415,000 persons) in the institutional population 1994 to 1999" (p. 3). Over 66 percent of the facilities are located in the Midwest and southern regions of the nation, and about 61 percent of the facilities are located in metropolitan areas.

The majority of nursing-facility beds in 1997 were owned by for-profit organizations (67 percent), followed by not-for-profit organizations (26.1 percent), with government-owned homes accounting for about 8 percent of all facilities. The consolidation of the nursing-home industry is reflected by the fact that between 1998 and 1999 the number of licensed beds in the nation's thirty-three largest nursing facility chains increased by almost 2 percent. These chains owned approximately 27 percent of all beds nationwide in 2000 with about 56 percent of all nursing homes in the United States being part of a chain.

A significant change in nursing facilities has been the addition of what has been called *special*

care or *subacute care* units within nursing facilities. These units "have emerged in an effort to meet the needs of subgroups of residents such as those with Alzheimer's disease or with relatively short-term post-acute needs" (Wunderlich and Kohler, p. 22). The number of dementia-specific special care units has also grown and "as of 1996, nearly one in four nursing homes had at least one organized dementia care unit, wing, or program" (NIA, p. 41). As a result of this growth, the Centers for Medicare and Medicaid Services (CMS) now track information on special units for residents with Alzheimer's disease. In addition, the Alzheimer's Association has developed specific guidelines for special care units (SCUs) and the Joint Commission of Accreditation of Healthcare Organizations has developed SCU standards. These types of units continue to be viewed by operators, staff, and family members as a better alternative to traditional nursing-facility care. Because of the lack of a standard definition for SCUs, the National Institute on Aging has supported a number of projects to examine the nature and effectiveness of these units. One of the significant outcomes of this research has been the development and testing of a method for classifying SCUs, which has allowed for a more effective comparison of the care provided across different types of SCUs.

Resident characteristics

One established fact about older adults is that in general they are living longer and healthier lives. There has also been an increasing availability of alternatives to nursing facilities (e.g., assisted living) and an increased use of community-based services (e.g., home health care), with the result that the profile of the "typical" nursing facility resident has changed in significant ways since 1985. There are now three older women for every older man in nursing facilities. This ratio has not changed since 1985, but the percentage of white residents declined from 93 percent in 1985 to 89 percent in 1997. It is very common for women to be widowed at the time of admission. Persons sixty-five years and older using a nursing facility in 1997 had an average age at admission of 82.6 compared to 81.1 in 1985. A common approach used by health care providers to measure functional ability in older adults is activities of daily living (ADLs). This method consists of measuring changes in the person's ability to perform six ADLs. ADLs include such functions as bathing, dressing, and eating. The mean number of ADLs that nursing facility residents experienced difficulty in increased from 3.8 in 1985 to 4.4 in 1997 (Sahyoun et al.; Wunderlich and Kohler). The four ADLs that nursing facility residents receive the most assistance with are bathing (96 percent of residents), dressing (87 percent), toileting (56 percent), and eating (45 percent). Approximately 50 percent of nursing facility residents are over the age of 85. Because of these increases in levels of disability (which have lead to much higher levels of frailty) and the trend towards entering the facility later, operational and clinical challenges have increased for administration and staff, who now must care for sicker, frailer residents with more complex medical problems. These changes have occurred in the context of an "increased use of preadmission screening, expanded role of Medicaid home and community-based waivers, the introduction of Medicare and Medicaid managed care programs, the general trend toward prospective payment, and more rapid discharges from hospitals" (Wunderlich and Kohler, p. 22). As a result, "the services that were once provided in the hospital setting are now more frequently available in the nursing home setting; assisted living environments are starting to provide nursing care; and home health agencies deliver services that were once available only in acute care environments or nursing homes" (Fairchild, Knebl, and Burgos, p. 84).

In 1997, approximately 58 percent of residents were admitted to a nursing facility from a hospital or another nursing facility. Another one-third were admitted from their homes, and 40 percent of this group had been living alone. The most common diagnoses at the time of admission were cardiovascular disease, mental and cognitive disorders, and disorders of the endocrine system (i.e., diabetes mellitus); and, almost without exception, residents had more than one diagnosis when they were admitted. These conditions often contribute to functional decline, which can impact ADLs and instrumental activities of daily living (IADLs) such as shopping and taking medication. When combined with other risk factors, such as living alone and low income, these conditions make it more and more difficult for a person to remain independent, increasing the risk for admission to an institutional environment such as a nursing facility.

Financial characteristics

The government's current expenditures for health care clearly favor nursing-facility care, which is costly—a conservative estimate put the cost of a nursing-home stay at $47,200 per year in 1999. Total nursing-facility care expenditures in 2000 were $92 billion, compared to $40 billion in 1988. The Congressional Budget Office (CBO) projects the nation's expenditures for long-term care services for the elderly will exceed $108 billion by the year 2010. The largest portion of these expenditures ($52 billion) will come from Medicaid; out-of-pocket expenditures will exceed $29.3 billion; Medicare will account for $16 billion; and private long-term providers will account for $11.2 billion. Medicare, which was designed to pay mostly for acute care or hospital costs, has historically paid for a very small portion of nursing facility care; this is expected to continue into the future, while long-term care insurance will likely play a more significant role. The growth in expenditures for nursing-facility care is projected to accelerate over this decade because of a number of factors, including rising provider costs in such areas as labor and liability rates. The CBO estimates that inflation-adjusted expenditures for long-term care for the elderly will grow annually by 2.6 percent between 2000 and 2040.

In 1997, average daily charges ranged from $136 for skilled care to $109 for intermediate care. For certified Medicaid beds, rates averaged $98, while Medicare rates were $216 per day. Across these rate categories, significant differences occurred based on such factors as ownership status and region of the country. For example, the rate for a skilled bed operated by a proprietary facility in 1997 was $139 per day, compared to $147 per day for a not-for-profit facility. The average daily rate for that same skilled bed in the northeast was $176, compared to a low of $115 in the South. Between 1990 and 2000, the desire of providers to fill a bed with a Medicare patient depended on the type and level of reimbursement and regulations. Currently, many providers are attracted to the Medicare program because of the relatively high reimbursement rates for these residents.

Administration and staffing

In 1997, it was estimated there were approximately 1.4 million full-time and part-time employees in nursing homes. The recruitment and retention of these employees, although a significant issue for all businesses today, pose some rather unique challenges for nursing-facility providers. The challenge of retention is critical in a nursing-facility environment because of the direct impact it has on quality-of-care issues. The administrative team, working with other staff in a facility, creates the culture of quality care. The ability to create and maintain a culture of quality is often hindered by high turnover of staff in many facilities. Singh and Schwab (1998) report that about 40 percent of nursing home administrators turn over each year, and the American Health Care Association (AHCA) reported in 1997 that the turnover rate for RNs and LPNs was 51 percent and that nurse's aides had a turnover rate of 93 percent. Registered nurses account for only 15 percent of the average nursing staff, while certified nurse's aides account for nearly 66 percent of staff. A number of factors contribute to staff turnover, including job stress, limited career opportunities, pay, and organizational culture. When looking at the clinical staff, the area that receives the most attention is pay. Based on 1997 data, the average RN was paid $16.88 per hour, LPN wages averaged $12.88, and nursing aide wages averaged $7.44. When these relatively low hourly rates are combined with a minimal benefit package, a strong economy, and the demands associated with caring for frail, medically complex persons, the challenge to retain quality employees can be easily appreciated.

The need to improve staffing standards and levels has received increased attention. In 1997, the staff-to-resident ratio for all direct-care staff was 89 per 100 residents and 59 nurse's aides per 100 residents. Certified nurse's aides spend the most time with residents, providing a significant portion of direct care, and yet they are often not well prepared to provide the level of care required by residents with increasingly complex medical problems. Based on the Medicare time studies that used the Online Survey, Certification, and Reporting (OSCAR) system, staffing hours for nurses averaged 3.5 hours per resident day (24 hours) for all nursing facilities in 1998. Registered nurses were found to spend 0.74 hours per resident day, LPNs spent 0.69 hours per resident-day, and nurse's aides averaged 2.09 hours. Because of the wide variation in resident care needs these numbers vary significantly across facilities. In contrast to the OSCAR finding of 3.5 hours per resident-day, a CMS time study

came up with 4.17 hours, and a recently convened expert panel found the average to be 4.55 hours.

The recently released Institute of Medicine study on improving the quality of long-term care adds its support to this issue by recommending that CMS not only require RN presence twenty-four hours per day, but also that minimum staffing levels for direct care be developed.

Finally, the increasing role of the medical director has contributed to improving the quality of care. Each facility is required to have a medical director, who provides care to those residents who do not have a primary care provider. The medical director also plays a critical role in shaping clinical policies and procedures. The voluntary certification of physicians as Certified Medical Directors offered through the American Medical Directors Association has assisted physicians to better understand not only their clinical role within long-term care, but also to have a better appreciation of how to more effectively work within a nursing facility and as an active member of the administrative team.

Conclusion

Nursing facilities continue to serve a vital role within the long-term care system, even as they struggle to deal with a number of issues ranging from delivering quality care to adequate reimbursement. The frenetic pace of change is driven by the dynamic environment in which they operate, which seems destined to continue to bring more and more uncertainty to the role they will play in the long-term care system in the future. The recent Nursing Home Initiative by CMS has helped to continue focusing attention on addressing nursing-home quality and on minimum staffing ratios. Whatever the future holds for nursing facilities, one thing seems certain: if they are to survive and prosper, they will have to continue to evolve to meet the ever-changing needs of the residents they serve and to find funding mechanisms to adequately support the services they provide.

THOMAS J. FAIRCHILD
JANICE A. KNEBL

See also ASSISTED LIVING; LONG-TERM CARE; MEDICAID; MEDICARE; NURSING HOME ADMINISTRATION; WORKFORCE CHALLENGES.

BIBLIOGRAPHY

Aventis Pharmaceuticals, Inc. *Institutional Highlights Digest*. Managed Care Digest Series, 2000.

American Health Care Association. *Facts and Trends 1999: The Nursing Facility Sourcebook*. Washington, D.C.: ACHA, 1999.

Congressional Budget Office. *Projections of Expenditures for Long-Term Care Services for the Elderly*. CBO, 1999. Available at www.cbo.gov/

FAIRCHILD, T. J.; KNEBL, J. A.; and BURGOS, D. "The Complex Long-Term Care Service System in Matching People with Services." In *Long-Term Care*. Edited by Zev Harel and Ruth Dunkle. New York: Springer Publishing Company, 1995.

GABREL, C. S. An Overview of Nursing Home Facilities: Data from the 1997 National Nursing Home Survey. Hyattsville, Md.: U.S. National Center for Health Statistics, 2000.

HEFFLER, S.; LEVIT, K.; et al. "Health Spending Growth Up in 1999; Faster Growth Expected in the Future." *Health Affairs* 20, no. 3 (2001).

MANTON, K. G., and GU, X. "Changes in the Prevalence of Chronic Disability in the United States Black and Nonblack Population above Age 65 from 1982 to 1999." *Proceedings of the National Academy of Sciences of the United States of America,* Early Edition. 8 May 2001. Available at www.pnas.org

National Institute on Aging. *Progress Report on Alzheimer's Disease 1999*. Silver Spring, Md.: Alzheimer's Disease Education and Referral Center.

SAHYOUN, N. R.; PRATT, L. A.; et.al. *The Changing Profile of Nursing Home Residents: 1985–1997*. National Center for Health Statistics, Centers for Disease Control and Prevention, 2001.

SINGH, D. A., and SCHWAB, R. C. "Predicting Turnover and Retention in Nursing Home Administrators: Management and Policy Implications." *The Gerontologist* 40, no. 3 (2000): 310–319.

WUNDERLICH, G. S., and KOHLER, P. O., eds. *Improving the Quality of Long-Term Care*. Washington, D.C.: National Academy Press,. 2001.

U.S. Census Bureau. "Nursing Home Residents 65 Years Old and Over by Selected Characteristics: 1997." In *Statistical Abstracts of the United States, 2000*. Washington, D.C.: Census Bureau.

NURSING HOMES: CONSUMER INFORMATION

Every year over 1.5 million people (of all ages) in the United States spend some time in a nursing home (McKnight's; Kassner and Bectel). Although many return home after a brief stay, others spend their last years as nursing home residents. Whether one plans to stay for a few weeks or a few years, choosing a nursing home is a difficult decision. Nursing homes vary in services provided, amenities available, type of staff, types of residents, and quality of care. Fortunately a great deal of information is available to assist prospective nursing home residents and their families in choosing the nursing home that best meets their needs. This information is largely of two types—general advice about how to choose a nursing home and what to look for when one visits, and specific information that allows consumers to compare individual nursing homes. This entry will discuss these two broad categories of information, explain how the information is gathered, and provide suggestions about how to use the information to make an informed decision.

General advice

Before focusing on nursing homes specifically, a good starting point is to understand the array of options called *long-term care*.

The federal Administration on Aging (AoA) has one of the most comprehensive Web sites for issues relating to older people, their families, and the general public. Covering everything from Alzheimer's disease to federal aging policy and government programs, the AoA Web site (www.aoa.gov) provides numerous links for consumers seeking information about older adults, long-term care in general, and nursing homes in particular.

Since nearly half of all the people who turned sixty-five in 1990 will spend some time in a nursing home (Kemper and Murtaugh, 1991), choosing a nursing home before one is actually needed is a valuable activity. Available advice includes how to discuss nursing home choices with family members, financial planning, how to purchase long-term care insurance, and guides for visiting nursing homes, with questions to ask and things to observe. Organizational and governmental sites such as AARP (www.aarp.org), the Centers for Medicare and Medicaid Services (www.medicare.gov), the American Association of Homes and Services for the Aging (www.aahsa.org), and the American Health Care Association (www.ahca.org) have publications that can be downloaded. Similar information is also available on commercial sites such as www.agenet.com, www.seniorsite.com, and www.elderweb.com. Many state and local departments on aging have similar materials with a special focus on local or state long-term care services. Because of the wide availability of these kinds of guides, no one should begin the nursing home search without one. Checklists can be printed from Web sites and completed for each facility one visits. After four or five facilities have been visited, the completed checklists provide important comparative information with which to make the choice that best meets the needs of the prospective resident.

Nursing home information

Specific information about individual nursing facilities has become widely available on the Internet. The federal government (at www.medicare.gov), state nursing home associations, state government departments, and newspapers have all gotten into the business of comparing nursing homes. More states are adding Web sites each year. Some Web sites use a report card grading system; others use stars, akin to restaurant and hotel rating systems. While these provide quick comparative information, not everyone's needs are the same. The things about a facility that are most important to one person may not be the things that those who developed the ranking system had in mind.

Facility deficiencies. One component included in almost all national- and state-level sites is information from the annual inspection survey. Every nursing facility that is certified to receive Medicaid or Medicare payments is visited at least once a year. At the annual visit the survey team collects information about the staff and residents, conducts interviews with a sample of residents; reviews a sample of resident records, inspects the physical aspects of the facility, and observes the provision of care. Over 150 different aspects of care are observed during each survey. In each area that the nursing home fails to meet the regulated standard, a deficiency is recorded. Deficiencies are classified according to their severity (the amount of potential harm that could come to residents), and their scope (wheth-

er the potential harm was isolated, affecting only one resident, or widespread, affecting many). In 2001 the national average number of deficiencies cited is six. Some Web sites post the proportion of compliance, which can be misleading. For example, Ohio surveys for 192 deficiencies, and the poorest performing facility was in 80 percent compliance, a B- in most grade books. Deficiency information is most useful when comparing one facility with another, and when the reasons for the deficiency can be explored.

The most comprehensive source of deficiency information is medicare.gov, the Medicare Web site; their *Nursing Home Compare* provides survey information for all Medicare and Medicaid facilities in the United States. Knowing whether a home has a history of harming residents, providing poor care, or otherwise jeopardizing those in its care is an important factor in the decision-making process.

However, this information has some limitations. First, surveys are conducted at approximately one-year intervals, so the information may be out of date. The nursing home may be quite different today than it was when the deficiencies were found. Historical survey data can help in interpreting the latest survey because they show whether a facility is improving or declining. No matter what is shown on the Internet, a visit to the facility should be part of the selection process.

Another limitation of survey data is that they may not be reliable. Different surveyors may produce very different lists of deficiencies for the same nursing home. It is not uncommon for nursing homes to find that a practice that has not caused a deficiency for years has suddenly become unacceptable when a new team of surveyors is sent in.

The deficiency language (which most Web sites use) is broad and general, so it is not clear what actually caused the deficiency. The Pennsylvania Department of Health posts the deficiencies, and the explanation of what caused each deficiency. This is helpful because it provides examples of the kinds of things that result in particular deficiencies. The department of health Web site in one's state should be checked to see if this information is available.

Despite the limitations mentioned above, comparative survey information is one important component of the nursing home choice. Knowing how one facility compares with the average in the state or with the facility down the street can certainly help in narrowing a search. It also provides guidance about what kinds of questions should be asked during a visit to a particular facility. Many high-quality facilities receive survey deficiencies; the things surveyors cite may not affect a resident's satisfaction with the facility at all. Some Web sites post results from resident and family satisfaction surveys—these results are important to consider in conjunction with the results collected during the annual survey.

Residents. Several Web sites (Medicare, Texas Department of Health) provide information about the characteristics of residents who live in each facility. Knowing more about the residents living in a facility can be useful in matching the needs of the prospective resident with the residents already being served. For example, if a facility has a much higher than average proportion of residents with behavioral symptoms (one of the resident classifications), it may specialize in dementia residents. On the other hand, there may be a higher proportion of residents with behavioral symptoms because the staff is poorly trained in behavioral management. Resident information can be useful in deciding whether the prospective resident is likely to fit in, and whether the facility has experience caring for others with similar needs. Quality indicators, taken from assessments of resident conditions, appear on some Web sites. They suggest areas where a facility has potential problems in providing care for certain kinds of residents. If quality indicators for the facilities in one's state cannot be located, one should ask to see the facility's quality indicator report.

Staff. Information about the number and type of staff is collected when each facility has its annual survey. The Nursing Home Compare Web site posts this information as nursing staff per resident. If one is choosing a nursing home for someone with complex medical conditions, then the number of registered nurses in the facility is likely to be more important than for someone who needs only basic assistance with bathing or dressing. A 2000 report to Congress recommended an optimal staffing measure of 2.9 hours of certified nurse aide staffing, per resident, per day (Health Care Financing Administration). However, if this standard is not met in the facilities being considered, it may be because the facility serves a diverse group of residents, some of

whom require much more or much less care than the average.

Using information wisely

A search for Nursing Home Survey, or Choose a Nursing Home, or a visit to any of the Web sites mentioned in this entry will provide plenty of information about long-term care and making nursing home comparisons. Internet information is highly useful for developing an understanding of long-term care and long-term care planning in general, locating facilities in the area one is interested in, learning more about those specific facilities, and preparing for nursing home visits. One can download a checklist for a visit and prepare specific questions about a facility's survey history, residents, care specialties, and staffing. One can easily make comparisons to narrow the search to the facilities most likely to meet the prospective resident's needs. However, gathering consumer information from the Internet is no substitute for the sights and sounds of a nursing home visit.

JANE KARNES STRAKER

See also LONG-TERM CARE; LONG-TERM CARE, QUALITY OF.

BIBLIOGRAPHY

Health Care Financing Administration. "Report to Congress: Appropriateness of Minimum Nurse Staffing Ratios in Nursing Homes." World Wide Web document, www.hcfa.gov

KASSNER, E., and BECTEL, R. W. *Midlife and Older Americans with Disabilities: Who Gets Help?* Washington, D.C.: AARP Public Policy Institute, 1998.

KEMPER, P., and MURTAUGH, C. "Lifetime Use of Nursing Home Care." *New England Journal of Medicine* 324, no. 9 (February 28, 1991).

McKnight's Online. "Frequently Asked Questions about Long-Term Care." World Wide Web document, www.mcknightsonline.com

NURSING HOMES: HISTORY

In the twenty-first century, nursing homes have become a standard form of care for the most aged and incapacitated persons. Nearly 6 percent of older adults are sheltered in residential facilities that provide a wide range of care. Yet such institutions have not always existed; rather, their history and development reflect relatively recent demographic and political realities that shape the experience of growing old. Before the nineteenth century, no age-restricted institutions existed for long-term care. Rather, elderly individuals who needed shelter because of incapacity, impoverishment, or family isolation often ended their days in an almshouse. Placed alongside the insane, the inebriated, or the homeless, they were simply categorized as part of the community's most needy recipients.

In the beginning of the nineteenth century, women's and church groups began to establish special homes for the elderly persons. Often concerned that worthy individuals of their own ethnic or religious background might end their days alongside the most despised society, they established—as the founder of Boston's Home for Aged Women (1850), explained—a haven for those who were "bone of our bone, and flesh of our flesh" (Haber and Gratton, p. 130). Advocates for these asylums contrasted their benevolent care with the horrors of those who were relegated to the almshouse. "We were grateful," wrote the organizers of Philadelphia's Indigent Widows' and Single Women's Society, one of the nation's earliest old age homes, in 1823, "that through the indulgence of Divine Providence, our efforts have, in some degree, been successful, and have preserved many who once lived respectfully from becoming residents of the Alms House" (Haber and Gratton, p. 130).

Although designed for those without substantial familial support, these early homes still generally required substantial entrance fees and certificates of good character. Through these policies, the founders strove to separate their own needy poor from, as the Boston founder explained, foreigners who "have taken possession of the public charities. . .as they have of the houses where our less privileged classes formerly resided" (Haber and Gratton, p. 130).

Not surprisingly, perhaps, throughout the nineteenth century the numbers of elderly people who found shelter in these institutions was rather limited. In 1910 the state of Massachusetts, reported that 2,598 persons resided in such asylums. The great majority of these individuals were widowed and single women who had lived their entire lives, or at least a great proportion, as citizens of the state. Although the institutions were hardly palatial, the amount spent on each

resident was far greater than the allocation for each almshouse resident. Much as their founders had hoped, the nineteenth-century old-age home operated to differentiate the "worthy" old of a particular religion or ethnic group from the most needy and desperate of the aged population.

As a result, for the most impoverished individuals, the almshouse still served as the last refuge in their old age. Throughout the nineteenth century, in fact, this institution appeared to play an increasingly important part in the long-term care of the old. Some states, such as Pennsylvania, periodically revoked outdoor relief in the form of money, wood, or clothes, demanding that those in need either struggle on their own or enter an almshouse. Moreover, as charity advocates removed other, younger paupers to institutions organized to specific needs—such as orphanages, work homes, hospitals, or insane asylum—elderly persons became the dominant almshouse residents. Thus, although the proportion of the elderly population that was institutionalized remained stable at about 2 percent, the percentage of elderly *within* almshouses soared. In 1880, 33 percent of the national almshouse population was composed of elderly individuals, but by 1923 the proportion had increased to 67 percent. Many of the superintendents of state and local institutions responded to the changing nature of their residents by altering the names of their asylums. In New York City, in 1903, the Charity Board renamed its public almshouse the Home for the Aged and Infirm. The city of Charleston followed suit in 1913, transforming their almshouse into the Charleston Home. In these institutions, their managers claimed, the old could find everything they needed in their last days.

Despite the name changes and the rosy descriptions that filled the institutions' annual reports, most people hardly looked upon the almshouse as a satisfactory solution to the demands for long-term care for the elderly. Throughout the early twentieth century, the institution remained a symbol of failure and despair. *Poorhouse*, according to early twentieth-century social analyst Harry C. Evans, was "a word of hate and loathing, for it includes the composite horrors of poverty, disgrace, loneliness, humiliation, abandonment, and degradation" (Epstein, p. 218). Often pointing to the rising percentage of aged individuals within these institutions as proof of increased dependency, pension advocates such as Abraham Epstein repeatedly argued that such institutions clearly revealed the inability of elderly persons to succeed in the industrial world. The almshouse, Epstein wrote in 1929, "stands as a threatening symbol of the deepest humiliation and degradation before all wage-earners after the prime of life" (p. 128).

By the 1930s, government officials accepted the argument that the rising proportion of elderly persons in almshouses was a sign that older people could no longer compete in the modern world. According to a government study in the 1930s, "the predominance of the aged in the almshouse is a sign of their increasing dependency" (United States Social Security Board). Despite the fact that the percentage of aged individuals who required such care appeared rather stable, both the tangible horrors of the almshouse and the rising percentage of aged individuals within such institutions convinced officials that radical measures needed to be taken. Moreover, many were sure that the almshouse had become a costly solution to the needs of the old. Assuming that all elderly individuals would eventually need support, they argued that small pensions were a less expensive solution.

In the movement to establish the Social Security program, therefore, concerns about the almshouse's central function in providing long-term care played an essential role. Hoping to eliminate the institution entirely, pension advocates barred any almshouse resident from receiving old-age support. "We were," wrote Pennsylvania's deputy secretary of public assistance, "rather enthusiastic to empty the poorhouses" (Thomas, p. 97). Although individuals who resided in a privately funded institution could be beneficiaries of pensions, almshouse residents were barred from such payments. This proviso was essential for establishing both the popularity and legitimacy of Social Security legislation. In asserting the constitutionality of the Social Security Act (1935), Supreme Court Justice Benjamin Cardozo, writing for the majority, proclaimed that "the hope behind this statute is to save men and women from the rigors of the poorhouse as well as the haunting fear that such a lot awaits them when the journey's end is near" (Haber and Gratton, p. 139).

To a large degree, many of the pension advocates had overestimated the impact of pensions on the lives of the needy elderly. Most had

simply assumed that, with monthly annuities, individuals could live independently. They saw little reason to reform the poorhouse or support it with financial resources. A few, however, such as aging advocate Homer Folks, argued that only about 15 percent of the almshouse population were in the institution because of strict financial need. "The others," he explained, "are physically infirm and sick, and have various kinds of ailments that require personal attention of the kind that you could not get in an individual home; [they] require nursing or medical attention . . . in some sort of institution" (Thomas, p. 40). Nonetheless, the symbol of the almshouse was so powerful that Folks's argument had little public support. Despite its relatively small inmate population, the almshouse stood as a tangible sign of a despised welfare system. There seemed little doubt that it needed to be eliminated.

In eradicating the almshouse, therefore, pension legislation had an unforeseen consequence. By barring almshouse inmates from payments, aged individuals in need of long-term care were forced to seek shelter in private institutions. In Charleston, for example, while some of the almshouse residents were able to leave the institution and, with the support of pensions, live on their own, many were compelled to enter private, often unregulated, sanitariums. In some cases, such a move was more a change in name than in place. In Kansas, for example, immediately following the enactment of Social Security, officials transferred well-established county homes into private control, although neither the residence nor its supervisors changed. Most importantly, however, the inmates could now be classified as recipients of private care, and the institution was able to receive residents' monthly annuities.

By the 1950s, the intent of policymakers to destroy the hated almshouse had clearly succeeded. Most poorhouses had disappeared from the landscape, unable to survive once their inmates no longer received federal annuities. As a result, and due to the lobbying of public hospital associations, Congress amended Social Security to allow federal support to individuals in public facilities. New legislation, including with the Medical Facilities Survey and Construction Act of 1954, allowed for the development of public institutions for the most needy older adults. For the first time, both public and private nursing-home residents were granted federal support for their assistance. As Homer Folks had predicted, not all elderly individuals could be supported in their own homes with monthly pensions; many incapacitated older adults required long-term care.

In 1965, the passage of Medicare and Medicaid provided additional impetus to the growth of the nursing-home industry, which, while it had been increasingly steadily since the passage of Social Security, grew dramatically. Between 1960 and 1976, the number of nursing homes grew by 140 percent, nursing-home beds increased by 302 percent, and the revenues received by the industry rose 2,000 percent. To a great extent, this growth was stimulated by private industry. By 1979, despite the ability of government homes to provide care, 79 percent of all institutionalized elderly persons resided in commercially run homes.

According to investigations of the industry in the 1970s, many of these institutions provided substandard care. Lacking the required medical care, food, and attendants, they were labeled "warehouses" for the old and "junkyards" for the dying by numerous critics. The majority of them, proclaimed Representative David Pryor in his attempt to initiate legislative reform in 1970, were "halfway houses between society and the cemetery" (Butler, p. 263). And, like the almshouses of old, people feared ending their days in the wards of these institutions and relatives felt guilty for abandoning their elders to nursing-home care.

Beginning in 1971, therefore, policymakers began to enact numerous government regulations in order to control the quality of long-term care. In 1971 the Office of Nursing Home Affairs provided a structure to oversee numerous agencies responsible for nursing-home standards. In 1972, reforms of Social Security established a single set of requirements for facilities supported by Medicare and for skilled-nursing homes that received Medicaid. Although this limited the ability of most individuals to enter skilled-nursing facilities, it increased the demand for intermediate-care facilities. Other amendments to the Older American Acts in 1973 and 1987 provided and strengthened statewide nursing home ombudsman programs. Nursing homes residents and their families now had a secure way of voicing any institutional complaints (Atchley, p. 511).

These policies, however, did not uniformly raise the standards of all nursing homes, nor did they eliminate the fear expressed by many of the

older adults who faced nursing-home admission with dread. Yet, as the percentage of the population over eighty-five has continued to grow, nursing home care has become an increasing reality for many of the nation's oldest old. By 2000, nursing homes had become a 100 billion dollar industry, paid largely by Medicaid, Medicare, and out-of-pocket expenses; and although only 2 percent of all elderly individuals between sixty-five and seventy-four reside in such institutions, the proportion of those over eighty-five increased to 25 percent.

While these aging individuals no longer face the horrors of the almshouse, the development of the modern-day industry reflects its historical roots. In establishing monthly annuities for the old and disqualifying all residents of public institutions, the creators of Social Security took direct aim at the despised poorhouse. In their initial policies, New Dealers were anxious to sever the connection between old age and pauperism. In barring all residents of public institutions from receiving pensions, however, they clearly underestimated the proportion of elderly persons who required residential support. As a result, they did not initially provide for public asylums or regulate the quality of private care. Although recent legislation has attempted to control nursing homes, and federal funds such as Medicaid contribute to their assistance, the problems that face long-term care for older adults are clearly tied to their historical development. In shutting the almshouse door, policymakers gave birth to the modern nursing-home industry.

CAROLE HABER

See also LONG-TERM CARE; LONG-TERM CARE, QUALITY OF; MEDICAID; MEDICARE.

BIBLIOGRAPHY

ATCHLEY, R. C. *Social Forces and Aging*. Belmont, Calif., 1994.

BUTLER, R. N. *Why Survive: Being Old in America*. New York: Harper and Row, 1975.

EPSTEIN, A. *The Challenge of the Aged*. New York: Alfred A. Knopf, 1929.

HABER, C., and GRATTON, B. *Old Age and the Search for Security*. New York: Cambridge University Press, 1994.

Massachusetts Commission. *Report of the Commission on Old Age Pensions, Annuities, and Insurance*. New York: Arno Press, 1976. Report originally published in 1910.

MOSS, F. E., and HALAMANDARIS, V. J. *Too Old, Too Sick, Too Bad: Nursing Homes in America*. Germantown, Md.: Aspen, 1977.

Pennsylvania Commission. *Report of the Pennsylvania Commission on Old Age Pensions*. Harrisburg, Pa.: J.L.L. Kuhn, 1919.

THOMAS, T. *Nursing Homes and Public Policy*. Ithaca, N.Y.: Cornell University Press, 1969.

United States Social Security Board. *Economic Security in Old Age*. Washington, D.C.: Government Printing Office, 1934.

NURSING HOMES: SPECIAL CARE UNITS

A movement to establish dementia special care units (SCUs) began in the United States in the 1960s. The movement gained momentum, becoming widespread in 1980s and 1990s. This growth was fueled by the recognition that Alzheimer's disease and other progressive dementias represent a serious public health problem, and by the advocacy of the Alzheimer's Disease and Related Disorders Association to improve care for individuals suffering from dementia. SCUs were also established in many nursing homes because it was recognized that their presence improved the image of the nursing home and helped to attract privately paying patients. Another impetus for establishing SCUs was the Omnibus Budget Reconciliation Act of 1987 (OBRA 1987), which emphasized a decreased use of physical and chemical restraints. In addition, the growing number of old-old persons, and thus the growing number of persons with dementing illnesses, mandated the development of "quality care" for such persons. For these reasons, SCUs have become more prevalent—in 2001 they existed in almost one-quarter of the nursing homes in the United States, almost double the number of SCUs that existed in 1990. Special dementia care programs are also being developed in residential settings.

SCUs vary greatly in terms of the number and composition of staff, the nature of activity programs, and patient care, but several features are generally found in all such units: they house only residents with dementing illness, and they offer specialized staff training, specific activity programming, family involvement, and a segregated and modified physical environment. However, all of these features are not necessarily present in any single SCU. As a result, while some SCUs reflect an honest effort to enhance

the quality of care given to this population, some reflect primarily the response to a marketing imperative, and the degree of care enhancement in such facilities, is, at best, questionable. For example, a survey of 436 nursing homes indicated that not all SCUs offered richer or more tailored services for dementia than did non-SCUs, and that most non-SCUs offered some dementia-specific features similar to those made available in SCUs. Another survey, which evaluated SCUs and non-SCUs according to the presence or absence of activity programming, mental health support, and nursing rehabilitation, found that 12 percent of SCUs did not have any of these special programs, and another 20 percent were deficient in two of the categories. Insufficient staffing and sparse activity programming was also found in a survey of nursing homes in the eastern United States: one-fourth of the facilities provided only minimal features, such as secure units.

Such differences fostered the creation by some states of standards for SCUs. These standards include elements such as: separate written policies and procedures, secured entries and exits, modification of the physical environment, including a separate dining room, access to a secure outdoor area, special staff education and training, specific staffing levels; and specific activities and social support. There is some evidence that these standards have had a positive impact on the type and quality of services provided by SCUs.

Prevalence estimates of dementia in nursing homes vary widely, mainly due to differences in study methodology. Studies that use direct assessment by trained clinicians yield higher estimates (65 percent to 75 percent) than surveys that use chart data or administrative data sets. A recent study of a new admission cohort (Moguziner, et al.) yielded an estimate of 48 percent. About 80 percent to 90 percent of nursing home residents are cognitively impaired. Recent findings suggest that all SCU residents suffer from a dementing illness. Among these residents, almost two-thirds are communication-impaired; 68 percent to 85 percent are in the late-stages of dementing illness; over half have severe-stage cognitive impairment; and, because of their level of dementing illness, almost half are not testable on neuropsychological tests. These prevalence estimates are significantly and substantially higher than are those found among non-SCU residents.

Perhaps dwarfing other considerations, the potential cost of providing care to persons with dementia in specialized settings is staggering. Nursing-home expenditures constitute a large and rapidly growing component of overall health care expenditures. In 1997, approximately $82 billion was spent on nursing-home care in the United States—about 8 percent of total health care expenditures. It is estimated that by 2030 the level of nursing-home health care spending will rise to $1,477.4 billion—9.25 percent of the estimated $15,969.6 billion total health care spending. While many disease processes lead to nursing-home placement, persons with Alzheimer's disease and related dementias are likely to contribute, at a minimum, 20 percent of total nursing home expenditures. However, given the increasing proportions of nursing-home residents with cognitive deficits, this almost certainly constitutes an underprojection.

A question remains as to whether the amount, and thus the cost, of personal care differs between special care and traditional care settings. A related question is the degree to which differential impacts are associated with such differences as have been found to exist. It is important to distinguish between costs (monetized service-time inputs) and charges made by nursing homes for services to residents. While the latter usually are regarded as estimates of the former, it is possible, perhaps even probable, that charges are sensitive to market pressures and, therefore, do not accurately reflect the actual costs associated with care for different individuals in different settings. The issue of possible differences in costs of staff inputs made in SCUs, as contrasted with counterpart costs in traditional care units, is particularly important for several reasons. First, staff inputs account for over 80 percent of the total costs of nursing-home care. Similarly, staff time expenditures constitute the largest component of cost of care that relates directly to the characteristics of individual residents. Second, in addition to the stipulation that SCUs house only residents with dementing illness, the majority of definitional criteria usually applied in making a distinction between special care and traditional care are staff related. Adhering to the view of SCUs as a separate form of nursing care, one would expect there to be higher staff ratios, more staff time spent in therapies and in staff support and supervision, and to have more SCU time spent in case management, including reporting and planning. Third, staff

inputs are the most immediately malleable major component of nursing home care: staff ratios, assignments, and patterns can be changed at will. In contrast, environmental changes usually take far more time to plan and implement.

Most evaluations to date, however, have shown that there are few, if any, differences between SCUs and traditional nursing-home units in terms of any of the dimensions along which such differences might be expected. In fact, there is a growing tide of feeling which holds that *special* care is really *quality* care for the growing proportion (now the majority) of nursing home residents who suffer from dementing illnesses. On the other hand, there is some evidence that there are slight (and statistically significant) differences between SCUs and traditional units (favoring the former) in terms of aide time spend serving residents, and in the impacts that increases in aide time have in SCUs. For example, using advanced data-gathering techniques, it has been shown that, on average, SCU residents receive almost eight minutes more (of an average total of slightly more than fifty-one minutes per resident, per day) of aide time than do their non-SCU counterparts in facilities which maintain both kinds of units. This difference increases to almost twenty-one minutes per day when the SCU residents are contrasted with residents of traditional facilities that do not maintain SCUs. Perhaps more important, from a cost-of-service point of view, it was found that additional aide service inputs gave more "bang for the buck" in SCUs than in traditional units—that is, for whatever reason, substantial increases (more than forty minutes average increase per day, per resident) in aide time had far greater effect in reducing resident agitation in SCUs than it did in non-SCUs.

Generally, it appears that SCU residents incur greater costs of inputs than do residents of more traditional types of units in terms of aides and speech therapists. However, although statistically significant, the differences between SCUs and traditional units tend to be clinically and economically trivial (e.g., less than three dollars per resident, per day, between SCUs and traditional units). However, these differences do become substantial when applied to all residents on a unit. For example, for a typical thirty-six-bed SCU, the difference is the equivalent of about one extra aide, divided between the day and the evening shifts. Additionally, investigators have suggested that both SCUs and non-SCUs (in nursing homes which support both) provide more aide and RN time per day on the day shift than do traditional units. This may reflect the fact that the presence of an SCU in a facility can have a beneficial facility-wide effect in terms of staff training and lower staff turnover. It is discouraging to note, however, how relatively few minutes are spent in the provision of direct care in either type of facility.

DOUGLAS HOLMES

See also ALZHEIMER'S DISEASE; LONG-TERM CARE.

BIBLIOGRAPHY

BURNER, S. T.; WALDO, D. R.; and MCKUSICK, D. R. "National Health Expenditures Projections Through 2030." *Health Care Financing Review* 14, no. 1 (1992): 1–29.

DAVIS, K; SLOANE, P.; MITCHELL, C.; PRESSIER, J.; GRANT, L.; HAWES, M.; LINDEMAN, D.; MONTGOMERY, R.; LONG, K.; PHILLIPS, C.; and KOCH, G. "Specialized Dementia Programs in Residential Care Settings." *The Gerontologist* 40, no. 1 (2000): 21–42.

ERNST, J., and HAY, J. "The U.S. Economic and Social Costs of Alzheimer's Disease Revisited." *American Journal of Public Health* 84, no. 8 (1994): 1261–1264.

FRIES, B.; MEHR, D.; SCHNEIDER, D.; FOLEY, W.; and BURKE, R. "Mental Dysfunction and Resource Use in Nursing Homes." *Medical Care* 31, no. 10 (1993): 898–920.

GERDNER, L., and BUCKWALTER, K. "Review of State Policies Regarding Special Care Units: Implications for Family Consumers and Health Care Professionals." *American Journal of Alzheimer's Disease and Related Disorders* 11 (1996): 16–27.

GLANDON, G.; LINDEMAN, D.; and HOLMES, D. "Issues in Measuring Costs in Institutional Settings." *Journal of Mental Health and Aging* 3, no. 1 (1997): 129–144.

GOLD, D.; SLOANE, P.; MATHEW, L.; BLEDSOE, M.; and KONANC, D. "Special Care Units: A Typology of Care Settings for Memory-Impaired Older Adults." *The Gerontologist* 31 (1991): 467–475.

GRANT, L., and ORY, M. "Alzheimer Special Care Units in the United States." *Research and Practice in Alzheimer's Disease* 4 (1999): 19–44.

GRANT, L.; KANE, R.; and STARK, A. "Beyond Labels: Nursing Home Care for Alzheimer's Disease In and Out of Special Care Units." *Journal of American Geriatrics Society* 43 (1995): 569–576.

HOLMES, D. "Special Care Units: What Makes Them Special?" *Nursing Home Economics* (February/March, 1996): 28–31.

HOLMES, D.; SPLAINE, M.; TERESI, J.; MONACO, C.; RAMIREZ, M.; and BARRETT, V. "What Makes Special Care Special: Concepts Mapping as a Definition Tool." *Alzheimer's Disease and Associated Disorders* 8, suppl. 1, (1994).

HOLMES, D., and TERESI, J. "Characteristics of Special Care Units in the Northeast Five State Survey: Implications of Different Definitional Criteria." *Alzheimer's Disease and Associated Disorders* 8, suppl. 1 (1994): S97–S105.

HOLMES, D., and TERESI, J. "The Costs of Care in Dementia Special Care Units, As They Relate to Care Outcomes." *Research and Practice in Alzheimer's Disease* 4 (2000): 199–216.

HOLMES, D.; TERESI, J.; LINDEMAN, D.; and GLANDON, G. "Measurement of Personal Care Inputs in Chronic Care Settings." *Journal of Mental Health and Aging* 3, no. 1 (1997): 119–127.

HOLMES, D.; TERESI, J.; and ORY, M. "Editorial: Special Care Units for People with Cognitive Impairment, Including Alzheimer's Disease and Related Disorders: an Overview." *Research and Practice in Alzheimer's Disease and Related Disease* 4 (2000): 1–17.

HOLMES, D.; TERESI, J.; RAMERIZ, M.; and GOLDMAN, D. "The Measurement and Comparison of Staff Service Inputs in Special Dementia Care Units and in Traditional Nursing Home Units Using a Barcode Methodology." *Journal of Mental Health and Aging* 3 (1998): 195–207.

LEON, J. "Characteristics of Dementia Admissions to Standard Nursing Homes and to Special Care Units." *American Journal of Alzheimer's Disease* (Jan/Feb, 1998): 1–14.

LEON, J.; POTTER, D.; and CUNNINGHAM, P. *Current and Projected Availability of Special Nursing Home Programs for Alzheimer's Disease Patients.* (DHHS Publication No. (PHS) 90–3463). Rockville, Md.: Public Health Service, 1990.

MAAS, M.; SWANSON, E.; SPECHT, J.; and BUCKWALTER, K. "Alzheimer's Special Care Units." *Nursing Clinics of North America* 29 (1994): 173–194.

MAGAZINER, J.; GERMAN, P.; ZIMMERMAN, S.; HEBEL, J.; BURTON, L.; GRUBER-BALDINI, A.; MAY, C.; and KITTNER, S. "The Prevalence of Dementia in a Statewide Sample of New Nursing Home Admissions Aged 65 and Older: Diagnosis by Expert Panel." *The Gerontologist* 40, no. 6 (2000): 663–673.

MASLOW, K. "Current Knowledge about Special Care Units: Findings of a Study By the U.S. Office of Technology Assessment." *Alzheimer's Disease and Associated Disorders* 8, suppl. 1 (1994): 14–40.

MEHR, D., and FRIES, B. "Resource Use on Alzheimer's Special Care Units." *The Gerontologist* 35 (1995): 179–184.

MORRIS, J., and LOMBARDO, N. "A National Perspective on SCU Service Richness: Findings from the AARP Survey." *Alzheimer's Disease and Associated Disorders* 8, suppl. 1 (1994): S87–S96.

PALMER, H., and COTTERILL, P. "Studies of Nursing Homes Costs." In *Long Term Care: Perspectives from Research and Demonstrations.* Edited by R. Vogel and H. Palmer. Washington, D.C.: Health Care Financing Administration, 1982. Pages 665–722.

TERESI, J. A.; MORRIS, J. N.; MATTIS, S.; and REISBERG, B. "Cognitive Impairment Among SCU and Non-SCU Residents in the United States: Prevalence Estimates from the National Institute on Aging Collaborative Studies of Special Care Units for Alzheimer's Disease." *Research and Practice in Alzheimer's Disease* 4 (2000): 117–138.

VOLICER, L., and SINARD, J. "Establishing a Dementia Special-Care Unit." *Nursing Home Economics* 3, no. 1 (1996): 12–19.

NUTRITION

Adequate research plays a crucial role in preserving the health status and functional independence of older adults. Conversely, malnutrition is associated with an increased rate of morbidity, mortality, and a failure to thrive in the elderly population.

Factors affecting adequate nutrition in elderly individuals

There are a number of factors that manifest in older age that may adversely effect nutritional status and promote significant weight and muscle loss. This weight loss, or anorexia of aging, is associated with further deterioration in nutritional status, increased hospitalization and disease rates, and premature death.

Factors influencing nutritional status in elderly persons may be divided into three categories: psychological, social, and medical. For instance, psychological disorders such as depression and dementia are highly correlated with loss of body weight in nursing homes and are the major causes of weight loss in free-living elderly individuals. In addition, numerous studies have suggested that social isolation, low socioeconomic

status, and poverty are also associated with reduced dietary intake and weight loss. Moreover, numerous medical factors such as the use of prescription medicines, poor dentition, institutionalization, a decrease in taste and smell sensations, and an inability to regulate food intake have all been suggested to decrease appetite and adversely affect nutritional status in older adults.

Challenges in assessing energy requirements

There are numerous problems that have hindered the establishment of nutritional recommendations in older adults. These problems are due, in part, to the reliance on measuring caloric intake to derive daily energy needs. Research has shown that when validated against newly developed techniques, the older methods used to assess caloric intake, such as self-recorded diaries, dietary interviews, and twenty-four-hour dietary recalls, consistently underestimate actual daily energy needs. In addition, the heterogeneity of the elderly population presents additional challenges. For instance, the current recommended daily allowances (RDAs) are suggested for individuals up to age fifty and to those over fifty-one years of age. However, this broad categorization of persons over fifty-one years does not take into consideration the numerous physiological differences and differing nutritional needs of individuals within this broad age group.

An alternative to assessing energy requirements by using energy intake methodologies is the utilization of daily energy expenditure, or the sum of calories burned throughout the course of a day. When an individual is weight stable, daily energy expenditure can be used as a proxy measure of daily energy needs.

Daily energy expenditure is comprised of three components: resting metabolic rate, the thermic effect of feeding, and the thermic effect of physical activity. Resting metabolic rate represents the greatest proportion of daily energy expenditure (60–75 percent), and is a measure of the energy required to sustain homeostasis and basic physiological functions. The thermic effect of feeding constitutes approximately 10 percent of daily energy expenditure and represents the energy cost of digesting, absorbing, storing, and metabolizing a meal. The most variable component of daily energy expenditure is the thermic effect of physical activity (15–50 percent), which includes the energy expended through both voluntary exercise and involuntary activities, such as shivering, fidgeting, and postural control. Research has suggested that age is associated with a decrease in all three of these components of daily energy expenditure.

A new and more accurate method to assess energy expenditure is the doubly labeled water technique, which was first validated for use in humans in the 1980s. This technique involves the oral administration of two isotopes of water (deuterium and oxygen-18), and is based on the fact that deuterium labeled water is lost from the body through the usual routes of water loss (urine, sweat, evaporation), whereas oxygen-18 labeled water is eliminated from the body not only as water, but also as carbon dioxide. Approximately one to three weeks following administration of the isotopes, urine samples are collected and analyzed to calculate carbon dioxide production, which is determined by the difference in the turnover rates of the two isotopes. Carbon dioxide production, in turn, is used to determine oxygen consumption, and hence energy expenditure.

The advantages of the doubly labeled water technique are: 1) it provides an accurate, noninvasive assessment of daily energy expenditure in the free-living environment; 2) measurements are performed over extended periods of time (two to three weeks), which helps account for the daily perturbations in energy expenditure; and 3) when used in combination with indirect calorimetry, it is possible to assess the thermic effect of physical activity. The disadvantages of the method lie mainly in its cost, which makes it impractical for widespread use in large-scale studies. Despite this limitation, however, doubly labeled water provides a more accurate measure of energy requirements than previous methods.

To support this claim, a 1996 summary of six studies utilizing doubly labeled water concluded that energy requirements in older individuals may be higher than the given recommendations. Other studies have also concluded that current recommendations underestimate energy needs of older, Caucasian men and women and African American men, but not African American women. These studies suggest that doubly labeled water may help us understand true energy needs and alleviate the various problems that have hindered the development of adequate nutritional recommendations for elderly persons. Furthermore, studies highlight the heterogenei-

ty of the elderly population and the necessity to focus on the development of individual, rather than group, recommendations.

Summary and future considerations

Due to the pivotal role proper nutrition plays in preserving health, preventing morbidity and premature death in older adults, and the myriad of factors that can compromise nutritional status in older age, there is a critical need to provide well-founded recommendations for age-related changes in energy requirements. However, the heterogeneity of the aging population, along with the inaccuracy of traditional energy intake methods to assess energy requirements, have hindered the development of such recommendations.

The development of the doubly labeled water technique has enabled the accurate measurement of daily energy expenditure in free-living individuals. The majority of doubly labeled water studies have suggested that current recommendations may underestimate the actual energy needs of the elderly population. Despite the cost, long-term longitudinal studies utilizing this new method are needed to accurately assess the age-related changes in energy requirements.

CHRISTOPHER L. GENTILE
ERIC T. POEHLMAN

See also CONGREGATE AND HOME-DELIVERED MEALS; MALNUTRITION; SARCOPENIA; TASTE AND SMELL.

BIBLIOGRAPHY

ROBERTS, S. B. "Energy Requirements of Older Individuals." *European Journal of Clinical Nutrition* 50 (1996): S112–S118.

STARLING, R. D., and POEHLMAN, E. T. "Assessment of Energy Requirements in Elderly Populations." *European Journal of Clinical Nutrition* 54 (2000): S104–S111.

NUTRITION, CALORIC RESTRICTION

The first work that linked caloric restriction to an extension of life span was published in 1935 by Clive McCay and his colleagues, nutritionists at Cornell University in Ithaca, New York. Their studies showed that restricting the food intake of rats soon after weaning increases their length of life. Since then, this finding has been confirmed many times in rats, mice, and hamsters. In most of these studies, animals fed *ad libitum* (allowed to eat as much as they want) were compared to those restricted to 50 to 60 percent of that amount of food, with care being taken to provide a sufficient diet to avoid malnutrition.

Decreasing food intake has also been found to extend the length of life of nonmammalian species such as fish, flies, nematodes, and water fleas. It has yet to be established that restricting food intake has such an effect on all, or most, species, however. This is because the effect of reducing food intake on longevity has yet to be assessed in most species, and also because the nutritional requirements of most species are not sufficiently known to be certain that one is not dealing with the effects of malnutrition.

Studies on rats and mice

Most research on the life-extending effects of long-term dietary restriction has been done on rats and mice. These studies have shown that the effects on longevity do not relate to a decrease in the intake of a specific nutrient, such as vitamins, minerals, and protein, or a dietary contaminant, but rather result from a decrease in intake of calories. It is for this reason that this phenomenon is referred to as *caloric restriction*.

Caloric restriction has been found to markedly increase the length of life when initiated in the young adult. It also does so when started as late as early middle age, but less markedly than in younger animals.

With increasing age, there is an increase in mortality. Analysis of age-specific mortality (the fraction of the population that dies during a specific age interval) reveals that caloric restriction reduces the age-associated increase in age-specific mortality of adult rats and mice. This finding strongly suggests that caloric restriction extends the length of life by slowing the rate of aging, a conclusion supported by the fact that it retards the age-associated deterioration of physiological functions. These functions range from fundamental cellular processes, such as DNA repair, apoptosis, proteolysis, signal transduction, gene expression, and many others, to integrated organismic functions, such as negotiating a maze. Caloric restriction also delays the occurrence or slows the progression of most age-associated diseases in rodents, including many different can-

cers, as well as degenerative diseases, such as nephropathy, cardiomyopathy, cataracts, and autoimmune diseases.

Many studies have aimed at discovering the mechanisms underlying the antiaging action of caloric restriction. Such knowledge would provide insights in the quest to understand the basic nature of aging and to develop interventions in aging. In their 1935 publication, McCay and his colleagues proposed that food restriction extended length of life in rats by retarding development and growth. However, the finding that life extension occurs when food restriction is started in adult life invalidates this hypothesis.

Caloric restriction is known to decrease the content of body fat, and excess body fat is associated with premature death in humans. Thus, some have hypothesized that caloric restriction increases the length of life by decreasing body fat. However, studies on rats by Helen Bertrand and her associates in Texas, and on mice by David Harrison and his associates in Maine, found that caloric restriction's action on body fat is not related to the antiaging effect.

Caloric restriction also decreases the body temperature of rats and mice. It is known that reducing the body temperature of poikilotherms (species in which body temperature varies with the environmental temperature) increases their life span. It was hypothesized that caloric restriction increases the length of life of rodents by decreasing body temperature, but several lines of evidence indicate this is not a valid hypothesis. For example, caloric restriction causes the body temperature in mice to decrease much more than in rats, but the increase in length of life is similar in both species. Also, restricting food intake in fish increases length of life without lowering body temperature. Finally, while the body temperature of mice maintained in a warm environment is not decreased by caloric restriction, these mice continue to exhibit most antiaging effects.

It is known that biological molecules, such as DNA, proteins, and lipids, are damaged by reactive oxygen molecules such as hydroxyl and superoxide radicals. Reactive oxygen molecules are generated by intrinsic living processes as well as environmental factors. In 1996, Rajindar Sohal and Richard Weindruch suggested that caloric restriction retards aging by decreasing oxidative damage. Caloric restriction does, indeed, retard the age-associated accumulation of oxidatively damaged molecules. It is often stated that this protective action results from a lowered specific metabolic rate (metabolic rate per unit of body mass); however, studies on both rats and mice have shown that caloric restriction can have life-extending and antiaging actions without decreasing the specific metabolic rate. Of course, a decreased production of reactive oxygen molecules is not dependent on a reduction in metabolic rate. Furthermore, enhancement of antioxidant defenses would also protect against damage from reactive oxygen molecules even if their rate of production did not change. Caloric restriction may well decrease the rate of production of reactive oxygen molecules, and/or increase the level of protection against their damaging effect, but there are not yet sufficient data to judge the importance of either. Indeed, the fact that caloric restriction increases the repair or removal and replacement of damaged molecules may play the major role in its ability to reduce the accumulation of oxidatively damaged molecules. However, the question of whether this ability of caloric restriction protects against the accumulation of oxidative damage is the reason for its antiaging action cannot be answered until the importance of oxidative damage in aging is clearly established.

Food restriction has been found to result in sustained reductions in blood levels of glucose and insulin without decreasing the ability to use glucose as a fuel. It does so, at least in part, by increasing insulin sensitivity. It has long been known that elevated blood levels of glucose and/or insulin cause damage similar to aging, and it has been suggested that maintenance of low levels of these substances underlies the antiaging action. Although much has been learned about the mechanisms responsible for the decreased levels of glucose and insulin, the hypothesis of their playing a major role in the antiaging action remains to be tested.

In 1998, this author proposed the *hormesis hypothesis*. Hormesis is defined as the beneficial action resulting from the response to a low-intensity stressor. Caloric restriction in rats and mice meets the criteria of hormesis. It causes a daily moderate elevation of blood glucocorticoid level, a characteristic action of a low-intensity stressor, and, in regard to beneficial action, it increases the ability of rats and mice to cope with the damaging actions of acute, intense stressors such as surgery, toxic chemicals, and high environmental temperature. Since aging appears to

be the result of the accumulation of unrepaired damage due to intrinsic processes, as well as environmental agents and their interactions, this increased ability to cope with stressors may well be the basis for the retardation of aging by caloric restriction. Indeed, genetic manipulations that retard aging in fruit flies, nematodes, and yeast have also been shown to increase the ability of these organisms to cope with acute, intense stressors. Moreover, the increased daily levels of blood glucocorticoids may well play a major role in the increased resistance to acute, intense stressors and in the antiaging action. Caloric restriction also enhances expression of stress response genes, thereby increasing the production of proteins that protect cells against damaging agents, possibly including agents that promote aging. Although many actions of caloric restriction fall within the realm of hormesis, this hypothesis has yet to be rigorously tested.

Studies on humans and nonhuman primates

Does caloric restriction retard aging and extend life in humans? It is not yet possible to answer this often-asked question because a carefully designed and executed study has not been done with humans—nor is it likely that one will ever be done. In lieu of this, studies on the effects of caloric restriction on surrogates—nonhuman primates—were started in the 1980s and early 1990s.

The rhesus monkey is the primate species most studied. Since the maximum life span of this species is estimated to be forty years, information on the effect of caloric restriction on the length of life of the rhesus monkey will not be available until the year 2025 at the earliest. Thus far, however, many of the effects of caloric restriction found in rats and mice have also been observed in the rhesus monkey. For example, as in rodent species, caloric restriction in the rhesus monkey decreases body temperature, decreases blood glucose and insulin levels, and increases insulin sensitivity. This kind of information indicates that caloric restriction may have an antiaging action in the rhesus monkey similar to that in rats and mice. However, one must be cautious about jumping to any conclusions since the relationship between a particular physiological effect of caloric restriction and its antiaging action still remains to be established in rodents.

In rhesus monkeys, caloric restriction decreases the risk factors for age-associated cardiovascular diseases. It decreases both body fat and its age-associated increased distribution to the abdominal region, as well as decreasing the blood level LDL (“bad”) cholesterol and increasing that HDL (“good”) cholesterol. It also improves glucose tolerance and prevents the development of Type II diabetes. Nevertheless, a definitive answer regarding the antiaging action of caloric restriction in the rhesus monkey awaits the findings of the longevity studies.

Future research directions

Calorically restricted rats and mice are important tools for learning about basic biological processes that underlie aging. Indeed, the findings to date have focused research on the potential importance of oxidative stress in aging, and have also drawn attention to a possible role of blood glucose and insulin levels. Additionally, this research has provided further evidence of a relationship between resistance to stressors and retardation of aging.

Understanding the mechanisms underlying the antiaging action of caloric restriction could well yield insights on possible interventions for the retardation of human aging. The development of pharmacological agents with antiaging actions similar to those of caloric restriction is a particularly promising possibility. Even if long-term caloric restriction were conclusively demonstrated to extend life in humans, however, it is not likely many would undertake such a Spartan existence. Thus, there may be need for a more palatable regimen, such as a daily pill.

It is anticipated that research in the twenty-first century will focus on defining the mechanisms responsible for the antiaging action of caloric restriction. Genetically engineered mice are increasingly being used in this endeavor. In such mice, specific genes are either underexpressed or overexpressed. Although conceptually appealing, interpretations of such studies are problematic for at least two reasons. One, it will be a Herculean task for an investigator to establish that the mouse has been altered only in regard to the particular characteristic or characteristics being assessed. Moreover, the antiaging action of caloric restriction may be due to the action of more than one gene; if so, the manipulation of a single gene might provide little or no insight. The probability is infinitesimal that a mouse could be designed with the appropriate level of expression of several genes involved in the antiaging process.

Another new approach being increasingly used is gene expression profile methodology, in which a broad array of genes are assessed. In one such study, although only 5 to 10 percent of the genome was monitored, caloric restriction was found to affect the expression of more than one hundred genes. Thus assessment of the entire genome may find the expression of well over one thousand genes to be modified by caloric restriction. With so many genes influenced, it will be incredibly difficult to interpret the findings in regard to the mechanism(s) responsible for the antiaging action of caloric restriction.

For these reasons, it will be a formidable undertaking to determine the mechanisms of the antiaging action of caloric restriction, though the thoughtful use of currently available methodologies, as well the employment of new technologies, should eventually bring success.

EDWARD MASORO

See also DNA DAMAGE AND REPAIR; GENETICS: GENE EXPRESSION; LIFE SPAN EXTENSION; LONGEVITY; NUTRITION; STRESS.

BIBLIOGRAPHY

DUFFY, P. H.; FEUERS, R. J.; PIPKIN, J. L.; BERG, T. F.; LEAKEY, J. E. A.; TURTURRO, A.; and HART, R. W. "The Effect of Dietary Restriction and Aging on Physiological Response of Rodents to Drugs." In *Dietary Restriction: Implications for the Design and Interpretation of Toxicity and Carcinogenicity Studies*. Edited by R. W. Hart, D. A. Neuman, and R. T. Robertson. Washington, D.C.: ILSI Press, 1995. Pages 125–140.

HOLEHAN, A. M., and MERRY, B. J. "The Experimental Manipulation of Ageing by Diet." *Biological Reviews* 61 (1986): 329–368.

HOLLIDAY, R. "Food, Reproduction, and Longevity: Is the Extended Lifespan of Calorie-Restricted Animals an Evolutionary Adaptation." *BioEssays* 10 (1989): 125–127.

LEE, C-K.; KLOPP, R. G.; WEINDRUCH, R.; and PROLLA, T. A. "Gene Expression Profile of Aging and Its Retardation by Caloric Restriction." *Science* 285 (1999): 1390–1393.

MASORO, E. J. "Hormesis and the Antiaging Action of Dietary Restriction: A Hypothesis." *Experimental Gerontology* 33 (1998): 61–66.

MASORO, E. J. "Caloric Restriction and Aging: An Update." *Experimental Gerontology* 35 (2000): 299–305.

MCCARTER R. J. M. "Caloric Restriction, Exercise, and Aging." In *Handbook of Oxidants and Antioxidants in Exercise*. Edited by C. K. Sen, L. Packer, and O. Hanninen. Amsterdam: Elsivier Science, 2000. Pages 797–829.

PAHLAVANI, M. A. "Intervention in the Aging Immune System: Influence of Dietary Restriction, Dehydroepiandrosterone, Melatonin, and Exercise." *Age* 21 (1998): 153–173.

ROTH, G. S.; INGRAM, D. K.; and LANE, M. A. "Caloric Restriction in Primates: Will It Work and How Will We Know?" *Journal of the American Geriatrics Society* 47 (1999): 896–903.

SABATINO, F.; MASORO, E. J.; MCMAHAN, C. A.; and KUHN, R. W. "An Assessment of the Role of the Glucocorticoid System in Aging Processes and in the Action of Food Restriction." *Journal of Gerontology: Biological Sciences* 46 (1991): B171–B179.

SOHAL, R. S., and WEINDRUCH, R. "Oxidative Stress, Caloric Restriction, and Aging." *Science* 273 (1996): 59–63.

WEINDRUCH, R., and WALFORD, R. *The Retardation of Aging and Diseases by Dietary Restriction*. Springfield, Ill.: Thomas, 1988.

WERAARCHAKUL, N.; STRONG, R.; WOOD, W. G.; and RICHARDSON, A. "Effect of Aging and Dietary Restriction on DNA Repair." *Experimental Cell Research* 181 (1989): 197–204.

YU, B. P. "Aging and Oxidative Stress: Modulation by Dietary Restriction." *Free Radical Biology and Medicine* 21 (1996): 651–668.

NUTRITION, DIETARY SUPPLEMENTS

Although Americans have long been consuming vitamin and mineral supplements, it was only in the 1980s and 1990s that a direct relationship between diet and health (and, therefore, the potential beneficial role for nutrient supplements beyond the minimum amounts required to avoid deficiency) became apparent. The elderly population is the most diverse and heterogeneous of any age group, and determining the nutritional needs of older adults is challenging because their physiology, medical conditions, lifestyles, and social situations are different from those of younger people.

Overview of dietary supplement use

Findings from the Third National Health and Nutrition Examination Survey, 1988–1994 (NHANES III) suggest that 40 percent of Ameri-

cans use dietary supplements. Total sales of dietary supplements in the United States in 2000 were estimated to be 16 billion dollars. Between the years 1990 and 1997, the prevalence of high-dose vitamin (megavitamins) use increased by 130 percent, while the use of high-dose herbal supplements rose 380 percent. Supplement use has been shown to increase with age, is consistent with more healthful lifestyles, and is reflective of higher family income and level of education. Approximately 56 percent of middle-aged and older adults consume at least one supplement on a regular basis.

Regulation of dietary supplements

The Dietary Supplement Health and Education Act (DSHEA) of 1994 laid the foundation for the current regulatory framework for dietary supplements. Dietary supplements have been defined by DSHEA as products (other than tobacco) intended to supplement the diet that bear or contain one or more of the following dietary ingredients: a vitamin; a mineral; an herb or other botanical; an amino acid; a dietary substance to supplement the human diet by increasing the total dietary intake; or a concentrate, metabolite, constituent, extract, or combination of any of the ingredients described above. This law amended the Federal Food, Drug, and Cosmetic Act of 1938 "to establish standards with respect to dietary supplements."

Under DSHEA, the U.S. Food and Drug Administration (FDA) regulates safety, manufacturing, and product information—such as claims on product labels, package inserts and accompanying literature. However, the FDA cannot require testing of dietary supplements prior to marketing.

Key nutrients for elderly persons

There is increasing evidence that B vitamins play a role in preventing blood vessel diseases and in maintaining normal neurologic function. Antioxidants help fight oxidation in the body, and thereby reduce chemical damage that may contribute to heart disease, cancer, cataracts, macular degeneration of the eyes, neurodegenerative diseases, and possibly even aging itself. The need for vitamin D and calcium in the prevention of osteoporosis due to bone mineral loss is well established.

Most elderly people do not get enough calcium. The optimal intake of calcium is not known, but the current recommended adequate intake (AI) for men and women over age fifty is set at 1,200 mg daily. Vitamin D status diminishes with age due to decreased dietary intake, decreased vitamin D absorption, decreased sun exposure, decreased skin synthesis of vitamin D, and decreased formation of active vitamin D in the kidney. Results from a number of research studies indicate that intake of calcium and vitamin D supplements can reduce the loss of minerals from bone.

Vitamin B_{12} is another nutrient that has been shown to be deficient in elderly persons. Ten to 30 percent of older adults may be unable to absorb naturally occurring vitamin B_{12} from their diet due to gastrointestinal disorders, but they can absorb B_{12} in fortified foods and dietary supplements. It is advisable for adults over 50 to meet their recommended intake by consuming foods fortified with B_{12} or supplement containing B_{12}.

Folate, another B vitamin, plays a crucial role in modulating the level of homocysteine, an amino acid normally found in blood. There is accumulating evidence that elevated homocysteine is an independent risk factor for heart disease and stroke. In the United States, fortified foods such as cereal and grains are a major source of folic acid, the synthetic form of folate, and the diets of most adults now provide recommended amounts of folate.

Numerous epidemiological studies have suggested that foods rich in dietary antioxidants, such as vitamin C, vitamin E, selenium, and the carotenoids, may reduce the risk for chronic disease. However, insufficient evidence exists to conclude that such nutrients, even in very high doses, such as may occur in the form of dietary supplements, will reduce the risk of disease.

Supplementation with modest doses of a combination of micronutrients may enhance immune function in older adults. For example, both zinc and vitamin B_6 deficits have been shown to alter immune function in the elderly, a condition which can be improved with supplementation.

Evidence is emerging from well-designed randomized clinical trials to suggest some herbal supplements are beneficial. However, it is not fully understood how many herbal preparations work, nor is the active component always known. Of the nearly two thousand herbal products in

use, very few have been adequately tested for efficacy and toxicity. Concern also exists for potential herb-drug interactions (as well as drug-supplement interactions)—an estimated 15 million adults took prescription medications concurrently with herbal remedies and/or high-dose vitamins in 1997.

A continuing challenge for consumers, as well as health care professionals, is the lack of information about dietary supplements, including their effectiveness, safety, standard dosage, side effects, interactions with medications and foods, and how they affect medical conditions. For some supplements, the evidence is considered substantive enough to warrant recommendations for usage, notably for calcium, vitamin D, vitamin B_{12} and folic acid. When considering a supplement, consumers should look for ingredients in products with the U.S.P. notation, which indicates that the manufacturer followed standards of preparation established by the U.S. Pharmacopoeia. It is important to realize that the label term *natural* does not guarantee that a product is safe, and consumers should read all labeling and dosage information carefully.

REBECCA B. COSTELLO

See also BIOMARKERS OF AGING; DNA DAMAGE AND REPAIR; LIFE SPAN EXTENSION; NUTRITION; STRESS.

BIBLIOGRAPHY

BOGDEN, J. D.; BENDICH, A.; KEMP, F. W.; BRUENING, K. S.; SKURNICK, J.; DENNY, T.; BAKER, H.; and LOURIA, D. B. "Daily Micronutrient Supplements Enhance Delayed-Hypersensitivity Skin Test Responses in Older People." *American Journal of Clinical Nutrition* 60 (1994): 437–447.

EISENBERG, D. M.; DAVIS, R. B.; ETTNER, S. L.; APPEL, S.; WILKEY, S.; VAN ROMPAY, M.; and KESSLER, R. C. "Trends in Alternative Medicine Use in the United States, 1990–1997: Results of a Follow-Up National Survey." *Journal of American Medical Association* 280 (1998): 1569–1575.

ERVIN, R. B.; WRIGHT, J. D.; and KENNEDY-STEPHENSON, J. "Use of Dietary Supplements in the United States, 1988–1994. National Center for Health Statistics." *Vital Health Statistics* 11 (1999): 244.

Institute of Medicine. *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride. A Report of the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes and its Panel on Calcium and Related Nutrients and Subcommittee on Upper Reference Levels of Nutrients, Food and Nutrition Board*. Washington, D.C.: National Academy Press, 1997.

Institute of Medicine. *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B_6, Folate, Vitamin B_{12}, Pantothenic Acid, Biotin, and Choline. A Report of the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes and its Panel on Folate, Other B Vitamins, and Choline and Subcommittee on Upper Reference Levels of Nutrients, Food and Nutrition Board*. Washington, D.C.: National Academy Press, 1998.

Institute of Medicine. *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids. A Report of the Panel on Dietary Antioxidants and Related Compounds, Subcommittees on Upper Reference Levels of Nutrients and Interpretation and Uses of Dietary Reference Intakes, and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board*. Washington, D.C.: National Academy Press, 2000.

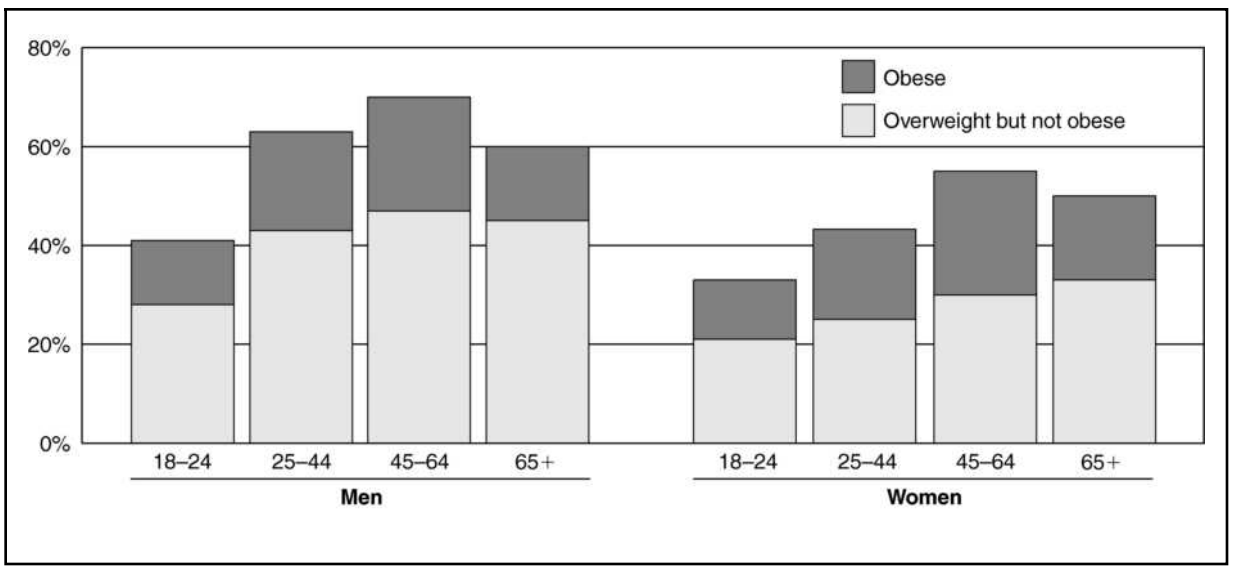
National Research Council. *Diet and Health: Implications for Reducing Chronic Disease Risk*. Washington, D.C.: National Academy Press, 1989.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES. *The Surgeon General's Report on Nutrition and Health*. Washington, D.C.: Government Printing Office, 1996.

NUTRITION, OBESITY

Obesity refers to the presence of excess total body fat (i.e., increased adipose tissue, or increased adiposity). Obesity is assessed by many different methods, and its exact definition varies widely. The so-called gold standard for the measurement of adiposity (degree of fatness) is underwater weighing, in which a subject is placed in a tank of water with only the head above the water line. The amount of space displaced by the subject*apos;s body (i.e., the rise in the water level) indicates the body*apos;s volume; that number is then compared to the subject*apos;s total weight (obtained on a balance scale), which determines the percentage of fat in the body. In 2002, the most accurate method for measuring total body fat, as well as body composition, was dual-energy X-ray absorptiometry, or DEXA. This instrument used in DEXA scans the entire body and, based on differences in the density of different tissues, calculates the bone mass, the lean tissue mass, and the fat mass. Percent body

Figure 1
Prevalence of overweight and obese adults adults by sex and age, 1997.



SOURCE: Centers for Disease Control/National Center for Health Statistics, National Health Interview Survey, 1997

fat is the amount of fat tissue relative to the total body weight.

As people age, body composition changes very gradually, with both total body weight and amount of body fat increasing into the fifties and sixties (see Figure 1). In later years, body weight usually stabilizes or declines slightly, while body composition changes to produce a greater percentage of body fat.

The most commonly used method for assessing degree of obesity is the Body Mass Index (BMI). The BMI is calculated from the height and weight. It was developed using metric numbers and is based on the following equation:

BMI = weight (in kilograms) divided by height (in meters squared)

In order to calculate the body mass index using pounds and inches, use the following formula to get BMI:

Step 1: Multiply weight in pounds by 705
Step 2: Divide the answer by height (in inches)
Step 3: Take that answer, and divide in again by height (in inches)

Table 1 shows a break down of body mass index by weight and height.

BMI is not a perfect measurement of the degree of fatness. For example, body builders can increase their weight without increasing their fat level. Similarly, elderly persons can have reduced muscle mass, which means that, for a given weight or BMI, they show a higher percentage of fat. Nevertheless, for the vast majority of persons, the BMI is a good indicator of obesity.

The National Institutes of Health (National Heart, Lung, and Blood Institute) has developed "Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults." These guidelines define two major levels of excess body weight: overweight, which is a body mass index number of 25 to 29.9; and obese, which is a body mass index number of 30 or greater. Further, the institute's guidelines are in accordance with the standards created by the World Health Organization, which allow for several degrees of obesity ranging from moderate to severe, all within the obese category. These degrees are shown in Table 2. With each increase in body mass index, there is an increase in the risk of comorbidities (obesity related diseases). As noted above, BMI tends to increase from early adulthood to late middle age, and this increase is primarily due to an increase in fat accumulation (Wolf and Colditz). In addition to this natu-

Table 1
Body Mass Index—BMI (kg/m²)

	19	20	21	22	23	24	25	26	27	28	29	30	35	40
Height	**Body Weight (lbs)**													
4'10"	91	96	100	105	110	115	119	124	129	134	138	143	167	191
4'11"	94	99	104	109	114	119	124	128	133	138	143	148	173	198
5'0"	97	102	107	112	118	123	128	133	138	143	148	153	179	204
5'1"	100	106	111	116	122	127	132	137	143	148	153	158	185	211
5'2"	104	109	115	120	126	131	136	142	147	153	158	164	191	218
5'3"	107	113	118	124	130	135	141	146	152	158	163	169	197	225
5'4"	110	116	122	128	134	140	145	151	157	163	169	174	204	232
5'5"	114	120	126	132	138	144	150	156	162	168	174	180	210	240
5'6"	118	124	130	136	142	148	155	161	167	173	179	186	216	247
5'7"	121	127	134	140	146	153	159	166	172	178	185	191	223	255
5'8"	125	131	138	144	151	158	164	171	177	184	190	197	230	262
5'9"	128	135	142	149	155	162	169	176	182	189	196	203	236	270
5'10"	132	139	146	153	160	167	174	181	188	195	202	207	243	278
5'11"	136	143	150	157	165	172	179	186	193	200	208	215	250	286
6'0"	140	147	154	162	169	177	184	191	199	206	213	221	258	294
6'1"	144	151	159	166	174	182	189	197	204	212	219	227	265	302
6'2"	148	155	163	171	179	186	194	202	210	218	225	233	272	311
6'3"	152	160	168	176	184	192	200	208	216	224	232	240	279	319
6'4"	156	164	172	180	189	197	205	213	221	230	238	246	287	328

SOURCE: Author

ral change in body weight with aging, increased body weight in general is associated with higher rates of mortality (see Figure 2).

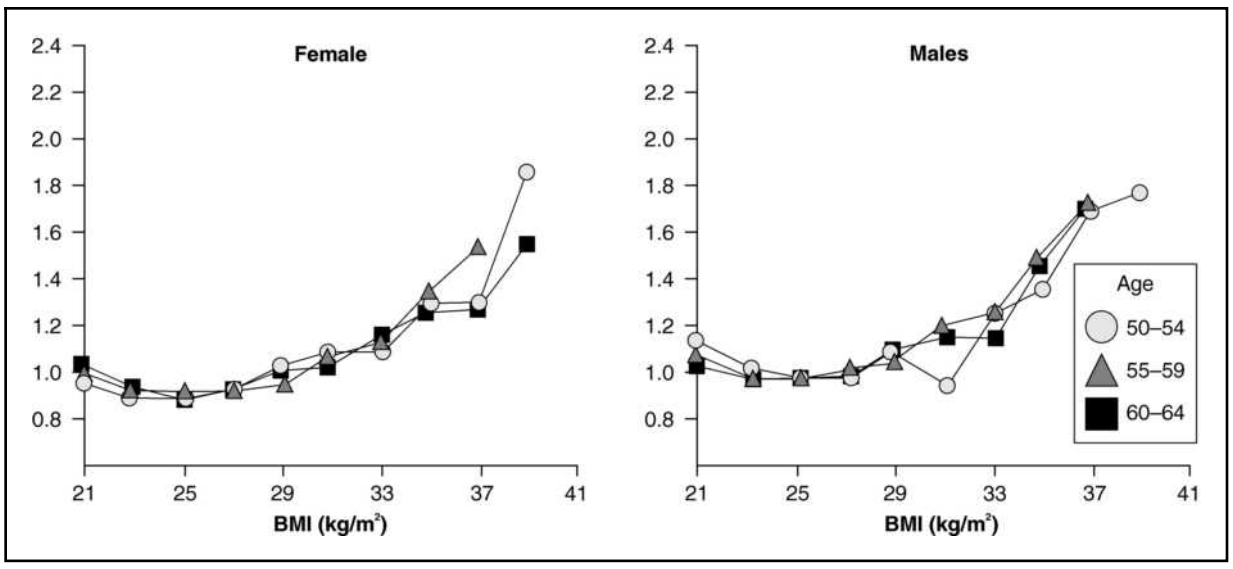
There is controversy about the contribution of body fat to mortality in the elderly. Some studies indicate that link between increased body fat and the increased risk of death is limited to people in the age range of twenty to sixty. Around age sixty, those studies say, the contribution of body fat to an increased risk of death decreases until it is negligible. Nevertheless, obesity has been identified as the second leading cause of preventable death in the United States (McGinnis and Foege).

Causes of obesity. For most individuals, the underlying cause of obesity is unknown. Strong evidence suggests that the degree of obesity is, in part, hereditary, the result of genes transmitted from the mother and the father. Estimates as to how large a role heredity and genes plays in obesity range from 30 to 70 percent. The remaining factors that contribute to obesity are thought to be environmental and behavioral factors, such as the ready availability of high calorie foods and the reduced levels of physical activity required on the job and in day-to-day activities.

Only a few people can trace their obesity to a precise gene defect. For example, in 1994 a gene was identified in rats and in mice which, when mutated or defective, caused them to become very obese (Zhang et al.). This gene, dubbed the ob (obese) gene, governs the production of a protein called leptin. Leptin is made by the adipose tissue and is released into the circulation system, where it is transported to other tissues containing the receptor for this protein, which is called the leptin receptor. Defects in either the leptin or the leptin receptor can result in obesity, but this form of obesity is very rare. Defects in a number of specific other genes can result in obesity in rodents, and scientists have identified the human counterparts to those genes. Nevertheless, all of the known gene mutations added together account for fewer than 100 cases of obesity in humans. In addition, there are a number of very rare genetic syndromes that are characterized by obesity, including, for example, Prader-Willie Syndrome and Pickwickian Syndrome. Even when those syndromes are factored in, less than one percent of obese persons have a known genetic cause of their obesity.

Some scientists believe that most of the genetic contribution to obesity is conveyed by the interactions of many different genes on many different chromosomes, each contributing in some small way to obesity. Genes interact with each other and with the environment, thus fur-

Figure 2
BMI and Age-Related Mortality



SOURCE: Adapted from Waaler, H. T. *Acta Med Scand.* 679 (supplement) (1984): 1–56.

ther complicating the medical community's ability to identify the exact causes of obesity, and as noted, the degree of obesity often naturally increases with age from the thirties to the sixties, further complicating the assessment of causes of obesity.

Additional risks

In addition to increasing the risk of death, obesity carries with it many other physiological changes that contribute to reduced health or increased morbidity (illness) (Bray and James). Obese persons have a higher likelihood of developing type 2 diabetes and cardiovascular disease. They also have a greater incidence of gallstones, joint disorders, certain cancers, and sleep apnea. In addition, obese persons frequently suffer from discrimination due to their body weight. Recent studies of the very obese in which significant weight loss was achieved and sustained using various gastrointestinal (stomach and intestinal) surgical procedures showed a great reduction in the illnesses listed above after obesity was reduced (Sjostrom et al.). Also, in nonhuman primates, the long term restraint of calories, adjusted to maintain a health body weight and to prevent the development of obesity, has been shown to prevent (or greatly delay) the development of the adult onset of Type 2 diabetes, which is the type most often associated with obesity (Hansen and Bodkin). In 2001, evidence suggested that the life long restraint of caloric intake sufficient enough to prevent the development of obesity also would postpone the average age of death and possibly extend overall life span (Hansen). The mechanisms underlying this improved morbidity and mortality through obesity prevention and calorie restraint are not yet known.

BARBARA C. HANSEN

See also BIOLOGY OF AGING; CHOLESTEROL; DIABETES MELLITUS; EXERCISE; GENETICS; NUTRITION, CALORIC RESTRICTION.

BIBLIOGRAPHY

BRAY, G.; BOUCHARD, C.; and JAMES, W. P. T. *Handbook of Obesity*. New York: M. Dekker, 1998.

HANSEN, B.C. "Prevention of Obesity." In *The Management of Eating Disorders and Obesity*. Edited by D. J. Goldstein. Totowa, N.J.: Humana Press, 1999. Pages 347–357.

HANSEN, B. C., and BODKIN, N. L. "Primary Prevention of Diabetes Mellitus By Prevention of Obesity in Monkeys." *Diabetes* 42 (1993): 1809–1814.

Table 2
Obesity is usually measured as body mass index (BMI).

Classification	BMI (Kg/m²)	Risk of co-morbidities
Normal range	18.5–24.9	Average
Overweight	≥ 25.0	
Pre-obese	25.0–29.9	Increased
Obese class I	30.0–34.9	Moderate
Obese class II	35.0–39.9	Severe
Obese class III	≥ 40.0	Very severe

NOTE: BMI = Weight (kg)/Height (km²)
SOURCE: Author

McGINNIS, J. M., and FOEGE, W. H. "Actual Causes of Death in the United States." *Journal of the American Medical Association* 270, no. 18 (1993): 2207–2212.

National Institute of Health–NHLBI. "Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults." In Eds. Washington, D.C., Government Printing Office, 1998.

SJOSTROM, C. D.; LISSNER, L.; and SJOSTROM. L. "Long-term Effects of Weight Loss on Hypertension and Diabetes: The S.O.S. Intervention Study." *International Journal of Obesity* 22 supp. 3 (1998): S78.

WOLF, M., and COLDITZ, G. A. "Social and Economic Effects of Body Weight in the United States." *American Journal of Clinical Nutrition* 63 (1996): 466S–469S.

World Health Organization. "Obesity: Preventing and Managing the Global Epidemic." In Eds. Geneva: World Health Organization, 1998. Page. 276.

ZHANG, Y.; PROECA, R.; MAFFEI, M.; BARONE, M,; LEOPOLD, L.; and FRIEDMAN, J. M. "Positional Cloning of the Mouse *Obese* Gene and its Human Homologue." *Nature* 372 (1994): 425–432.

OCCUPATIONAL THERAPY

The primary focus of occupational therapy is enabling individuals to participate actively and meaningfully in their day to day lives. *Occupation* is defined as any meaningful activity a person may do throughout the course of a day, including taking care of one's self (self care), contributing to society through paid and unpaid work (productivity), and simply enjoying life (leisure). Individuals may experience many obstacles to participating in occupations as a result of the aging process, disability, environmental change, or other circumstances. Occupational therapists may work in the home, hospital, clinic, or community setting to enable clients to adapt to or overcome obstacles and optimize their involvement in daily life.

The ability to perform an occupation is impacted by interaction between the activity, the skills, and attributes of the individual and the environment. Occupational therapists strive to optimize performance by facilitating a positive interaction between the components of the person, environment, and occupation. Identified areas of concern for occupational therapy can be grouped into the three broad categories: self care, productivity, and leisure.

Self-Care

The area of self-care encompasses all of the tasks an individual does throughout the day to look after his or herself. It includes activities such as personal care, functional mobility, and community management. Personal care includes such tasks as feeding oneself, bathing, personal hygiene, dressing, and toileting. Activities involved in community management may include driving, taking public transportation, grocery shopping, completing community errands, and managing one's finances.

The aging process or disabilities affecting an older person may lead to difficulties in completing self-care occupations. For example, decreased balance or strength may make it difficult for older people to get about their home or community independently and safely. Disabilities such as arthritis can make seemingly simple tasks such as washing one's feet or doing up buttons or zippers extremely difficult. The onset of a dementia such as Alzheimer's may impact a person's ability to carry out effectively personal care activities or to manage their finances.

Occupational therapists play a valuable role in addressing the difficulties encountered in performing self care occupations as a person ages. The occupational therapist can assess the client's ability to complete a chosen occupation, such as bathing. During the assessment process, the therapist needs to consider a variety of factors including the client's goals, individual abilities and limitations, the environment, and the nature of the task itself. Depending on the situation, intervention may focus on the individual, adapting the environment, or modifying the task. For example, a goal identified by a client may be to regain independence with bathing. In this situation the therapist may work to help the client to develop the strength needed to get in and out of the tub, they may recommend modifying the environment to include an assistive aid such as a grab bar, or suggest the client consider adapting the task by sitting on a bath chair. Regardless of the method of intervention the focus is on enabling

the clients to reach their goals, in this example independence with bathing.

Productivity

Productivity refers to an individual's contributions to society through both paid and unpaid work. Older adults often take part in the productivity occupations of household management, caring for family members, volunteer work, or paid employment. The physical and/or cognitive limitations that older adults may encounter can affect an individual's ability to fulfill productivity roles and responsibilities. For example, following a stroke individuals may experience a loss of function in their dominant hand making many household tasks—carrying a pot, opening a can, or pouring a cup of tea—difficult with the use of only one hand. The occurrence of a stroke may also impact an individual's memory, concentration, or attention span, leading to potential safety concerns in the kitchen, such as leaving items on the stove unattended or forgetting to turn off the burner.

The maintenance of skills necessary to manage a household and remain in their own homes is often of primary importance to older adults. Occupational therapists work with individuals and their families to promote independence and safety in the home environment. By addressing the physical or cognitive limitations, modifying the task or adapting the environment and support structure, the occupational therapist enables individuals to meet their household management responsibilities.

Leisure

In late adulthood, individuals place great importance on their leisure time, often pursuing hobbies, interests, and opportunities for socialization. Leisure activities may include quiet recreation such as reading or crafts, active recreation such as travel or community outings, and socialization such as visiting with friends and family. Many older adults have hobbies which they have participated in throughout their lives and may now have difficulty completing due to new physical or cognitive limitations. For example, knitting can become difficult as a result of pain experienced from arthritis in the hands. An occupational therapist can facilitate a hand therapy program to improve the range of motion and strength of the client's hands or adapt the knitting needles so the client is able to continue knitting. Spending time with family often plays a meaningful role in an individual's life. Occupational therapy is beneficial in providing suggestions to allow a client to interact with family or friends. For example, a therapist might suggest adapting a telephone for an individual with a vision impairment to facilitate communication with family members.

Summary

Occupational therapists are integral members of the older adult's health care team. By promoting the maintenance and development of the skills required for the job of living, occupational therapists enable clients to participate in those activities that are most important to them. Whether the goal be continuing to live independently, caring for a family member, or maintaining participation in individual pursuits, the occupational therapist can foster and enhance an older adult's quality of life.

TOBI FLEWWELLING
HEATHER WHITE

See also HOME ADAPTATION AND EQUIPMENT; HOME CARE AND HOME SERVICES; FRAILTY; FUNCTIONAL ABILITY; MULTIDISCIPLINARY TEAM; PHYSICAL THERAPY; REHABILITATION.

BIBLIOGRAPHY

Canadian Association of Occupational Therapy. "Position Paper on Occupational Therapy with the Elderly Population." *Canadian Journal of Occupational Therapy* 55, no. 2 (1988): Centerfold.

CUTLER LEWIS, S. *Elder Care in Occupational Therapy*. Thoroughfare: N.J.: Slack Inc., 1989.

HOBSON, S. "International Year of Older Persons: What Occupational Therapists have to Celebrate." *Canadian Journal of Occupational Therapy* 66, no. 4 (1999): 155–160.

LAW, M.; BAPTISTE, S.; CARSWELL, A.; MCCOLL, M. A.; POLATAAJKO, H.; and POLLACK, N. *Canadian Occupational Performance Measure*, 2d ed. Ottawa: CAOT Publications ACE, 1994.

TOWNSEND, E.; STANTON, S.; LAW, M.; POLATAAJKO, H.; BAPTISTE, S.; THOMPSON-FRANSOM, T.; KRAMER, C.; SWEDLOVE, F.; BRINTNELL, S.; and CAMPANILE, L. *Enabling Occupation: An Occupational Therapy Perspective*. Ottawa: CAOT Publications ACE., 1997.

OLDER AMERICANS ACT

The Older Americans Act (OAA) is the principal piece of federal legislation designed to provide a range of community services to adults age sixty and above. The law was enacted in 1965, during a time when the federal government was inaugurating a broad range of domestic social policies. The overarching goal of the OAA—to promote the independence of older Americans—has remained largely unchanged since its enactment. However, there have been important changes in emphasis and strategy within that overarching framework. In addition to assuring provision of a range of services to older Americans, the OAA was also central to creating an infrastructure of organizations and advocates working on behalf of older adults at the state and local levels and in the private as well as the public sector. Despite limitations in funding and modifications in direction over the years, the OAA can be judged to have generated significant improvements in the lives of older adults since 1965.

Development of the Older Americans Act

Important as it has been in making social services available to older people, the OAA was a relatively minor item among the legislation that was enacted by the federal government during the mid-1960s. The major aging-related policy event of the time was the enactment of Medicare, the federal health insurance program for the elderly. Yet, had it not been for the struggle surrounding Medicare, the OAA probably would never have been passed. That is because many different individuals and organizations mobilized on behalf of Medicare, but not all of them were doctors, hospitals or other providers concerned only with access to health care. Many older people and their advocates wanted the federal government to recognize the presence and needs of older Americans in a broader and more symbolic way than Medicare alone could do. Many professionals, providers of non-health-related services, also wanted federal financial support for their services (Binstock).

As a result of these twin pressures, the OAA was passed as a piece of legislation that served both to give symbolic recognition to the presence of older Americans in national life and to provide to them community-based services beyond those associated with health care alone. Title I of the OAA was very clear on both of these points, declaring that "the older people of our Nation are entitled to secure full and free enjoyment of the following objectives" and going on to list ten broad areas in which the federal government should act on their behalf.

While these objectives extended to income maintenance, employment, and housing, among others, the remainder of the OAA itself concentrated principally on the organization and provision of social services to be provided to older people living in their homes in their communities. Title II established the Administration on Aging within the federal Department of Health, Education, and Welfare (which became the Department of Health and Human Services in 1977). The Title III community grant program was by far the most important of the original titles in the act. It provided federal matching funds to the states to establish State Units on Aging, which would serve as focal points for state-level activities directed toward older people. Title IV authorized a research, demonstration, and training grants program, and the original Title V established an advisory committee on aging within the Department of Health, Education, and Welfare.

Despite its broad mandate, early funding under the OAA was very small by the standards of the federal government, only $7.5 million in 1966 and $10.3 million in 1967. These dollars were barely sufficient to help the new state agencies get off the ground and to fund a few service efforts, mainly in senior centers. Indeed, there was talk in 1970 of eliminating the program because so little was being done (Sheppard).

However, events in 1971 led to a massive and unexpected increase in the size and scope of the OAA program. The precipitating event was a speech that President Richard Nixon gave to the White House Conference on Aging held that year (Pratt). The president was opposing a 20 percent increase in Social Security benefits being proposed by the Democrats, and in order to please his audience of 4,500 older Americans, he focused his attention on the small but appealingly named Older Americans Act. The president called for a five-fold increase in appropriations to the level of $100 million and the creation of new sub-state area agencies on aging that would plan aging services in over six hundred planning and service areas. Thus, even though the president continued to oppose the much more expensive increase in Social Security benefits, the audience gave him a standing ovation for these remarks,

Table 1
Federal Expenditures Under the OAA

1966	$ 7.5 million
1968	18.5 million
1970	28.1 million
1972	101.7 million
1974	227.8 million
1976	324.3 million
1978	749.7 million
1980	919.1 million

SOURCE: Author

and the Older Americans Act—almost over night—became one of the nation's largest social services programs.

OAA programs continued to grow rapidly throughout the 1970s. The area agencies on aging were established, and they succeeded in pressing both federal and state governments for more OAA money. In 1972 a new nutrition program was added to the OAA, one that today rivals the social services under Title III in size and importance. The best indicator of the OAA's growth, however, is the enormous increase in appropriations, increasing from $7.5 million in 1966 to over $900 million in 1980 (see Table 1).

The major spending increases came in the social services and nutrition programs and also in a new community services employment program for low income older people. By the end of the decade, there was in place what one analyst referred to as "the aging network" (Estes), consisting of the federal, state, and area agencies, and the literally thousands of direct service organizations that these governmental bodies contracted with for actual services provision.

This expansion of programs and spending under the OAA during the 1970s is important for several reasons. First, services were made available to many more older people than would have been possible with more modest growth. Second, the new aging network became a political force, being able to both lobby for increases in OAA expenditures and around issues of broader concern to older Americans. Third, the growth and the leveling off that came in the 1980s was indicative of broader changes in aging politics that were emerging by the late 1970s. And fourth, the aging network had sufficiently institutionalized itself by the dawn of the more conservative 1980s and the presidency of Ronald Reagan so that it was able to maintain itself quite successfully while programs elsewhere were being dramatically downsized (Hudson, 1994).

Since the early 1980s, the OAA has been largely in a consolidation mode. Some modifications and additions have occurred, but its size and mission have remained relatively unchanged. Thus, on the matter of funding, appropriations reached $953.7 million by 1983, but seventeen years later had only risen another $350 million to $1.3 billion. These increases average out to roughly $20 million a year in comparison to the 1970s, where the average annual increases approximated $90 million per year. Other significant legislative changes over this latter time period include new authorizations for in-home services for frail elders, long-term care ombudsman program, health education and illness prevention programs, prevention of elder abuse and neglect, and a heightened emphasis on the needs of older people with greatest economic and social needs (U.S. Administration on Aging, 1999). More recently, new attention has been devoted to intergenerational concerns and the needs of those providing care to the frail elderly. Organizationally, the biggest change was the elevation of the Commissioner on Aging—head of the Administration on Aging—to the rank of Assistant Secretary for Aging within the Department of Health and Human Services.

After considerable modification over the years, the titles authorized under the OAA most recently are as follows: Title I: Objectives; Title II: Administration; Title III: Supportive Services, Meals, In-Home Services Preventive Health Services; Title IV: State and Local Innovations and Projects of National Significance; Title V: Senior Community Service Employment Program (administered by the Department of Labor); Title VI: Grants to Indian Tribes; Title VII: Vulnerable Older Americans/Senior Rights.

Issues under the Older Americans Act

Eligibility for benefits. The spirit and formal wording of the OAA holds that all citizens over the age of sixty are eligible for OAA-funded services. Yet, whether the amount is $7.5 million or $1.3 billion, there is nowhere near enough funding for all those over sixty to benefit from the program. Even so, from the very beginning there has been strong pressure that the OAA

should not be "means-tested," that is, have provisions whereby individuals would have to demonstrate that their income is below a given level before they could receive services. Such programs have long been associated with "welfare," and Congress has consistently made clear that it did not want services under the OAA to have any such connotation.

The eligibility dilemma OAA administrators have long faced, then, is how to concentrate or target benefits on older people deemed the most in need of services without imposing a formal means test. The emphasis on who, in fact, are vulnerable populations for OAA purposes has varied over time, but the following conditions and populations have been invoked: those in greatest economic or social need, rural older people, low-income minority individuals, the frail and disabled, and members of different racial and ethnic groups. Apart from these variations in emphasis, the more important point is that OAA programs in most parts of the country have devoted services disproportionately to older people who are poor, of minority status, and frail (Holt; Justice).

In more recent years, this last issue of frailty has increasingly dominated both eligibility and spending decisions under the OAA. The aging of the American population and especially the aging of the older population itself have meant that more individuals are suffering from chronic illness and disability than ever before. As a result, many state and area agencies find themselves doing what is occasionally referred to as "functional means-testing," that is, determining how limited people are when it comes to basic daily tasks such as dressing and walking. Services are now usually limited to those with several such "deficits," and they are frequently available only to individuals with limited incomes. Adding a home-delivered meals component to the OAA's nutrition program and adding a new subtitle to the act directed at in-home services makes clear this new emphasis on frail elderly people.

Mission and benefits

Within the rubric of supporting independent living for older people, the OAA has long had a multiple mission. Most clearly, the state and area agencies were to plan for the elderly's service needs and to contract with private agencies that would then provide those concrete services. But this entire aging network was also charged with serving as an advocate for older people and as a coordinator of services that were provided by large agencies—such as mental health departments—that were outside of this network itself. Indeed, the very establishment of a "network" was seen by some as detracting from this larger infusion function that the OAA's designers had very much in mind (Hudson, 1986).

During the act's early years, there was concern that these different mandates would weaken the overall impact of the OAA and those working under it. However, more recent events, largely outside of the control of any of these individuals, have lessened that concern. First, the network has become sufficiently large in the context of other human services agencies that it could both provide and advocate in ways that made the functions synergistic rather than separate. Second, the growing frailty of the older population brought the OAA, and agencies operating under it, increasingly into the world of long-term health care. In this arena, aging network agencies found themselves involved with the much larger Medicaid health care program. While Medicaid serves low income people of all ages, roughly one-third of Medicaid expenditures are directed toward frail elders, living either in nursing homes or in the community. The nature of the OAA and Medicaid interface varies greatly around the United States, but in some states the Medicaid money dedicated to these older individuals has completely or partially come under the aegis of the state unit on aging. In recent years, many states have also appropriated additional money directed toward care of community-based elders, with these monies usually administered by aging network agencies. And, attesting in particular to the issue of disability, today roughly half of the traditional state units on aging also have administrative responsibility for disabled adults who are under the age of sixty (Justice).

Intergovernmental and administrative issues

In the formal terms of federalism, the OAA is a federal-state grant-in-aid (GIA) program whereby the federal government makes funds available to the states and requires that they follow certain guidelines and contribute monies of their own on a matching basis. Most of the grants initiated in the 1960s—such as the OAA—tended to be "categorical," that is they contained quite

rigid federal requirements in order for states to receive federal funding. Because states were simultaneously administering many grants, they often found coordinating different federal requirements very cumbersome. As a result, more recent GIAs are "block grants," giving states much more flexibility in grant administration (Holt). This trend has held in the case of the OAA, where today states enjoy much greater choice in services to be delivered (e.g., home or congregate meals) and around agreements to be struck with other state-level agencies (e.g., the state Medicaid agency).

This trend in federalism, new pressures being brought on state governments by increasing numbers of frail elders living in their states, and twenty years of nearly level federal funding for the OAA have combined to make the states increasingly important in aging-related policymaking. Unlike the early years of the OAA, when the states were heavily dependent on both OAA dollars and AoA (Administration on Aging) approvals, the situation today finds the states in the lead in the design and funding of new programs with both the OAA and AoA playing a secondary role. Problematic as this might seem, ironically, it is in keeping with what OAA's founders actually had in mind in 1965. Their hope was that the OAA would stimulate initiative and innovation in state governments and that, having served as a catalyst, the OAA itself might become a less central player (Hudson, 1995).

Conclusion

After very shaky early years and a remarkable spurt of growth in the 1970s, the OAA has had a fairly stable history in more recent years. However, attention has shifted from addressing the preferences of relatively able older people living in the community to meeting the needs of very frail people in hopes of allowing them to remain in the community. As a result of this "geriatric imperative," the OAA, and especially the aging network agencies it brought into existence, have found themselves increasingly drawn to the world of long-term health care. Given that these clients' needs are multifaceted and the agencies serving them are multiple in number, it has become increasingly important for individual states to tailor their response to these new pressures in a coordinated manner. Many of the agencies created through the OAA have been key players across the nation in implementing these coordinated long-term care efforts.

Because the OAA itself has not grown during this period of long-term care expansion, it has become a relatively smaller element in this new and larger service universe. And the Administration on Aging—charged with running the OAA from Washington—has itself been weakened by years of personnel and funding cuts. Indeed, AoA's most recent strategic plan is again reminiscent of the symbolism of the early years, speaking of the need "to provide leadership," "promote cross-cutting initiatives," and "gerontologize America" (U.S. Administration on Aging, 1985). Yet, those who designed the OAA and those who continue to oversee it from today's AoA can take considerable solace in the fact that many state and other agencies operating from the now ubiquitous "aging network" are playing leadership and cross-cutting roles across the nation.

ROBERT B. HUDSON

See also ADMINISTRATION ON AGING; AREA AGENCY ON AGING; CONGREGATE AND HOME-DELIVERED MEALS; HOME CARE AND HOME SERVICES; MEALS; MEDICAID; SENIOR CENTER.

BIBLIOGRAPHY

BINSTOCK, R. H. "Interest-Group Liberalism and the Politics of Aging." *Gerontologist* 12 (1972): 265–280.

ESTES, C. L. *The Aging Enterprise*. San Francisco, Calif.: Jossey-Bass, 1979.

HOLT, B. J. "Targeting in Federal Grant Programs: The Case of the Older Americans Act." *Public Administration Review* 54 (1994): 444–449.

HUDSON, R. B. "Capacity-Building in an Inter-Organizational Context: The Case of the Aging Network." In *Perspectives on Management Capacity-Building*. Edited by B. W. Honadle and A. Howitt. Albany: State University Press of New York, 1986. Pages 312–333.

HUDSON, R. B. "The Older Americans Act and the Defederalization of Community-Based Care." In *Services to the Aged: Public Policies and Programs*. Edited by P. Kim. New York: Garland Publishing Co., 1994. Pages 41–76.

JUSTICE, D. "The Aging Network: A Balance Between Universal Coverage and Defined Eligibility." In *The Future of Age-Based Public Policy*. Edited by R. Hudson. Baltimore: Johns Hopkins University Press, 1997. Pages 168–177.

PRATT, H. J. *The Gray Lobby*. Chicago: University of Chicago Press, 1976.

SHEPPARD, H. *The Administration on Aging—Or a Successor?* U.S. Senate Special Committee on

Aging. Washington, D.C.: U.S. Government Printing Office, 1971.
U.S. Administration on Aging. "The Strategic Plan of the Administration on Aging." 1985. Available on the Internet at www.aoa.gov
U.S. Administration on Aging. "Historical Evolution of the Older Americans Act." 1999. Available on the Internet at www.aoa.gov

THE OLDEST OLD

As many nations of the world experience aging populations, attention is increasingly turning to changes within the older population itself, especially changes in the age structure of this older population. As a general statement, over time the elderly population is likely to become older; such a phenomenon is important because there are likely to be important differences among age groups within the older population, such as health status and economic well-being.

The aging of the older population occurs primarily because of reductions in death rates, which in many countries have become concentrated in the older ages. In the United States, for example, life expectancy at birth increased by more than 50 percent during the twentieth century; not surprisingly, most of the increase was due to reduced mortality among children and the elderly. However, almost all of the declines in mortality among children occurred prior to 1950, while declining mortality for the elderly occurred much more recently, during the final decades of the twentieth century. Thus, while population aging (the number or share of the population that has reached some specified birthday, usually, the sixtieth or sixty-fifth) is mostly due to reductions in fertility, the aging of the older population and the rising number and share of the "oldest old" (conventionally those at least eighty-five years of age) is mostly due to reductions in old-age mortality.

To illustrate the dynamics of the oldest old population, consider census data from the United States, which first became available for this age group beginning in 1910. That census enumerated 167,500 very old Americans who accounted for about two of every thousand of the nation's 92 million persons and only 4 percent of the 3.9 million Americans aged sixty-five or older. By mid-century, there were 578,000 Americans who had reached their eighty-fifth birthday. Their share of total population, while still very small, was about twice what it had been in 1910. Current estimates of the very old population of the United States suggest nearly 4.3 million individuals or about fifteen of every thousand Americans. In the past half century, the number of oldest old Americans has risen more than seven fold while the national population has not even doubled. Forecasts by the U.S. Bureau of the Census for the next fifty years suggest 19.4 million very old Americans by 2050, nearly 5 percent of the projected national total (see Figure 1).

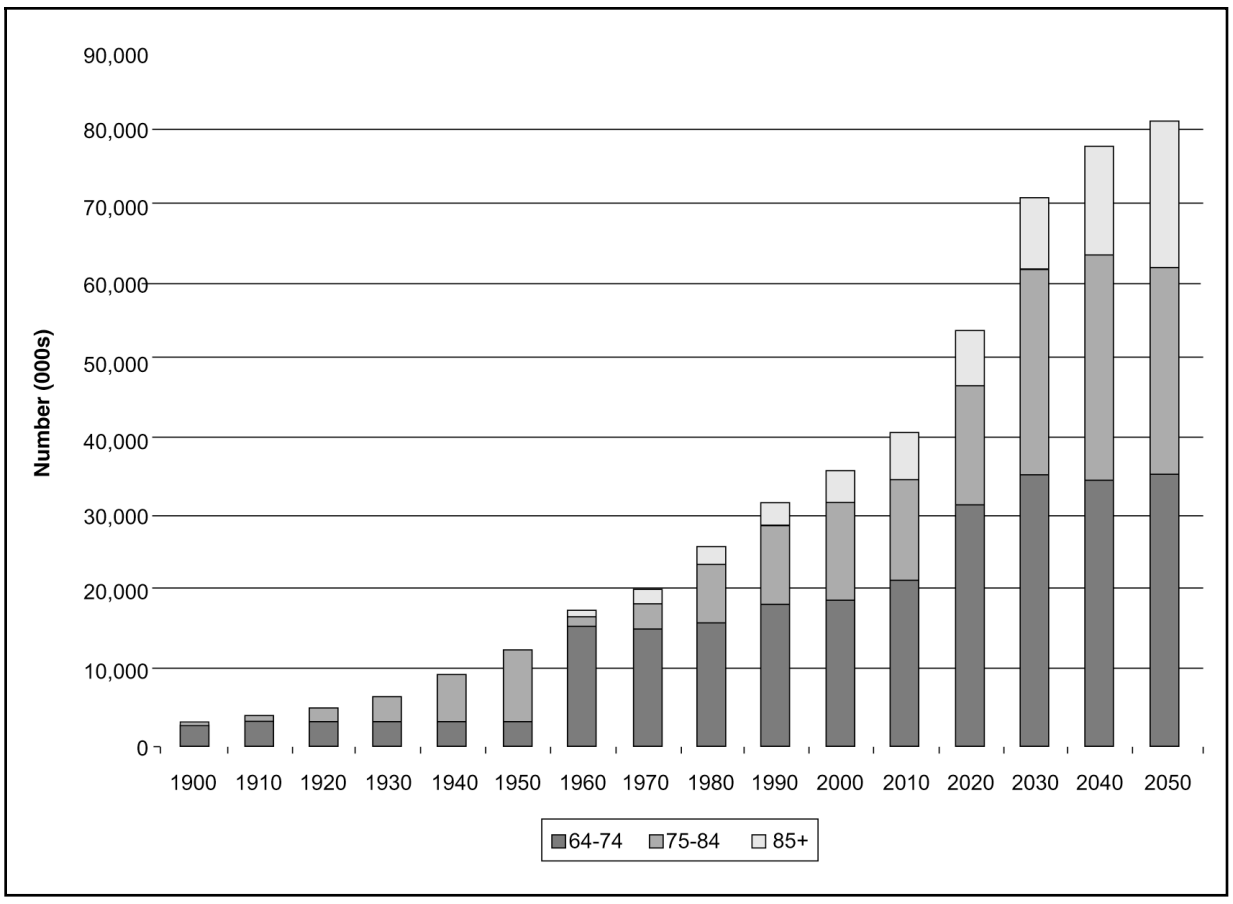
Gerontologists are particularly interested in these demographic trends because the oldest old have historically differed from the more general older population in many important respects. While it is not possible to state with any certainty that this pattern of differences will continue in the future, there are several interrelated issues that must be taken into account when contemplating the social and economic consequences of the demographic shifts summarized above.

Gender issues

The nexus of this issue is suggested by the sex ratio, or the number of men per one hundred women in a population. The oldest old are a largely female population—at present there are forty-three very old American men for every one hundred very old women, a level much lower than that found for the younger (persons sixty-five to eighty-four years of age) elderly—seventy-six per one hundred—or among the entire population—ninety-six per hundred. Such a pattern, which would be characteristic of almost any national population, simply reflects the lifelong advantage women have with respect to mortality. Due to this mortality difference and the customary pattern of men marrying women a few years younger than themselves, the very old population is overwhelmingly composed of widows.

In countries such as the United States, where old-age pensions tend to be earnings based, and where women have only recently spent much of their adult life in the paid work force, the oldest old tend to fare relatively poorly from a financial perspective. Since a widow's pension income may diminish or disappear altogether, it is not surprising that nearly one in four very old women is impoverished, compared with less than one in six very old men, less than one in ten younger elderly, and about one in seven of all Americans.

Figure 1
Older Population by Age: 1900–2050



SOURCE: U.S. Bureau of the Census

Health status

The health status of the very old is also a matter of considerable interest, especially given that a significant share of their health-care expenses is paid with public funds. The proportion of the population with one or more limitations in the activities of daily living (ADL) tends to rise sharply with age. While nearly nine in ten persons aged sixty-five to sixty-nine reported no problems with ADLs, this was true for only about 40 percent of the oldest old. A closely related issue is the extent to which the oldest old population resides in a nursing home or similar institution, a living arrangement strongly conditioned by the health and marital status of the individual (persons with a surviving spouse are far less likely to be nursing home residents than are the widowed). Fewer than one tenth of Americans aged eighty to eighty-four resided in a nursing home when the 1990 census was taken, but the incidence of institutionalization was sharply higher among oldest Americans; for those age eighty-five and older, nearly one in four were in a long-term care environment. This issue is of great import to policy makers at the federal and state levels, since many nursing home costs are paid through the jointly funded Medicaid program.

The aging of the oldest old

Like the U.S. Census Bureau forecasts for a rapid expansion of the oldest old population, in both relative and absolute terms, forecasts by the United Nations Population Division and statistical agencies of various nations show a similar trend in practically all nations. In all likelihood, the aging process so characteristic of both overall

and elderly populations will characterize the oldest old as well: currently two-thirds of those aged eighty-five and over are aged eighty-five to eighty-nine and less than 2 percent are at least one hundred. The population forecast for 2050 suggests that only half of that year's oldest population will be in the comparatively young range of eighty-five to eighty-nine, while more than 5 percent will be centenarians.

While these future numbers are uncertain, they should nevertheless give one considerable pause for reflection. Practically all of the characteristics that have been summarized here are correlated with age: widowhood, poverty, and ADL problems are not only more common among the oldest old than among younger individuals, but they are more prevalent among those aged ninety to ninety-four than among those aged eighty-five to eighty-nine, among those aged ninety-five to ninety-nine than among those aged ninety to ninety-four and so on. From a simple cross-sectional perspective, then, the increase in the numbers of the oldest old and the aging of this group would seem to augur poorly for society.

Outlook for the future

However, the outlook is not necessarily gloomy. Like any age group in a population, the oldest old at a specified point in time comprises individuals with differing lifetime experiences. Over time, the lifetime experiences of those currently aged eighty-five and over will be changing. Thus, the characteristics of the oldest old cannot be viewed as fixed, either absolutely or relative to the norm of some other age group. This process, known as *cohort succession* suggests that the oldest old of the future will differ from that of the present in some material respects. While health status deterioration and widowhood seem inevitable consequences of advancing age, the same need not be true for poverty.

Oldest old women of the future will generally have much more lifetime labor market experience than do their counterparts today and, accordingly, greater access to pension income in their own right. The availability of such pension income greatly reduces the prospect of poverty. Furthermore, the amount of education an individual has attained will condition her occupation and earnings history. In the aggregate, a person with more education will have had access to better paying jobs with greater benefits throughout her working life. As the oldest old of 2000 (persons born prior to the World War I) are gradually replaced over the next several decades first by the parents of the baby boom generation and then by the baby boomers themselves, the average level of education completed will rise from less than completion of secondary school to nearly one year of college.

In summary, it seems inevitable that those aged eighty-five and over will grow in numbers and proportions for the foreseeable future. At present, the economic well-being of this group is generally inferior to that of younger persons. This situation need not persist, at least to the same degree, over time because the process of cohort succession guarantees that the oldest old of future decades will differ from those of the present in several respects, including more favorable financial prospects.

WILLIAM J. SEROW

See also CENTENARIANS; COHORT CHANGE; LONGEVITY; entries on REPRODUCTION, SELECTION, SOCIAL ASPECTS; POPULATION AGING.

BIBLIOGRAPHY

GRUNDY, E. "Demography and Gerontology: Mortality Trends among the Oldest Old." *Ageing and Society* 17 (1997): 713–725.

PERLS, T. "The Oldest Old." *Scientific American* 272 (January 1995): 70–75.

SEROW, W. J., and SLY, D. F. "Trends in the Characteristics of the Oldest-Old: 1940 to 2020." *Journal of Aging Studies* 2 (1998): 145–156.

SUZMAN, R. M.; WILLIS, D. P.; and MANTON, K. G. *The Oldest Old*. New York: Oxford University Press, 1992.

ORGANIZATIONS IN AGING

See FEDERAL AGENCIES AND AGING; INTERNET RESOURCES; POLITICAL BEHAVIOR; PROFESSIONAL ORGANIZATIONS; VOLUNTEER ACTIVITIES AND PROGRAMS

OSTEOPOROSIS

Osteoporosis is a bone disease that affects over ten million Americans and 1.4 million Canadians. Persons with this disease have low bone mass and structural deterioration of bone tissue. This causes the bone to become more fragile and

An elderly woman with a Dowager's hump caused by osteoporosis. (Corbis photo by Lester V. Bergman.)

more likely to fracture. Osteoporosis is often referred to as a "silent disease" because most people are unaware that they have the disease until they actually sustain a fracture. Although awareness of the disease is growing, many persons remain undiagnosed and undertreated.

Consequences of osteoporosis

Although osteoporosis increases the likelihood of any bone breaking, the typical sites are the wrist, hip, and vertebrae. It is estimated that at least one-half of the women and one-eighth of the men over age fifty will suffer an osteoporotic fracture in their lifetimes. Hip fractures are among the most devastating consequences of osteoporosis. Twenty percent of persons die within one year of breaking a hip and only one-third will regain their pre-fracture functional level. The morbidity from vertebral fractures is also considerable. The pain from an acute fracture can last weeks to months, and elderly persons in particular may require admission to hospital for pain management. Chronic back pain may occur, and persons with multiple vertebral fractures may lose height to the extent that their ribs rest painfully on the top of their pelvic bones. Economically, osteoporosis resulted in $13.8 billion of nursing home and hospital costs in the United States in 1995 alone.

Risks

Osteoporosis is a multifactorial disease. Although osteoporotic fractures occur most commonly in old age, risk factors can be traced back to childhood. A person's peak bone strength is established by the age of twenty. Although many people think of bone as an inert object, it is actually a living tissue, continually renewing itself to correct defects that occur from wear and tear. Cells called osteoclasts break down areas of bone and create cavities, which are then filled with new bone that is produced by the osteoblast cells. As we age, the rate of bone breakdown exceeds the rate of bone formation, and bone loss occurs at a rate of 1 percent each year. This increases to 2 to 5 percent per year during the first five years after menopause and also increases somewhat after the age of seventy-five. By the age of eighty, the average woman will have lost 30 percent of her skeleton. Thus, it can be understood that the larger the peak bone mass established in early life, the more will remain after years of progressive bone loss. A diet low in calcium and vitamin D and low physical activity in childhood decrease the peak bone mass and therefore increase the risk of osteoporosis. Premature menopause (natural or surgically induced) causes the rapid bone loss period associated with estrogen deficiency to occur earlier. Women, because of menopause, and because of a relatively lower peak bone density, are at higher risk that men. As bone loss occurs progressively through life, age itself is an important risk. Other risk factors include excessive alcohol use, caffeine consumption, race (white or Asian), a thin small frame, and a positive family history. Medical conditions such as hyperthyroidism and hyperparathyroidism, and drugs such as steroids and anticonvulsants, are also important contributors to osteoporosis.

Diagnosis

The diagnosis of osteoporosis is often not made until a typical osteoporotic fracture has occurred. However, patients can be diagnosed earlier by measuring bone density. This is most commonly done using an X-ray technique called a DEXA (dual energy X-ray absorptiometry) scan. The bone density of the person is then calculated as the number of standard deviations

(SD) above or below the average value of a healthy young adult. The lower the bone density, the higher the risk of fracture. The WHO (World Health Organization) defines osteoporosis as a bone mineral density 2.5 SD below the young adult average. Other methods such as heel ultrasound and CT scans can also be used, although they have not been as extensively studied. Screening for osteoporosis is a controversial area and guidelines vary, but all recommend individual consideration of the person's risk factors and the treatment being considered.

Treatment

The best treatment for any disease is prevention. To maximize bone density, attention must be paid to ensuring adequate calcium and vitamin D intake, frequent weight-bearing exercise, and minimal alcohol and cigarette use from an early age. Estrogen and other medications such as bisphosphonates can decrease the amount of bone lost at the time of menopause. Persons requiring steroids for prolonged periods of time can be treated with bisphosphonates. Even among persons with established osteoporosis, there is much that can be done to reduce further bone loss, increase bone density, and, most importantly, prevent fractures. As many persons have a diet deficient in calcium and vitamin D, supplements are often needed to ensure a daily intake of 1200–1500 mg of elemental calcium and 400–800 IU of vitamin D. Medications that decrease bone turnover include estrogen, SERMs (selective estrogen receptor modulators, such as raloxifene), bisphosphonates (such as etidronate, alendronate, and risedronate), and calcitonin. These have been proven to increase bone density and to reduce vertebral fractures. Estrogen, risedronate, and alendronate have also been proven to decrease the risk of hip fracture. The selection of the best medication for the individual person depends on their other illnesses and risk factors, consideration of potential side-effects, and cost. Although much attention is focused on increasing bone density, equally, if not more important, are measures to reduce the falls that lead to fractures. Exercise, especially balance and resistance training, has been proven to reduce falls. Many medications such as benzodiazepines, antidepressants, and antipsychotics increase the risk of falls and should be stopped or reduced if possible. Vision should be checked. Attention should also be paid to home safety. Throw rugs should be discarded or taped down, grab bars should be installed in the bathroom and there should be adequate lighting. The person should wear sturdy flat shoes and be encouraged to use a walking aid if required. Hip protectors, which are shorts with pads over the hip bone, can also prevent hip fracture.

Conclusion

In summary, osteoporosis is a common and underdiagnosed disease. The consequences of osteoporotic fractures are serious and include pain, functional decline, institutionalization, and death. However, today much can be done both to prevent osteoporosis and to treat established disease. Effective treatment to prevent fractures includes both medications to increase bone density and measures to prevent falls.

JANET GORDON

See also ARTHRITIS; BALANCE AND MOBILITY; HIP FRACTURE; MENOPAUSE; PHYSIOLOGICAL CHANGES; ORGAN SYSTEMS; BONE.

BIBLIOGRAPHY

LAURITZEN, J. B.; PETERSEN M. M.; and LUND B. "Effect of External Hip Protectors on Hip Fractures." *Lancet* 341(2 January 1993): 11–13.

"Osteoporosis: Review of the Evidence for Prevention, Diagnosis and Treatment and Cost Effectiveness Analysis." *Osteoporosis International* 8, Suppl 4. (1998): S1–S88.

"Prevention and Management of Osteoporosis: Consensus Statements from the Scientific Advisory Board of the Osteoporosis Society of Canada." *Canadian Medical Association Journal* 155, no. 7 (1996): 921–965.

REID, I. R. "Pharmacological Management of Osteoporosis in Postmenopausal Women." *Drugs & Aging* 15, no. 5 (1999): 349–363.

P

PACE

See HEALTH AND LONG-TERM CARE PROGRAM INTEGRATION

PAIN MANAGEMENT

Pain is an unpleasant sensation induced by a noxious stimulus, and is transmitted along special nerve pathways to the brain. Many older adults state that it is the experience of chronic pain, more than anything else, that alters their individual sense of themselves, making them finally "feel old." While many age-related conditions give rise to pain, the experience of pain itself is nevertheless not part of normal aging. Indeed, there is evidence that the thresholds for some types of pain appear to be increased in older adults (i.e., they feel some types of pain less readily than younger adults).

Pain is one modality of the sensory system (others are the experience of light and deep touch, temperature, and vibration sense). Pain is a useful sensation that warns the body of injury, but chronic pain can be both physically wearing and psychologically debilitating. Pain sensation is perceived as a consequence of pain receptors (nocioceptors) located throughout the body. Through peripheral nerve pathways, pain impulses travel to the spinal cord and thence to the brain. In the brain several structures participate in the transmission of the pain impulses and in their appreciation in consciousness. Some part of the appreciation of pain appears to be susceptible to conscious manipulation, but many of the pain pathways are mediated as reflexes (i.e., they are not subject to conscious control).

Pain receptors function differently in different parts of the body, as reflected, in part, by differences in the ability to distinguish the source of pain. For example, pain in the hand can be localized very precisely to within millimeters of its source, whereas pain in the heart, as in a heart attack, can be experienced in the chest, arm, or jaw. Indeed, in some elderly people who have acute pain, it can be manifested as delirium, and not as any specific complaint of pain.

To understand such a broad class of sensations, pain can be approached in a number of ways. One way is to contrast acute pain with chronic pain. The latter is not just acute pain that has persisted, but pain that impacts on emotions and on an individual's sense of well-being, often in such a way that each feeds back negatively on the other.

Pain is traditionally divided by its likely source, as being somatic (e.g., pain in joints, muscles, skin), visceral (e.g., from irritation, stretching, compression, or infiltration of organs such as the heart, liver, or lungs), or neuropathic (i.e., pain arising from the peripheral nerves, the spinal cord, or certain parts of the brain, especially the thalamus). Of all the types of chronic pain, neuropathic pain can be the most difficult to treat with traditional analgesic medications. Nontraditional approaches seem to offer some benefit in all types of pain, although they apparently need to be used with regularity to achieve their greatest impact.

Pain is a particularly important problem among older adults who undergo surgery, and the discipline of anesthesia has developed many strategies for pain relief in older adults. Pain con-

trol is also an important focus of palliative care. In community-dwelling older adults who are physically frail, it appears that pain is common and its control is often inadequate. Pain is linked to the progression of disability in older adults who are functionally impaired.

The principles of pain management in older adults are similar to pain management principles in general. The lowest effective doses should be employed. Drugs for chronic pain should be given proactively on a regular basis, and not in reaction to pain. Even when patients are in the hospital, they should have a role in determining how often pain medication is given, and at what dose. Where chronic pain is poorly controlled by a single medication, combinations of medications should be used, in conjunction with nonpharmacologic approaches. Such approaches can include massage, acupuncture, and therapeutic use of heat and cold, as well as techniques such as yoga, visualization, self-hypnosis, and biofeedback.

Pain is experienced as even more noxious when it is accompanied by emotional upset (such as fear or anger), and especially when it is accompanied by a sense of lack of control. In consequence, counseling to provide insight into these factors, as well as techniques to help patients regain control, can be particularly beneficial. For this, the setting of precise goals can be especially useful. Specifying a range of goals, from being always pain free to something short of that, allows progress to be measured and the results of intermediate states to be documented. This in turn allows more precise dose adjustments. Finally, people with chronic pain can be reassured that waxing and waning is common, and that other stressful events in their lives can make pain seem worse. Often this helps patients to cope with residual anxiety about underlying problems that provide a secondary source of worry when pain seems less easy to control.

KENNETH ROCKWOOD

See also ANESTHESIA; ARTHRITIS; BRAIN; PALLIATIVE CARE; TOUCH, SENSE OF.

BIBLIOGRAPHY

GREGORATOS G. "Clinical Manifestations of Acute Myocardial Infarction in Older Patients." *American Journal of Geriatric Cardiology* 10, no. 6 2001: 345–347.

LANDI, F.; ONDER, G.; CESARI, M.; GAMBASSI, G.; STEEL, K.; RUSSO, A.; LATTANZIO, F.; and BERNABEI, R. "Pain Management in Frail, Community-Living Elderly Patients." *Archives of Internal Medicine* 161, no. 22 (2001): 2721–2724.

LEVILLE, S. G.; LING, S.; HOCHBERG, M. C.; RESNICK, H. E.; BANDEEN-ROCHE, K. J.; WON, A.; and GURALNIK, J. M. "Widespread Musculoskeletal Pain and the Progression of Disability in Older Disabled Women." *Annals of Internal Medicine* 135, no. 12 2001: 1038–1046.

LI, S. F.; GREENWALD, P. W.; GENNIS, P.; BIJUR, P. E.; and GALLAGHER, E. J.; "Effect of Age on Acute Pain Perception of a Standardized Stimulus in the Emergency Department." *Annals of Emergency Medicine* 38, no. 6 (2001): 644–647.

RYBARCZYK, B.; DEMARCO, G.; DE LA CRUZ, M.; LAPIDOS, S.; and FORTNER, B. "A Classroom Mind/Body Wellness Intervention for Older Adults with Chronic Illness: Comparing Immediate and 1-Year Benefits." *Behavorial Medicine* 27, no. 1 (2001): 15–27.

PALLIATIVE CARE

A report released by the Institute of Medicine's Committee on Care at the End of Life states that individuals often suffer needlessly at the end of life. According to this report, the organization of the health care delivery system in the United States impedes delivery of good end-of-life care, and, in addition, physicians and nurses lack the basic training necessary to provide good end-of-life care. Findings such as this have fueled a variety of efforts to improve care at the end of life. One important step in this effort is to increase public and consumer understanding of palliative care.

The World Health Organization (WHO) defines palliative care as the "combination of active and compassionate therapies to comfort and support individuals and families living with a life-threatening illness. During periods of illness and bereavement, palliative care strives to meet physical, psychological, social, and spiritual needs, while remaining sensitive to personal, cultural, and religious values, beliefs, and practices" (World Health Organization). Ideally, palliative care should begin when one is diagnosed with a life-limiting illness for which there is no known cure, such as congestive heart failure, chronic lung disease, and many forms of cancer. Palliative care may initially be combined with medically aggressive therapies to promote comfort, or it

may be the sole focus of care as an individual approaches death. According to the WHO, the philosophy of palliative care encompasses the following tenets:

- Individuals and families have the right to participate in informed decisions and make treatment choices
- Palliative care affirms life and regards dying as a normal process
- Palliative care does not hasten or postpone death
- Care focuses on the total person, including physical, psychological, and spiritual aspects
- Palliative care provides support to the family and other loved ones during a patient's illness
- Palliative care interventions aid the patient in living each day to its fullest possible potential, within an illness context

Most people, including both consumers and health care providers, assume that palliative care is for individuals who are terminally ill. The decision to refocus care from active disease treatment with hopes of a cure to treatment that focuses on comfort and preparation for death occurs when attempts at a cure are no longer beneficial. Unfortunately, the boundaries between *disease cure* and *disease comfort* are often blurred and indistinguishable.

Before 1900, individuals often died of infectious and/or very short-term disease processes. Death was expected, familiar, and viewed as a natural process. With improvements in public health (particularly in nutrition and sanitation); the development of antibiotics; the movement of the sick from homes to institutions; and the continuous advancement of life-saving technologies, the nature of illness and dying changed. Most deaths now occur in older adults who have lived with one or more progressive, long-term, debilitating illnesses for months or years. The central difference between dying in 1900 and dying today is the trajectory towards death. In 1900, dying was quick and recognizable, whereas today it is difficult to recognize, and the timing of death is almost impossible to predict. The prolonged nature of illness and dying requires a broader conceptualization of palliative care that combines active disease treatment with aggressive symptom management, emotional and spiritual support, ongoing communication, and preparation for death. This approach acknowledges that dying is an extended process and that death may be months or years away.

The essential components of palliative care include a multidisciplinary team, aggressive symptom management, patient and family support, advance planning of care, and death preparation. The focus is on the whole person and on the person's loved ones. A multidisciplinary team of health care providers, including physicians, nurses, social workers, and clergy, is used to attend to the physical, emotional, and spiritual needs of the person. Hospice is one avenue by which a patient can receive palliative care services. Unfortunately, hospice services only reach about 17 percent of individuals who die each year. Federal guidelines define eligibility for hospice admission as including only persons who have six months or less to live. In light of the difficulty in recognizing when someone is dying, and in predicting the timing of death, this guideline limits the number of people who have access to hospice services. In general, barriers to palliative services also include a lack of education about health care providers, a lack of consumer awareness of palliative care, and a lack of acceptance of death in society at large.

Although there are inadequacies in end-of-life care, advances in palliative care are being made. These advances include the development of educational programs to train specialists in palliative care, the addition of palliative education into medical and nursing schools, and the development of palliative care teams in hospitals. In addition, scientific evidence supports the alleviation of chronic physical pain with common analgesics and adjunct therapies. This is important because 20 to 30 percent of individuals will need to be referred to a palliative care specialist for adequate pain relief. Scientific evidence has also shed light on the role of nutrition and hydration in advancing illness. For many individuals who are approaching death, the use of feeding tubes does not prolong life, nor does it decrease the incidence of aspiration pneumonia. Loss of appetite and weight can be a normal part of the dying process, and, in any case, it is more often a dry and sore mouth, not dehydration, that causes discomfort. Palliative care specialists are especially skilled at helping family members differentiate between abnormal but treatable and normal declines in appetite, and at helping family members relieve common physical discomforts.

Communication between a patient and care provider regarding treatment goals is especially

important. There is a need to frame discussions around the burdens and benefits of treatment options within the patient's interpretation of his or her own quality of life.

Palliative care is for all persons who live with a life-limiting illness. As older adults live longer with chronic, debilitating illnesses, the delivery of palliative care from a multidisciplinary team is imperative to maximize the quality of life of these patients on a daily basis.

SARAH FORBES

See also CANCER; COMPETENCY; DEATH AND DYING; EUTHANASIA AND SENICIDE; HOSPICE.

BIBLIOGRAPHY

BILLINGS, J. A. "What is Palliative Care?" *Journal of Palliative Medicine* 1 (1998): 73–81.

Institute of Medicine, Committee on Care at the End of Life. *Approaching Death: Improving Care at the End of Life*. Edited by M. J. Field and C. K. Cassel. Washington, D.C.: National Academy Press, 1997.

World Health Organization. "Cancer Pain Relief and Palliative Care." World Wide Web document, www.who.int/HIV-AIDS

PANEL STUDIES

A panel study is defined as a study that collects information on the same individuals at different points in time. The various data collections are often called waves. A panel study is therefore a longitudinal study; it differs from other studies that collect information over time, such as time series and cohort studies, in that it studies the same persons longitudinally.

Advantages

Panel studies are the optimal design for addressing some of the core questions in aging research: first by measuring in each wave the same characteristics in the same persons, panel studies are able to provide descriptions of changes experienced by individual persons over time and differences between people in their individual change patterns. For example, measures of cognitive functioning and diagnosed diseases are collected at each wave in the Health and Retirement Study, a panel study of physical and mental health and their labor force and economic consequences. Change can then be defined either as transition from one state to another on a categorical variable (e.g., the transition from "no diabetes" to "diabetes") or as difference in level on a continuous variable (e.g., the extent of decline or improvement in cognitive functioning). The absence of change, or stability, may also be of interest.

A single panel study of persons of a limited age range can describe change or stability associated with aging for only one cohort. It is generally recognized that aging is conditioned by the historical, political, economic, and societal contexts in which it takes place. For example, the onset of diabetes depends on lifestyle factors such as obesity or lack of exercise, and lifestyle factors have been changing. Therefore panel studies of different cohorts who age through different historical times are required for generalizeable descriptions of change. But even a multiple-cohort design cannot provide a definitive distinction between aging and historical phenomena; direct investigations of specific causal factors such as lifestyle on diabetes onset represent a more fruitful approach.

Second, panel studies with several waves are the best quasi-experimental design for investigating the causes and consequences of change with high internal validity. While a true experimental design generally is considered the strongest design for investigating causal patterns, many potential causes of interest to aging researchers are not amenable to experimental manipulation. In the above example lifestyle as a potential cause of the onset of diabetes is not easily manipulated, nor is it feasible to manipulate the onset of diabetes in order to study its hypothesized effects on quality of life outcomes. Quasi-experimental designs that depend on the naturally occurring variation of potential causes are the next best alternative. Because naturally occurring variation depends on other causal factors (e.g., the fact that those with healthy lifestyles differ in many other ways from those with less healthy lifestyles), the data collection must be planned to ensure that those other factors are measured and careful statistical control of those factors must be applied during the analysis of the data from quasi-experimental designs. Panel studies have an important advantage over those that use the simpler quasi-experimental design of a single, cross-sectional data collection in that they allow for better specification of the time-ordering between presumed cause and effect.

Challenges

Panel studies pose fairly formidable methodological challenges. The lag between waves needs to be consistent with the change patterns of interest. For example, whereas the impact of a medication's side effect on cognitive functioning may last only weeks, the effect of obesity and lack of exercise on onset of diabetes may not take place for ten or more years. Also, measurement must be consistent over waves in order not to confound change in the underlying characteristic with measurement change, and it needs to be inclusive in order to capture all possible causes and outcomes and controls.

Most of the big panel studies utilize population probability samples that permit generalization to the target population and provide for external validity. Such generalizations can be biased by missing data, including nonresponse to initial recruitment, missing information to specific measures, and—particularly critical for panel studies—dropping out of later waves, because those with missing data may be systematically different from those without. Potential biases can be reduced by minimizing nonresponse and attrition during conduct of the panel study, by imputing missing responses after data are collected, and by modeling missing information during data analysis.

All of these design considerations imply that a fair amount of prior knowledge about the phenomenon of interest and its explanations is required to optimally design a panel study. Moreover, relevant knowledge continues to accumulate over the often lengthy life of a panel study and can make an ongoing study obsolete. Finally, panel studies tend to be very expensive to conduct and therefore tend to be designed with several objectives in mind; the multipurpose nature can interfere with a design tightly focused on a specific hypothesis.

Data analysis

Many options for analysis of panel data are available. For outcomes in the form of simple transitions between two waves, logistic regression analysis may be used. For example, the transition from "no diabetes" at wave t to "diabetes" at wave t+1 may be so analyzed. The "competing risks" of dying and dropping out of the study may be modeled by using multinomial regression analysis that allows for multiple outcomes. In the case of transitions for which exact timing is available such as death or retirement, survival or hazard analysis techniques allow a refined assessment of the change patterns and the causal dynamics. For outcomes in the form of continuous variables such as a performance measure of cognitive functioning, ordinary least squares regression analysis can model the amount of change between two waves. Autoregressive structural equation modeling and growth curve analysis permit the specification of multiwave change and stability; in the former change is conceived as relative change, in the latter as absolute change. For both types of models statistical procedures exist that allow for the evaluation and control of measurement error. In all of these analytical techniques potential causes—conceptualized either as status or change—may be evaluated as statistical predictors. In multiwave panel studies different lags between cause and consequence can also be evaluated.

Examples of panel studies for the study of aging

Major panel studies for studying age-related changes, their causes and consequences include the Baltimore Longitudinal Study of Aging, the Panel Study of Income Dynamics, the Health and Retirement Study, the Americans' Changing Lives Survey, The Berlin Longitudinal Study, the National Long Term Care Survey, The Established Populations for Epidemiologic Studies of the Elderly, and the Longitudinal Study of Aging.

A. Regula Herzog

See also Developmental Psychology; Surveys.

BIBLIOGRAPHY

Alwin, D. F., and Campbell, R. T. "Quantitative Approaches: Longitudinal Methods in the Study of Human Development and Aging." In *Handbook of Aging and the Social Sciences,* 5th ed. Edited by Robert H. Binstock and Linda C. George. New York; Academic Press. Forthcoming.

Kasprzyk, D.; Duncan, G. J.; Kalton, G.; and Singh, M. P., eds. *Panel Surveys.* New York: John Wiley & Sons, 1989.

Menard, S. *Longitudinal Research.* Newbury Park, Calif.: Sage, 1991.

Eddie Jean Roberts (left) visits her mother, 111-year-old Jewel Roberts (right), every day to assist with meals and basic care at the elder Roberts's new home, which was donated by Habitat for Humanity. (AP photo by Donna McWilliam.)

PARENTAL OBLIGATIONS

Parents of grown children can find themselves in ambiguous situations in our highly technical society. Young adults need many years of education to find good jobs that provide financial independence. Consequently, adult children today take longer to marry and often return home to live with their parents. How much should their parents help them? The moral dilemmas become more complicated if young adults have children of their own, and have difficulties carrying out their parental duties successfully. Do grandchildren have a claim upon their grandparents' resources?

An argument against unlimited support

The argument is made by many that there is a limit to parental obligations to support adult children. If parents have spent arduous decades caring for their offspring, paying tuition for colleges, and perhaps helping with graduate education, they can conclude that they have fulfilled their moral duty. It is not fair to expect older parents to support their adult children indefinitely, or to raise their grandchildren as surrogate parents. As persons live longer, older parents can have many post-childrearing years to engage in life projects that need not include helping their children forever, much less caring for grandchildren. To support an adult child well beyond the age of legal maturity, or to actively care for a grandchild, should be seen as optional, a matter of preference but not a moral requirement. If there are family emergencies it is argued, then outside familial social services can be engaged to solve the problem.

The argument against giving unlimited support is based upon the principle that an individual's moral obligations are limited to fulfilling promises and contracts that he or she has explicitly incurred. Marital partners, for example, have moral obligations to one another because of the marital contract—unless a divorce takes place. Adults who consent to sexual intercourse should foresee the reproductive consequences; they incur obligations to the children that they conceive and bring to birth. Persons who legally adopt children also have obligations to them. Parents have contractual obligations to protect, nurture, and adequately educate their dependent children until they enter adulthood and can support themselves.

The law recognizes these parental obligations and provides penalties when they are not met. Inheritance rights and other legal protections and privileges are accorded to legitimate children. But in writing a will, parents can leave their money to whomever they please. Parents are not morally or legally obligated to help with the financial burdens of their children's marriages and formation of households, although they may follow the cultural norms and do so.

But giving the next generation a good start is different from giving lifetime support. In some unfortunate situations adult children are mentally or physically handicapped or emotionally impaired. Parents should respond to emergencies but are justified in arranging solutions that do not include having the adult child live at home. In other cases the presence of ideological conflict or moral delinquency justifies a parent's withdrawing support that would encourage antisocial behavior. Parents fear becoming "enablers," that is, inadvertently giving aid to their adult children that permits immature, manipulative, or self-destructive conduct. Making decisions about when, and how much, to help before withdrawing is extremely difficult, especially if parents possess adequate resources, but are not wealthy enough to guarantee lifetime support.

When adult children have their own children, the situation becomes more problematic. What do grandparents owe their grandchildren? Here again the argument can be made that grandparents have no moral responsibility to their grandchildren because they had no control over the sexual and reproductive behavior of adult children. Adults, it is said, are independent individual moral agents and their parents cannot be held morally responsible for the consequences of what they do. Parents do not give consent to the birth of grandchildren. Older parents have completed their own moral responsibilities for child care. They can invoke a kind of statue of limitations and the right to divorce themselves from the next generations' needs. The fact that many grandparents regularly take care of their grandchildren and transfer resources to them is a matter of preference and discretionary choice. A grandparent who refuses to help an adult child or a grandchild should not be judged to be morally remiss, in the way that a parent would be if he or she refuses to support a child. A Supreme Court decision recognizes this moral principle by giving sole control and responsibility to a child's parents, and refusing grandparents any rights of visitation, if parents object.

Nonetheless, in 2001 four million American children resided in households headed by their grandparents as their chief caretakers. Drugs, mental dysfunction, economic problems, divorces, illness, death, incarceration, and other family emergencies are given as reasons. A few ethnic subgroups in America still follow patterns of patriarchal, extended family residence, but this is not the society's norm. When adult children are residing in their parents' home, along with their children, it is usually because of some need that older parents are responding to. In millions of other families, grandparents are also investing time and money to help care for their grandchildren. Is there an argument to be made that grandparents do have extended moral obligations to both their adult children and grandchildren?

An argument for the extended moral obligation to adult children and grandchildren

Older parents can have moral obligations to their adult children and their grandchildren that brook few exceptions or limitations. Some argue that if all goes well with adult children and they are raising their children successfully, grandparents still have an obligation to encourage and morally support their adult children and grandchildren. They should show interest, give attention, and supply as much supplementary help as will contribute to the family's flourishing. Nurturing attentions that help, but do not spoil or distort, a grandchild's development should be given. In emergencies the grandparents have a moral responsibility to give more financial and emotional support, and in cases or real crises, they have a duty to provide back-up surrogate parenting and childcare, if they can. These moral claims of families in crises are grounded upon a more capacious, richer ethic of moral responsibility than a highly individual morality limited to fulfilling contracts.

An adequate morality of family obligations affirms the principle that as human beings we have moral obligations and responsibilities for which we do not individually contract. It is not enough to require only that human beings operate as detached selves pursuing self-interests. As human beings we are moral agents who exist in embedded networks of attachment that make

valid moral claims upon us. No child contracts to be born a member of a family or of the human community. No one gives informed consent to be a member of earth's ecosystem. Yet we have moral obligations to our families, to our communities, and to protect the earth's environment for future generations. We live in time and will always face unforeseen events and challenges. We could not function outside of interdependent communities' relationships, so we have corresponding moral obligations that transcend individual projects and choices. Modern moral perspectives have overemphasized individual liberty, abstract ethical principles, and the idea that moral obligation is limited to formal legal agreements freely assumed.

Such a truncated moral vision cannot adequately respond to the demands and realities of communal living, especially life in families. For one thing, it assumes that individuals experience goods and duties alone, and ignores the "together goods" that can only arise in interactions and relationships with others. Yes, we have a moral duty to do no harm, and fulfill individual promises and contracts, but we also have an obligation to further the common good.

In an adequate morality, individuals are bound to respect and care for other human beings because they possess intrinsic value and worth as ends in themselves. The moral claims of others must be recognized as equal to one's own. The United Nations Universal Declaration on Human Rights expresses the ethical obligation of individuals to treat each other in "a spirit of brotherhood" that entails respecting and responding to their needs and moral claims. In the teachings of the great world religions the demand is also made that persons treat each other with care and compassion. Those in need have a moral claim upon those with resources. A morally mature person must be ready to respond to unexpected events and the unforeseen needs of his neighbors. The Good Samaritan happened to be passing by on the road. In families, the members are always traveling on the road together. Parents are their adult children's keepers and have obligations to grandchildren.

We have special duties to those who are near (and dear) to us. Our duties arise from our state in life, that is, where we live and with whom we are interconnected. Those whom we know and with whom we have emotional ties can be helped most effectively by us. Our families, our neighbors, our fellow workers, our countrymen have stronger claims on our care than others, because they are near at hand and can benefit from our care. The more emotionally intimate and long-standing the relationship, the greater the moral weight of our obligation.

Older parents have moral obligations to their adult children and grandchildren because they can play a special role in supporting them, a role that exists because of a unique irreversible connection between the generations. The biological (or adoptive) relationship links individuals to the past and has consequences for the future. Kinship ties carry responsibilities for support that strengthen the common good in the present and for the future. I was given life by my parents, the argument goes, and my adult children and their children would not exist if not for me. Older generations pass on the culture to the young. Grandparents can intervene if need be on the behalf of grandchildren, with their parents, with other family members, and with outside individuals and institutions. When in cases of need grandparents do not have the means or capacity to support adult children or grandchildren at home, they can still serve as loving advocates within the social service system by maintaining close contact. If there is some bitter family conflict and divisiveness, older parents are morally obligated to work to heal the breach.

Civil society and healthy communities depend upon strong and healthy family commitments. Without experiencing socialization within the family none of the public virtues can be acquired easily. An adequately functioning family engenders bonds of love, altruism, and mutually cooperative behavior. We respect and love those outside of the family, those recognized as the larger human family, because we first learned to feel respect, moral obligation, empathy, and love in the family setting. Families are one place in our society where it is possible to completely follow the altruistic ideal of "from each according to their means, to each according to their needs." The positive emotions of love and joy that arise from giving have been as important to human flourishing as other drives for survival. The altruism of grandparents to their adult children and grandchildren is also supported by an evolutionary analysis of human nature.

Evolutionary perspectives on family altruism

Kinship obligations to progeny and their offspring are primary features of human societies. The human species is highly social, and each adult that reaches reproductive age is the product of years of family and group nurture. No pair of procreative parents springs full grown into the world or can survive alone. In an evolutionary perspective, the primary human drive is to perpetuate one's own genes through successful mating and reproduction. But without a third generation the parental genes die. The innate drive for successful descendants motivates the many family systems that formally emphasize extended family responsibilities. New evolutionary analyses of the helping behavior of grandparents focuses upon the ways that greater help is given to those grandchildren whose genetic relationship to the grandparents is certain, that is, a daughter's offspring over a daughter-in-law's. In new studies of surviving Stone Age tribes anthropologists have discerned a *grandmother effect*. Those children of a woman whose mother actively forages roots and foodstuffs to supplement their diet, weigh more than other children. Speculation then arises that the helping role of grandmothers may provide an evolutionary explanation of why women live beyond their reproductive years and experience menopause. Their care for their grandchildren provides a selective advantage. Perhaps it will soon be discovered that the help and investment of both grandparents in their adult children's nurturing of grandchildren provide advantages. Human beings, however, do not live by evolutionary mechanisms alone, so moral obligations within families do not depend upon unconscious innate drives to selectively reproduce genes. The argument for the obligation of parents to their adult children and their grandchildren is a moral one that morally convinces. It is also important that it is in accord with innate tendencies of the human species for group survival.

Conclusion

As life expectancies increase families live together for many more decades than ever before. There are new problems and challenges that arise from a complex, highly technological, individualistic society. But there is also more time for families to enjoy each other's company, give mutual support, mend broken ties, and express love and gratitude. Within families the grandparent-adult child-grandchild relationship is unique. As more attention is focused on the ethics of family relationships, the moral obligations of older parents to help adult children rear grandchildren will be affirmed and appreciated. Many grandparents make sacrifices for their extended families and grandchildren; the nurturing influence of grandparents operates as a hidden force for human survival.

SIDNEY CALLAHAN

See also FILIAL OBLIGATIONS; GRANDPARENTHOOD; INTERGENERATIONAL EXCHANGES; INTERGENERATIONAL JUSTICE; PARENT-CHILD RELATIONSHIP.

BIBLIOGRAPHY

BLUSTEIN, J. *Parents and Children: The Ethics of the Family*. New York: Oxford University Press, 1982.

CALLAHAN, S. *Parents Forever: You and Your Adult Children*. New York: Crossroad, 1996.

O'NEIL, O., and RUDDICK, W., eds. *Having Children: Philosophical and Legal Reflections on Parenthood*. New York: Oxford University Press, 1979.

PARENT-CHILD RELATIONSHIP

Throughout recorded history, there has been an interest in understanding the causes and consequences of the complex relationship between parents and children. Despite frequently expressed worries about the weakening of intergenerational ties, the evidence has demonstrated the continued intensity and influence of these ties. In fact, recent research has shown that the intensity of the bond retains its strength even long after the parents' deaths (Shmotkin, 1999). Of interest here is the relationship between adult children and their parents, particularly factors that affect the quality of relations between the generations. Also important in this discussion is how the childless fare, relative to parents, in terms of happiness and well-being in their later years.

Parent-adult child relations in historical context

Changes in American society during the twentieth century led parent-adult child rela-

A middle-aged woman hugs her elderly mother. Love and respect are key parts of a healthy parent-child relationship. (PhotoEdit)

tions to be of increasing interest to scholars, policymakers, and the lay public. Gains in average life expectancy have provided parents and children the opportunity for even more enduring intergenerational relationships than in previous eras. For example, men born in 1920 were expected, on average, to live to be only 54; by 1950, their life expectancy had risen to 66, and by 1996, to 73. Women's life expectancy increased even more across the same period, from 55 for women born in 1920, to 71 in 1950, and 79 in 1996. Such increases in life expectancy provide greater opportunities for meaningful family exchanges across the generations.

However, the opportunity for greater family involvement may not be sufficient to produce warm and supportive intergenerational relations. In fact, both the popular and scholarly literatures have often framed parent–adult child relations as potentially problematic. Such concerns can be attributed to certain societal trends that may create obstacles to harmonious and supportive relations between the generations. *First,* increased life expectancy leads to a greater likelihood that families will spend longer periods of time caring for disabled elderly relatives. Coupled with declining fertility, this development suggests that larger numbers of elderly people will be cared for by fewer offspring. Adult children, in turn, will bear the costs of caring for aged parents, with fewer siblings to assist them.

In addition, the nature of parent-child relations in later life became substantially more voluntary toward the end of the twentieth century. That is, elderly parents' relationships with grown children are characterized by choice, rather than by obligation. In the past, control of family resources was a major method of ensuring contact with, and care by, children. In contemporary society, the young are dependent on the labor market for their livelihood, rather than on elderly parents. Further, norms of filial responsibility were more clearly articulated in the past. At present, the amount and nature of parent-child contact and the degree of mutual aid between the generations tend to be individually negotiated, with only limited guidance from society.

What is remarkable, in the face of such obstacles to high relationship quality, is that parent–adult child ties tend, on average, to be warm and supportive despite the difficulties that both generations face.

The quality of parent-adult child relations

Children and parents' social characteristics and intergenerational relations. It has been demonstrated that both children's and parents' social characteristics are crucial to an understanding of intergenerational relations. Three social characteristics play a particularly important role in determining the quality of parent-child relations in later life: age, gender, and race.

Age. Theories of adult development and intergenerational relations suggest that the age of the adult child affects the quality of parent-child relations. These theories argue that as adult children become older, there is less conflict and greater closeness in the parent-child relationship because maturational changes reduce differences between parents and adult children, thus minimizing the bases for conflict between them. Further, these theories posit that as children and parents age, there is greater tolerance for any intergenerational differences that remain. Empirical studies conducted with both adult children and elderly parents provide support for these theories by showing consistently that relations are more harmonious when children are older.

Gender. A review of the literature suggests that the gender of both parent and child affects intergenerational relations. Studies of the effects of gender consistently demonstrate stronger affectional ties between mothers and daughters than any other combination. For example, mothers report more positive affect with adult daughters than sons, and they are more likely to rely on daughters than sons as confidants and comforters. In turn, adult daughters report greater feelings of closeness to mothers than fathers.

The literature on other parent-child gender combinations suggests that there is greater closeness and less conflict in both mother-son and father-daughter pairs than in father-son pairs. The preponderance of studies of intergenerational relations have found that adult sons report greater closeness to mothers than to fathers, whereas fathers report greater closeness to daughters than to sons.

Race and ethnicity. Research on ethnic diversity in families in the later years has grown considerably during the past two decades. Most of this work has focused on differences between black and white families; however, both Hispanic and Asian families have also received attention.

The literature has revealed some consistent differences in intergenerational relations between black and white families. In particular, elderly blacks are substantially more likely than whites to live in two- and three-generational households, and to be involved in their grandchildren's day-to-day activities. Further, it appears that there is greater closeness and less intergenerational conflict in black than in nonblack families. C. V. Willie (1988) has argued that older blacks are less insistent that younger family members adhere to their elders' customs than are nonblacks, which might reduce the basis for conflict over intergenerational value discrepancies; however, the few studies that have investigated this issue have not provided a consistent picture.

Parent–adult child relations among Hispanics appear to differ from those of both blacks and whites. For example, parent-adult child contact is more frequent among Hispanics than whites or blacks, and Hispanic parents are more likely to live with their adult children than are blacks or whites. Further, several studies suggest greater intrafamily support in Hispanic than non-Hispanic white families. However, because most of these studies do not separate the role of adult children from that of other close family members, it is difficult to determine with certainty whether parent-child relations are closer in Hispanic than non-Hispanic families.

Although the population of elderly Asians is growing rapidly in the United States, there is relatively little literature on parent–adult child relations among these ethnic groups. The literature that exists suggests that there are inconsistencies in the patterns of parent-child relations among Asian-American families. On one hand, filial piety is still normative, and parent–adult child coresidence is common, yet Chinese-American parents who do not live with their children have lower frequency of contact with them than do black, white, or Hispanic parents. Further, value differences which might lead to conflict between parents and children are increasingly common in Asian families.

Life events, parent-child relations, and parents' well-being. Changes in either parents' or children's social characteristics may have profound effects on intergenerational relations. It is important to distinguish between transitions that are experienced by adult children and those experienced by elderly parents, as well as to make a distinction between two types of transitions: those that are normative—that is, transitions that

are socially acceptable and expected to occur at a given time—and those that are nonnormative.

Effects of adult children's normative transitions. Numerous studies have found a consistent pattern of increased intergenerational closeness and contact when children experience normative transitions. For example, parents and adult children appear to become closer when children establish separate households, marry, and become parents. In part, there is a positive change in intergenerational relations when adult children experience these normative transitions because such transitions confirm that the adult child is conforming to societal norms regarding maturational development. An often neglected point is that normative transitions also improve parent-child relations because these transitions increase the number of social structural positions that adult children share with their parents.

Effects of adult children's nonnormative transitions. Considering that normative transitions generally intensify affectional bonds, it is not surprising to find that nonnormative transitions sometimes affect parent-adult child relations detrimentally. However, whether the nonnormative transition affects relations appears to be determined greatly by the extent to which the transition challenges parents' values.

Recent studies of adult children's transitions support this argument. For example, studies have shown that relations between middle-class sons and their parents often become strained when the adult children, particularly sons, lose their jobs. Further, adult children's relationships with their parents have been found to suffer when the children engage in illegal behaviors, regardless of whether the actions lead to legal action.

Nonnormative transitions that do not challenge the parents' values appear to have far less impact on parent-adult child relations. For example, it appears that adult children's returning to live in their parents' homes creates little distress in the parent-child relationship. The preponderance of the literature suggests that a child's divorce also has little or no deleterious effect on the quality of parent-child relations. In fact, some findings suggest that there might even be an increase in parent–adult child closeness following a child's divorce. However, studies have not examined whether the effects of an adult child's divorce on parent-child relations is affected by either circumstances surrounding the divorce or by the parents' values regarding marriage.

Children's stressful life events and parents' well-being. While negative life events in the lives of adult children do not necessarily affect the quality of the parent-child relationship, they do affect parents' psychological well-being. Studies have shown that problems experienced by adult children, and contact with children during these periods, can detrimentally affect elderly parents' well-being. For example, it has been found that parents whose adult children have had mental, physical, substance abuse, or stress-related problems experience greater depression and emotional distress than do parents whose children did not have these problems.

Further, parents of mentally ill adults have been found to experience both substantial psychological distress and reduced marital quality because of problems associated with their children's bizarre and threatening behaviors. Violence and abuse by adult children has been found to be particularly distressing to elderly parents.

Morale may also suffer if adult children's problems require parents to continue to provide them with care and support. Such continued assistance is associated with increased psychological distress among the elderly. Thus, to the extent that problems experienced by children lead to their increased dependency, the quality of the relationship tends to decline, and decrements in psychological well-being can result.

Effects of parents' normative transitions. Both retirement and widowhood have been identified as normative transitions that have potential for affecting relationships between parents and adult children. Some scholars have suggested that parental retirement might represent a major crisis for adult children because it could signify that parents could lose their productive roles and eventually die. Further, it has been argued that children might fear that the resulting decrease in parental income would require them to assume financial responsibility for their parents while they are still supporting their own children. However, recent studies that have been conducted on this issue have found either no effects of retirement on intergenerational relations, or greater contact and closeness between the generations.

In contrast to retirement, the widowhood of a parent involves a direct change in the lives of

adult children. Widowhood has been found to be one of the most stressful of all life events, and marks a drastic change in the life of the surviving spouse. Adult children have been found to be a particularly important source of emotional support and instrumental assistance to the surviving parent during this time. Further, there appears to be a general pattern of stability and continuity in parent-child relationships following widowhood.

Effects of parents' nonnormative transitions. Divorce is among the most common nonnormative transitions in the lives of parents of adult children. The preponderance of work on this topic has shown that the detrimental effects of parental divorce on intergenerational relations continue throughout the life course. For example, it has been found that both divorced and remarried parents provide less emotional support to their adult children, have less frequent contact, and report lower levels of parent-child solidarity than do parents who have not divorced. The effects of divorce on closeness vary by gender of the parent. Divorce appears to be more detrimental to fathers' than mothers' relationships with their adult children. In fact, many mothers and daughters continue to have very close relationships following the mother's divorce.

Family caregiving to elderly parents: patterns and consequences

As the elderly population grows, so will the number of family members involved in their care. It is estimated that in 2001, approximately 2.2 million people provided unpaid help to elderly disabled relatives, and that these individuals provide 80 percent of the care received by the frail elderly. Of these individuals, more than one-third were adult children. Daughters continue to be substantially more likely than sons to be primary caregivers to their parents, although sons' participation in caregiving has increased. In part, daughters' greater caregiving to elderly parents can be explained by the general trend toward a traditional division of family tasks in the United States. However, another contributing factor is that older parents are more likely to be cared for by adult children of the same gender, and gender differences in life expectancy result in a larger number of women than men who receive care.

Reviews of the caregiving literature have shown that caregivers experience increased depression and demoralization, as well as increased psychiatric illness. Although the evidence is less clear, caregivers also appear to be more vulnerable to physical illness. Further, studies of caregiving suggest that these physical and psychological costs of caregiving are greater for women than men, and women who become caregivers are more likely than men to experience a loss of income and retirement benefits as a consequence of their caregiving.

Studies of the effects of caregiving on the quality of the parent-child relationship do not provide an entirely consistent picture. Some studies indicate that declines in parents' health often result in decreased closeness and attachment between them and their adult children; however, other research suggests that caregiving is more likely to have positive than negative consequences on relationship quality.

There are theoretical bases for suggesting that the motivation of adult-child caregivers determines whether caregiving has positive or negative effects on the parent-child relationship. In particular, it has been suggested that adult children who are motivated by attachment, rather than by exchange or obligation, would experience better relationships. Findings of research on the connection between caregiver motivation and the quality of parent-child relations support this argument by revealing that the parent–adult child caregiving relationship is better when daughters are motivated by feelings of affection and closeness.

Effects of childlessess on the elderly

Considering the closeness and mutually supportive relationships that many adult children and elderly parents enjoy, it is reasonable to expect that elderly individuals who are parents would be happier than those who do not have children. However, the research on this issue has consistently demonstrated that individuals who are childless are as happy and well-adjusted as are parents, even in the later years. Further, people who are sixty-five or older and do not have children are more likely to report advantages than disadvantages of childlessness. Individuals who have remained childless have been found to develop social networks that compensate for the absence of support from adult children. However, the emphasis on such compensatory mechanisms vary by gender. For example, childless women are more likely than their male counter-

parts to develop close friendship networks and become involved with community and religious organizations. Not surprisingly, older individuals who are the most likely to be disadvantaged by their childlessness are widowed men who had been dependent primarily on their wives for instrumental and emotional support.

The one area in which there are substantial differences between the experiences of parents and the childless in the later years is living arrangements. Elderly people who are childless are about 50 percent more likely to live in some form of residential care at some point than are parents. One might expect that this would mean that childless men would be the most likely to live in residential care at some point in their later years; however, the fact that women are more likely to be childless, combined with their longer life expectancy, means that childless women are more likely than childless men to live in residential-care facilities at some point.

J. JILL SUITOR
KARL PILLEMER

See also CAREGIVING, INFORMAL; FILIAL OBLIGATIONS; INTERGENERATIONAL EXCHANGES; KIN; PARENTAL OBLIGATIONS.

BIBLIOGRAPHY

ARDITTI, J. A. "Rethinking Relationships Between Divorced Mothers and Their Children: Capitalizing on Family Strengths." *FAMILY RELATIONS* 48 (1999): 109.

AQUILINO, W. S., and SUPPLE, K. "Parent-Child Relations and Parents' Satisfaction with Living Arrangements When Adult Children Live at Home." *Journal of Marriage and the Family* 53 (1991): 13–27.

BRODY, E. M. *Women in the Middle: Their Parent-Care Years*. New York: Springer, 1990.

BULCROFT, K. A., and BULCROFT, R. A. "The Timing of Divorce: Effects on Parent-Child Relationships in Later Life." *Research on Aging* 13 (1991): 226–243.

CHAKRABARTI, S.; KULHARA, P.; and VERMA, S. K. "The Pattern of Burden in Families of Neurotic Patients." *Social Psychiatry and Psychiatric Epidemiology* 28 (1993): 172–177.

CONNIDIS, I. A., and MCMULLIN, J. A. "Permanent Childlessness: Perceived Advantages and Disadvantages Among Older Persons." *Canadian Journal on Aging* 18 (1999): 447–465.

DEWIT, D. J., and FRANKEL, B. G. "Geographic Distance and Intergenerational Contact: A Critical Assessment and Review of the Literature." *Journal of Aging Studies* 2 (1988): 25–43.

FREDRIKSEN, K. I. "Gender Differences in Employment and the Informal Care of Adults." *Journal of Women & Aging* 8 (1996): 35–53.

FULIGNI, A. J.; TSENG, V.; and LAM, M. "Attitudes Toward Family Obligations among American Adolescents with Asian, Latin American, and European Backgrounds." *Child Development* 70 (1999): 1030–1044.

GOTTLEIB, B. H., and PANCER, S. M. "Social Networks and the Transition to Parenthood." In *The Transition to Parenthood: Current Theory and Research*. Edited by G. Y. Michaels and W. A. Goldberg. Cambridge, U.K.: Cambridge University Press, 1988.

HAGESTAD, G. "Dimensions of Time and the Family." *American Behavioral Scientist* 29 (1987): 679–694.

JOHNSON, C. L. "Postdivorce Reorganization of Relationships Between Divorcing Children and Their Parents." *Journal of Marriage and the Family* 50 (1988): 221–231.

KAMO, Y. "Racial and Ethnic Differences in Extended Family Households." *Sociological Perspectives* 43 (2000): 211–229.

KAUFMAN, G., and UHLENBERG, P. "Effects of Life-Course Transitions on the Quality of Relationships Between Adult Children and Their Parents." *Journal of Marriage and the Family* 60 (1998): 924–938.

KIM, H. K., and MCKENRY, P. C. "Social Networks and Support: A Comparison of African Americans, Asian Americans, Caucasians, and Hispanics." *Journal of Comparative Family Studies* 29 (1998): 313.

KIVETT, V. R. "Centrality of the Grandfather Role Among Older Rural Black and White Men." *Journals of Gerontology* 46 (1991): S250–258.

KULIS, S. S. "Social Class and the Locus of Reciprocity in Relationships with Adult Children." *Journal of Family Issues* 13 (1992): 482–504.

LOGAN, J. R., and SPITZE, G. "Family Ties: Enduring Relations Between Parents and Their Grown Children." *Journal of Marriage and the Family* 44 (1996): 217–224.

LUBBEN, J. E., and BECCERRA, R. M. "Social Support Among Black, Mexican, and Chinese Elderly." In *Ethnic Dimensions of Aging*. Edited by D. E. Gelfand and C. M. Barresi. New York: Springer, 1987.

MORBARAK, M. E.; SCHARLACH, A. E.; and L. SOKOLOV, BIRBA J. "Employment, Social Networks, and Health in the Retirement Years." *International Journal of Aging and Human Development* 35 (1992): 145–159.

MYLES, J. *Old Age in the Welfare State*. Lawrence: University Press of Kansas, 1989.
NEWMAN, K. S. *Falling from Grace: The Experience of Downward Mobility in the American Middle Class*. New York: Free Press, 1988.
PHINNEY, J. S.; ONG, A.; and MADDEN, T. "Cultural Values and Intergenerational Value Discrepancies in Immigrant and Non-Immigrant Families." *Child Development* 71 (2000): 528–539.
PILLEMER, K., and SUITOR, J. J. "Elder Abuse." In *Handbook of Family Violence*. Edited by V. Van Hasselt, H. Bellack, R. Morrison, and M. Hersen. New York: Plenum, 1988.
PILLEMER, K., and SUITOR, J. J. "Will I Ever Escape My Child's Problems? Effects of Adult Children's Problems on Elderly Parents." *Journal of Marriage and the Family* 53 (1991): 585–594.
PITCHER, B. L., and LARSON, D. C. "Elderly Widowhood." In *Aging and the Family*. Edited by S. J. Bahr and E. T. Peterson. Lexington, Mass.: Lexington Books, 1989.
ROBERTS, R. E. L.; RICHARDS, L. N.; and BENGTSON, V. L. "Intergenerational Solidarity in Families: Untangling the Ties That Bind." *Marriage and Family Review* 16 (1991): 11–46.
ROBINSON, K. M. "Family Caregiving: Who Provides Care, and At What Costs?" *Nursing Economics* 15 (1997): 243–247.
ROSSI, A. S., and ROSSI, P. H. *Of Human Bonding: Parent Child Relations Across the Life Course*. New York: Aldine de Gruyter, 1990.
SELTZER, M.; MAILICK, L.; and WAILING, L. "The Dynamics of Caregiving: Transitions During a Three-Year Prospective Study." *The Gerontologist* 40 (2000): 165–178.
SHMOTKIN, D. "Affective Bonds of Adult Children With Living Versus Deceased Parents." *Psychology and Aging* 14 (1999): 473–82.
SILVERSTEIN, M.; PARROTT, T. M.; and BENGTSON, V. L. "Factors that Predispose Middle-Aged Sons and Daughters to Provide Social Support to Older Parents." *Journal of Marriage and the Family* 57 (1995): 465–475.
SPITZE, G., and LOGAN, J. R. "Employment and Filial Relations: Is There a Conflict?" *Social Forum* 6 (1991): 681–697.
SPITZE, G.; LOGAN, J. R.; DEANE, G.; and ZERGER, S. "Adult Children's Divorce and Intergenerational Relationships." *Journal of Marriage and the Family* 56 (1994): 279–293.
STONE, R.; CAFFERATA, G. L.; and SANGL, J. "Caregivers of the Frail Elderly: A National Profile." *The Gerontologist* 27 (1987): 616–626.
SUITOR, J. J., and PILLEMER, K. "Did Mom Really Love You Best? Exploring the Role of Within-Family Differences in Developmental Histories on Parental Favoritism." *Motivation and Emotion* (2000): 104–115.
SUITOR, J. J., and PILLEMER, K. "The Presence of Adult Children: A Source of Stress for Elderly Couples' Marriages?" *Journal of Marriage and the Family* 49 (1987): 717–725.
SUITOR, J. J.; PILLEMER, K.; KEETON, S.; and ROBISON, J. "Aged Parents and Aging Children: Determinants of Relationship Quality." In *Handbook of Aging and the Family*. Edited by Victoria Bedford and Rosemary Bliezner. Westport, Conn.: Greenwood Press, 1985.
UMBERSON, D. "Relationships Between Adult Children and Their Parents: Psychological Consequences for Both Generations." *Journal of Marriage and the Family* 54 (1992): 664–674.
WALKER, A. J.; MARTIN, S. S. K.; and JONES, L. L. "The Benefits and Costs of Caregiving and Care Receiving for Daughters and Mothers." *Journal of Gerontology* 47 (1992): S130–139.
WENGER, G. C.; SCOTT, A.; and PATTERSON, N. "How Important is Parenthood? Childlessness and Support in Old Age in England." *Ageing and Society* 20 (2000): 161–82.
WHITE, L. "The Effect of Parental Divorce and Remarriage on Parental Support for Adult Children." *Journal of Family Issues* 13 (1992): 234–250.

PARKINSONISM

Parkinsonism is a term that describes a group of disorders in which patients present with varying combinations of tremor, muscle rigidity, slowed movements (bradykinesia), and postural disturbances, including falls. In addition to these signs (not all of which need to be present), patients with parkinsonism also exhibit other neurological symptoms. Parkinsonism needs to be distinguished from idiopathic Parkinson's disease, in which the cardinal diagnostic features of tremor, rigidity, bradykinesia, and postural disturbance are present. To make a diagnosis of Parkinson's disease, each of these symptoms must be present and responsive to levodopa, a medication that is converted to dopamine, which is a natural substance depleted in Parkinson's disease. In addition, from a neuropathological point of view, patients with idiopathic Parkinson's disease have dopaminergic cell degeneration in substantia nigra, an area found in the deep part of the brain, and these cells contain characteristic debris within the nuclei of the cells, called *Lewy bodies*. Patients with parkinsonism, in

Marie Kenny, ninety, of Falls Church, Virginia, who has Parkinson's disease, carries the Olympic torch through her hometown on December 21, 2001. Kenny was nominated to carry the torch for the 2002 Winter Games by her daughter, who wanted to honor her mother for raising a family as a single mother in the 1960s. (AP photo by Linda Spillers.)

general, do not have these neuropathological findings in the substantia nigra to the same extent and, clinically, they are poorly responsive to levodopa.

Clinical syndromes

There are a wide variety of clinical syndromes that exhibit symptoms of parkinsonism, including various neurodegenerative disorders such as multiple system atrophy (MSA), dementia with Lewy bodies (DLB), corticobasal ganglionic degeneration (CBGD), and progressive supranuclear Palsy (PSP). Vascular changes can also cause parkinsonism. The other group of disorders that demonstrate parkinsonism include drug-induced parkinsonism, resulting from dopamine-receptor blockade (i.e. neuroleptics, such as thioridazine or haloperidol). Certain toxins, such as manganese and MPTP (an impurity found in certain recreational drugs) also cause parkinsonism. Metabolic disorders, such as Wilson's disease, in which copper accumulates in the brain and elsewhere, also causes parkinsonism.

Clinical features of parkinsonism

Tremor. The characteristic tremor of Parkinson's disease is a 3 to 6 hertz (hz) rest tremor with pill-rolling quality, that is, the tremor is more pronounced when the person is at rest and, when looking at the hands, the thumb and index finger move in a circular motion. This too can be seen in patients with other parkinsonian syndromes. For example, up to 80 percent of patients with multiple system atrophy, have tremor. In DLB, tremor occurs in 25 to 76 percent of patients.

Rigidity. Muscle rigidity occurs in 89 to 99 percent of patients with Parkinson's disease, and it is also seen in patients with other parkinsonian syndromes. Patients with rigidity have the sensation of stiffness. Clinicians who examine them find that the muscles feel rigid when they are put through passive movement.

Bradykinesia. Bradykinesia is defined as slowness of movement and an inability to maintain a motor act. It is present in 77 to 98 percent of patients with Parkinson's disease, and can also occur in all other parkonsonian syndromes.

Postural instability. While postural instability is one of the cardinal features of Parkinson's disease, it occurs in many other parkinsonian syndromes. In the aging population, because of multiple sensory deficits, including musculoskeletal problems, postural instability results in a sense of poor balance and tendency to fall.

Asymetric onset. Asymmetric onset: that is, onset of symptoms such as tremor or rigidity, on one side, is found in most patients with Parkinson's disease, and in many other parkinsonian syndromes. For example, up to 42 percent of patients with asymmetric onset of parkinsonism had a diagnosis other than Parkinson's disease.

Speech disturbance. Many patients with Parkinson's disease have low volume of speech (hypophonia). They may also have stuttering or involuntary repetition of phrase with increased rapidity (palilalia). These speech disturbances are also seen in other disorders, such as PSP, in which a pronounced change in voice may be an early feature.

Dementia. While dementia has been estimated to occur in between 25 to 40 percent of pa-

tients with Parkinson's disease, the cognitive deficits are not as prominent as in other parkinsonian syndromes. So-called dementia subcortical syndrome (with mental slowing and decreased mood) can occur in other parkinsonian syndromes, such as PSP and MSA. Mood and psychotic disorders do occur in some patients with Parkinson's disease, but can be more common in other parkinsonian syndromes.

Autonomic dysfunction. Autonomic dysfunction, such as blood pressure falling when the patient stands, occurs in some patients with Parkinson's disease and is exacerbated by medications. This, however, is not a prominent feature of Parkinsons' disease, but it can be a significant feature of other parkinsonian syndromes. For example, orthostatic hypotension is one of the hallmarks of MSA.

Eye movements. While patients with Parkinson's disease exhibit mild abnormalities in their eye movements, such abnormalities are a subtle feature and are often not readily evident in clinical examination. They can be a significant feature, however, in other parkinsonian syndromes, such as PSP, in which there is marked difficulty in looking down.

Neuroanatomical considerations

Patients with parkinsonism have pathologic involvement of the basal ganglia, which are structures found deep in the brain. The basal ganglia have specific connections with other structures, in particular the thalamus and the cerebral cortex. Several basal ganglia thalamocortical circuits have been described, but it is the motor circuit that is predominantly involved in patients with parkinsonism. In general, there are two parallel motor circuits; one called the *direct circuit* and the other called the *indirect circuit*. These circuits serve to turn off various basal ganglia structures, so that, acting with other parts of the brain, human movements (especially of the hands) can be finely controlled. Both of these circuits include cells in the cerebral cortex that have connections with the basal ganglia, the latter structures being the ones not functioning properly in parkinsonism. In the direct pathway, cells expressing GABA (gamma aminobutyric acid) and substance P-chemicals used by these cells to communicate with other cells, project to (globus pallidus interna and substantia nigra pars reticulata) certain parts of the basal ganglia where they have an inhibitory effect on the cell structures. Various feedback mechanisms are required, so that, from these structures there are GABAergic inhibitory projections to the thalamus, which, in turn, has an excitatory projection back to the cortex. In the indirect pathway, there is excitatory projection from the cerebral cortex to another part of the basal ganglia, the striatum. Then, from the striatum there is GABAergic/enkephalinergic inhibitory projection to the globus pallidus pars externa, which, in turn, a GABAergic inhibitory projection to the subthalamic nucleus. Other feedback loops exist; for example, from the subthalamic nucleus there is excitatory projection to the globus pallidus pars interna and substantia nigra pars reticulatta. Once again, from these structures there is an inhibitory GABAergic projection to the thalamus and the circuit is completed by an excitatory projection from the thalamus back to the cortex. Perhaps the best known of the basal ganglia loops in parkinsonism involves the substantia nigra pars compacta, which uses the neurotransmitter dopamine. This is the neurotransmitter that is reduced in Parkinson's disease—and replaced to provide benefits to patients with the disorder. Again, there is a balance of pathways: the direct pathway has an excitatory influence on the cortex which results in increased movement; while the indirect pathway has an inhibitory influence on the cortex that reduces movement. In parkinsonism there is a general reduction of excitatory input to the cortex, resulting in reduced movement. For example, involvement of substantia nigra pars compacta (as in Parkinson's disease) leads to reduction in dopamine going to the striatum. In parkinsonism, reduction in cells in the substantia nigra pars compacta leads to a reduction in input to the motor cortex, which leads to reduction in movement. Blockage of dopaminergic receptors in the striatum by neuroleptic drugs, such as thioridazine and haloperidol, has a similar effect, leading to drug-induced parkinsonism.

Treatment

Most patients with Parkinson's disease respond to levodopa, which is, in fact, essential in diagnosis. By contrast, the response to levodopa is not as reliable as a diagnostic tool in other parkinsonian syndromes. For example, only a minority of patients with PSP respond to levodopa temporarily. While most patients with multiple system atrophy have an initial response to levodopa, this response is usually not sustained.

Up to 87 percent of patients with DLB respond to levodopa temporarily.

Prognosis

Parkinsonism, either alone, (as in Parkinson's disease) or in association with other neurological illnesses, appears to reduce life expectancy in older adults. How this occurs is not clear, nor is it clear what role treatment plays. These and other issues suggest that further research is needed to come to grips with the challenge of parkinsonism in an aging society.

SULTAN DARVESH

See also BALANCE AND MOBILITY; BRAIN; DEMENTIA; DEMENTIA WITH LEWY BODIES; FRAILTY; MULTIPLE SYSTEMS ATROPHY; SPEECH; TREMOR.

BIBLIOGRAPHY

COLCHER A., and SIMUNI, T. "Other Parkinson Syndromes." In *Neurologic Clinics: Movement Disorders,* vol. 19. Edited by H. I. Hurtig and M. B. Stern. Philadelphia: W. B. Saunders, 2001. Pages 629–649.

CUMMINGS, J. L. "Intellectual Impairment in Parkinson's Disease: Clinical, Pathologic, and Biochemical Correlates." *Journal of Geriatric Psychiatry and Neurology* 1 (1988): 24–36.

HUGHES, A. J.; DANIEL, S. E.; and LEES, A. J. "The Clinical Features of Parkinson's Disease in 100 Historically Proven Cases." *Advanced Neurology* 60 (1993): 595–599.

LOUIS, E. D., and FAHN, S. "Pathologically Diagnosed Diffuse Lewy Body Disease and Parkinson's Disease: Do the Parkinsonian Features Differ?" *Advanced Neurology* 69 (1996): 311–314.

MARK, M. H. "Lumping and Splitting the Parkinson Plus Syndromes: Dementia with Lewy Bodies, Multiple System Atrophy, Progressive Supranuclear Palsy, and Cortical-Basal Ganglionic Degeneration." *Neurologic Clinics: Movement Disorders,* vol. 19. Edited by H. I. Hurtig and M. B. Storm. Philadelphia: W. B. Saunders, 2001. Pages 607–627.

MITCHELL, S., and ROCKWOOD, K. "The Association between Parkinsonism, Alzheimer's Disease, and Mortality: A Comprehensive Approach." *Journal of the American Geriatric Society* 48 (2000): 422–425.

MORTIMER, J. A.; CHRISTENSEN, K. J.; and WEBSTER, D. D. "Parkinsonian Dementia." In *Handbook of Clinical Neurology,* vol. 46. Edited by P. J. Vinken, G. W. Bruyn, and H. L. Klawans. Amsterdam: Elsevier; 1985. Pages 371–384.

RAJPUT, A. H. "Prevalence of Dementia in Parkinson's Disease." In *Parkinson's Disease: Neurobehavioral Aspects.* Edited by S. J. Huber and J. L. Cummings. New York: Oxford University Press, 1992. Pages 119–131.

WENNING, G. K.; BEN-SHLOMO, Y.; MAGALHAES, M.; DANIEL, S. E.; and QUINN, N. P. "Clinicopathological Study of 35 Cases of Multiple System Atrophy." *Journal of Neurology, Neurosurgery, and Psychiatry* 58 (1995): 160–166.

PENSIONS: FINANCING AND REGULATION

Except in a hypothetical individualistic and primitive society, where each person produces for his or her own consumption, everyone depends for survival, at least in part, on an allocation of goods and services produced by others. This allocation can be based on trade, perhaps facilitated by money, or made in accordance with a perceived obligation. For persons with reduced productivity resulting from advanced age or disability, the obligation might be based on family loyalty, institutionalized charity, or past meritorious service (e.g., in the case of a military veteran). For an individual entrepreneur, the allocation could come as rent for a farm or shop developed in the past.

Current cost funding

In the industrial age, income to elderly persons often derives from past employment and the payment structure is formalized as a pension plan. The obligation becomes financial and contractual. For self-employed persons retirement income often comes from an individualized financial plan rather than from a family's loyalty or public charity. The income transferred to elderly persons is often paid from financial assets built up over the working lifetime or, as is common in social insurance systems, as an allocation of current income without an intervening fund. For example, in 1861 the federal government established the first major nondisability pension program in the United States, providing for the retirement of military officers after forty years of service. This pension program involved direct payments from the military budget. The first re-

tirement programs of private employers also involved direct payments to retirees and the payments were considered a current business expense.

This type of pension funding or budgeting, in which the plan sponsor pays benefits each year from current general revenue and accounts for the payments as a current business expense, is called current-cost or pay-as-you-go funding. There are two basic objections to current-cost funding. The first is an accounting issue. One of the goals of accounting is to match the costs of production with the revenue generated by the goods and services produced. If costs and revenues are mismatched, the faulty information may result in bad business decisions. Current cost funding charges pension benefits against current revenues when in fact the services on which the pension is based may have been provided many years earlier. This could be a serious mismatching of costs and revenues. This objection to current-cost funding could be mitigated if the operating statement of the pension plan sponsor contained an expense item that is an estimate of the cost of future pensions associated with service in the current year. This is now required by financial accounting standards in the United States.

The second objection to current-cost funding of pension plans is the lack of security of employee pension expectations when benefit payments come directly from the plan sponsor. The payments depend on the continued economic viability of the sponsor. In a dynamic economy the survival and prosperity of a plan sponsor is not assured.

There are two methods for increasing the security of plan members. The first is some sort of insurance program to make the benefit payments if the sponsor cannot. The second is the creation of a pension fund, a pool of investments independent of the sponsor from which benefits will be paid and which will receive pension contributions. The separate pool of investments can also generate investment income that will lead to lower required contributions than those in a current-cost system with identical benefits. There is also a powerful macroeconomic reason for favoring a fund. The allocation of income to retirees comes from the body of goods and services created by the economy. If this body is bigger as a result of pension savings that result in investment in plant, tools, research, and education, the total system for maintaining the income of retirees may increase the economic well-being of all. In fact, in the United States savings made through pension plans have been the principal source of new capital since World War II.

Developing a plan

The development of a pension funding or budgeting plan starts with the economic and demographic characteristics of the group to be served. These characteristics can be observed, but the level of retirement benefits to be provided is an important decision that is influenced by the human resource management philosophy of the sponsor. The benefit level decision may also be influenced by the members, sometimes expressed through collective bargaining. The benefit level is often studied by using replacement ratios. The replacement ratio is (income rate after retirement/income rate before retirement).

After the qualitative decision on benefit level is made, the decision is quantified as a formula for benefits that may depend on age, service, and salary history. The cost and liabilities of a pension plan are derived by calculating actuarial present values (APV) of future possible payments. An APV is the product of an expected payment amount and the probability that the amount will be paid, and a discount factor that recognizes that, because of investment income, a dollar today is worth more than one due to be paid in the future. For example, suppose $1,000 will be paid in ten years to a person now age sixty-five if the person is then alive. The APV of this contingent payment at age sixty-five is:

$$\begin{aligned} \text{APV} &= \$1{,}000 \times \left[\begin{array}{l}\text{Probability}\\ \text{life age 65}\\ \text{survives to 75}\end{array}\right] \times \left[\begin{array}{l}\text{Discount}\\ \text{Factor}\end{array}\right] \\ &= \$1{,}000 \times \left[0.88043\right] \times \left[(1.08)^{-10}\right] \\ &= \$407.81. \end{aligned}$$

The probability of survival from age sixty-five to seventy-five in this example was taken from the 1983 Group Annuity Mortality Table (Females) and an investment return rate of 8 percent per year was assumed. In valuing the liabilities of a pension plan—the actuarial present value of future promises—many calculations of this type are required.

The next decision in constructing a pension plan is to select one of two broad classes of plans, defined benefit (DB) and defined contribution (DC). In the 1990s hybrid plans with some of the

characteristics of both types of plans were introduced.

DB plans specify the benefit formula and it becomes the foundation of the funding plan. The sponsor may have a great deal of freedom in funding the plan. DB plans reduce the risk, the possibility of unfortunate events, for plan participants and allow sponsors some flexibility in making contributions to the pension fund. It is also fairly easy to include benefits for members near retirement age and the higher liability for these older members as part of the general liability of the plan. The members, however, will not have the satisfaction of watching an individual account balance grow, and the fixed nature of benefits causes the sponsor to manage the consequences of adverse experience as well as to benefit from favorable experience.

In a DC plan a set of defined contributions for each participant is determined with the objective of achieving the replacement ratio goal set in the initial planning. Each member can have the satisfaction of watching an individual asset account grow. The management of early withdrawals from the plan is easy because of the individual nature of the funding. From the sponsor's viewpoint, DC plans may reduce the flexibility in making annual contributions, but required risk management is far less because the pension obligation is met once the budgeted annual contribution is made.

During the period of rapid growth of private pension plans in the United States following World War II, DB plans were more common. Since the 1980s, DC plans have increased in importance. The early preference for DB plans can be attributed to pressure from organized labor to include workers near retirement age and to have the risk of deviations from expected experience managed by the sponsor. In addition, plan sponsors valued the ability to make actual contributions within a wide range. The shift to DC plans can be attributed to the satisfaction of members in observing an individual account grow, especially in periods of high investment returns, and the ease of managing the transfer from one pension plan to another in a period of high labor mobility. To sponsors DC plans seem to minimize their risk. Within a few years in the late 1970s and early 1980s, real rates of investment return (investment return rate − price inflation rate) went from negative to historic highs. This roller-coaster experience brought home to sponsors the financial risks of DB plans. The mounting costs of compliance with tax regulations and accounting standards also discouraged sponsors from adopting DB plans.

Regulation

The next steps in designing the financing of a pension plan are heavily influenced by government policy. The security of plan participants is enhanced if the pension fund is large. A plan with assets in excess of estimated liabilities can absorb market variations in the value of assets or the higher costs of possible low mortality without requiring additional contributions by the sponsor. On the other hand, pension funds are increased by the inflow of contributions and, in general, such contributions are recognized as a business expense of the sponsor in the determination of income tax. Thus a government must compromise between encouraging large pension fund contributions, which will increase the security of pension expectations but shrink the base of the income tax, and bounding such contributions to save the tax base. A lower bound on annual pension plan contributions would enhance the security of pension expectations but reduce the flexibility of sponsors in meeting pension obligations.

In the United States the regulation of pension plans before 1974 was in the hands of the Internal Revenue Service. The concern was to place a reasonable upper bound on pension contributions deductible for income tax purposes. The upper bound was stated as (normal cost) + (.10 × Initial accrued liability), where normal cost is an estimate of the cost of the plan attributable to the current year under the funding plan adopted, and initial accrued liability is the amount of liability under the funding plan adopted at the time the plan started. The objective was to prohibit a reduction in the income tax by rapid reduction in the accrued liability recognized when the plan started.

In 1974 the comprehensive Employee Retirement Income Security Act (ERISA) was passed, and upper and lower bounds on pension contributions were enacted. The upper bound was somewhat different from the pre-1974 rule mentioned above, but it incorporated the same basic ideas. What was new, with an acknowledgment that adequate funding was in the public interest, was a minimum funding requirement. The minimum contribution requirement was

stated in terms of normal cost plus an amount of the initial accrued liability, depending on the type of plan, and an adjustment for deviations in actual experience from that assumed in earlier estimates of liabilities.

A related set of public policy issues arises about the management of the pension fund. One option is the use of book reserves, pension liability estimates that are included in the balance sheet of the sponsoring organization rather than on the balance sheet of a separate pension plan entity. Under this plan the estimated annual cost of the plan is an expense of the sponsoring organization and the contributions increase the size of the internally held book reserve. This plan is attractive in the absence of an active capital market and can be used to finance the expansion of a sponsoring organization. The disadvantages are that this nondiversified investment reduces the security of the income of beneficiaries. In addition, less of a nation's savings pass through open capital markets, where market forces will tend to allocate them to projects with the highest rate of return. With the absence of the discipline of open markets, macroeconomic growth could be compromised.

In the United States, ERISA held out income tax advantages only to those pension plans with external pension funds. Pension plans are prohibited from acquiring or holding more than 10 percent of plan assets in the securities or real property of the sponsor. Other nations have made more extensive use of book reserves. For example, Germany permits the use of book reserves to finance DB pension plans. Book reserves facilitated the internal financing of the rebuilding of the German industrial plant following World War II, when the German financial markets were chaotic. The sponsor's risk of insolvency in many nations permitting book reserves is managed by compelling participation in an insolvency insurance plan.

Financial accounting rules in the United States force sponsors providing post-retirement health benefits to account for their value using book reserves. These accounting rules are applicable to publicly held companies and are set by the Financial Accounting Standards Board (FASB). FASB is an independent, nongovernmental agency. In 1990 it issued *Standard of Financial Accounting 106* which required employers sponsoring post-retirement health plans to report on their financial statements estimates of the liability of these plans. Post-retirement health benefits have not been the subject of detailed federal regulation.

Although ERISA discouraged the use of book reserves for pension plans, it also created the Pension Benefit Guarantee Corporation to ensure at least the partial payment of pension benefits under DB plans when the sponsor was unable to meet the funding requirements. The insurance system is funded by a premium related to unfunded accrued liability that is paid by all DB plans.

Individual and social plans

This discussion has often used the term "sponsor." The pension plans discussed have involved an arrangement between a sponsor, usually an employer, and members, usually employees, to provide retirement income. There are two large, very different, classes of retirement programs that do not fit into this framework.

Standard advice is to save for old age and the inevitable rainy day. The advice remains good, but it has also become embedded in tax policy. To encourage self-employed individuals and workers whose employers do not provide a formal pension plan to save for retirement, Congress has created several sections of the Internal Revenue Code, for different types of workers, that provide for the creation of special savings accounts for retirement purposes. These accounts are special in that income diverted to the account and the investment earnings of the account are not subject to income taxation until withdrawn. These tax-sheltered retirement savings vehicles have become popular. The question of whether they have generated new savings or diverted existing savings to tax shelters remains open.

Examples of these retirement programs will illustrate their history and variety. Individual retirement plans were authorized by ERISA in 1974. Originally these plans were limited to individuals not already participating in an employer sponsored tax qualified plan or other tax favored arrangement. Later the eligibility was broadened. These individual retirement plans are funded through Individual Retirement Accounts (IRAs). Tax Sheltered Annuities have an even longer history and can be sponsored by tax-exempt entities organized for religious, educational, or research activities. Keogh plans were authorized in 1962 and are designed for self-

employed individuals. Section 401(k) plans are named for the section of the Internal Revenue Code that regulates them. They are designed for employees and are typically funded through salary reductions and matching contributions by employers.

Roth retirement accounts, named for their sponsor in Congress, are a recent addition to this list of individual retirement programs. Roth accounts are fundamentally different in that contributions are subject to income taxation but withdrawals are not.

The high rate of poverty among the elderly during the Great Depression was among the forces that moved the Congress to create an almost universal Social Security program in 1935. Social Security includes several types of benefits, but the old-age income part is a DB plan with replacement ratios that decline as career average indexed wages increase. Social Security has been funded primarily by a payroll tax on a modified current-cost basis. The modification has been the existence of a trust fund that stabilizes results across economic cycles.

In the early 1990s there were approximately three taxpaying workers for each beneficiary. By 2020 it is likely that there will be approximately two taxpaying workers for each person receiving benefits. The resulting financial crunch for a current-cost system is forcing political consideration of increasing the normal retirement age, shifting the system partially to a DC program, and actions to increase productivity by the time the crunch occurs.

JAMES C. HICKMAN

See also EMPLOYEE RETIREMENT INCOME SECURITY ACT; INDIVIDUAL RETIREMENT ACCOUNTS; TAXATION.

BIBLIOGRAPHY

COSTA, DORA L. *The Evolution of Retirement: An American Economic History 1880–1990*. Chicago: University of Chicago Press, 1998.

GRUBBS, DONALD S. "The Public Responsibility of Actuaries in American Pensions." *North American Actuarial Journal* 3 (1999): 34–41.

MCGILL, DAN M.; BROWN, KYLE N.; HALEY, JOHN J.; and SCHIEBER, SYLVESTER J. *Fundamentals of Private Pension,* 7th ed. Philadelphia: University of Pennsylvania Press, 1996.

TROWBRIDGE, CHARLES L. "ABC's of Pension Funding." *Harvard Business Review* 44, no. 2 (1966): 115–126.

PENSIONS, HISTORY

This section discusses the historical development of employer-provided private pensions, both internationally and in the United States. It also considers the historical development of the normal retirement age.

Pension history: international

Only about a dozen high-income countries have voluntary employer-provided private pension systems that pay benefits to a sizable percentage of their retirees. These countries include Canada, Germany, Ireland, Japan, the United Kingdom, and the United States. In these countries, however, usually only 50 percent or less of retirees are covered. Only in countries where most workers belong to a union, such as the Netherlands, is the coverage rate substantially higher.

In other high-income countries, such as Australia and Switzerland, private employer-provided pensions have been mandated, thus achieving coverage for most of the workforce. In France, industry-wide pensions are mandated, and, following the lead of Chile in 1981, a number of countries in the 1990s and early 2000s mandated individual-account pension plans. These countries include Argentina, Chile, Colombia, Peru, and Uruguay in Latin America, and Hungary and Poland in Eastern Europe. The World Bank became a proponent of this approach during the 1990s, and played a role in its spread.

In the poorer, developing countries of Africa and Asia, most workers are generally not covered by either a pension or a social security program. Without this coverage, agricultural workers in rural areas tend to work longer into old age, with family members taking over the more physically demanding tasks. When people are no longer able to work, their families are expected to provide for them.

In middle-income countries, such as Brazil and Indonesia, pensions are provided to workers in the high-income sector. In these countries, multinational companies have played a role in the international spread of employer-provided pensions. In Brazil, pensions are provided by state-owned enterprises and multinational companies.

In most countries, the early history of pension provision is similar. Pensions were first pro-

vided to retired military personnel. Later, large bureaucratic organizations, such as the railroads and banks, provided pensions to long-service employees. Government employees also generally were among the first groups to be covered.

At first, pensions were provided on an ad hoc basis as charity rather than as an earned right. Over time, pension benefits have become more formalized as defined benefit plans, with written documents specifying their features. They have also become an earned part of compensation—employees have a legal claim to them. Starting from different origins, defined contribution pensions developed out of employer-sponsored savings plans.

Social security programs around the world provide different types of income support. The term *social security* refers to government programs that provide retirement income benefits. Social security has been a factor in the development of pensions in most countries. In western Europe and Japan, private pensions predated social security. Japan and the United Kingdom chose to protect private pensions from being replaced by social security programs by allowing employers to contract out of social security, thus reducing social security contributions and benefits, if minimum standards are met by an employer-provided pension plan. In contrast, countries with generous social security benefits, such as Italy and Austria, have little need for additional pension benefits and, consequently, few pension plans have developed.

The development of the income tax system has also played an important role in the development of private pensions around the world. While pensions predated personal income taxes in many countries, their growth (of income taxes) has been aided by special tax preferences that all countries with well-developed pension systems offer. The importance of the role of income taxes was demonstrated during the 1990s, when the income tax preferences for private pensions were revoked in New Zealand, and private pension coverage subsequently declined. In Brazil and many other developing countries, relatively few workers pay income taxes because their income is below the threshold for liability. Thus, in those countries the incentives provided by the tax system do not affect most workers. The expansion of the personal income tax system to cover most workers in the United Kingdom during World War II was instrumental in making pension coverage widespread in that country.

The history of pensions has also been shaped by the history of the macroeconomy. The Great Depression of the 1930s was much less severe in the United Kingdom than in the United States, and the reduction in pension coverage during that period was consequently less in the United Kingdom. During the early part of the twentieth century, France and Germany experienced hyperinflation, which had a devastating effect on funded pensions. The experience of hyperinflation appears to have had a long-term effect on the pension systems of these countries, with both countries now relying primarily on unfunded pensions where benefits are paid for out of current income.

During the 1990s, voluntary defined contribution plans grew in importance in many countries, probably aided by the strength of financial markets during that decade. They are also growing in importance in the Anglo-Saxon countries of Australia, Canada, Ireland, and the United Kingdom, and they are increasing in importance in the European countries of Austria, Belgium, Germany, Greece, Netherlands, Spain, and Switzerland. The majority of new plans in Australia, Ireland, Switzerland, and the United Kingdom are now defined contribution plans.

Pension history: United States

The development of private pensions and Social Security in the United States parallels their development internationally. Pensions evolved through American history in ways resulting in closely intertwined private and public pension systems.

As in other parts of the world, pensions initially were provided to those in financial need or as gratuities. In colonial America, the Presbyterian and Moravian churches paid pensions to their ministers' widows and orphans, while the new U.S. government granted annuities to Revolutionary War veterans for their service to the country.

The view of pensions as gratuities had not changed when Congress passed legislation in 1862 to provide annuities to Union soldiers disabled in the Civil War. This program grew to include widows and orphans, and the definition of disability was liberalized over the years. During its peak years in the mid-1890s, the Civil War pension program functioned much like a social insurance program and consumed 43 percent of federal expenditures.

After the Civil War, pensions gradually transformed from ad hoc payments because of financial need to formal plans designed to retain valued employees and ease superannuated employees off the job. Modern pension plans first appeared in the railroad industry. American Express, then a railroad freight company, established the first formal U.S. plan in 1875. Pension plans spread to other railroad companies, then to other industries. The federal and state governments followed suit, and the federal government established a plan for its employees in 1920. By then over three hundred plans covered 15 percent of the U.S. work force.

During the 1920s, businesses realized they needed sounder financing of an increasingly expensive benefit they had funded on a pay-as-you go basis. Insurance companies managed much of the growing private system's assets, providing annuities to eligible workers using employer funds. After a period of growth that lasted through the 1940s, insurance company provision of group pension annuities to employers declined due to rising costs, the advent of Social Security, and the rise of union involvement in pensions.

Private pensions enjoyed tax-favored status early in their development. By the end of 1921, companies could deduct pension plan contributions and escape paying tax on the pension trust investment income. When it became apparent in the late 1930s that pensions primarily benefited higher-paid employees, Congress instituted requirements for plans to maintain tax-favored status. The Revenue Act of 1942 required plans to include a minimum percentage of employees and to provide benefits that did not disproportionately favor the highly paid. It also enacted the first funding requirements for pensions.

Social Security has also played a major role in the development of U.S. private pensions. The Great Depression brought with it the realization that a federal response was necessary to address the poverty suffered by 50 percent of the elderly population. In 1934, President Franklin D. Roosevelt formed the Committee on Economic Security, whose recommendations resulted in Social Security's passage in 1935. The new program provided retirement income to workers beginning at age sixty-five. Amendments to Social Security in 1939 added spouse and dependents' benefits. Later amendments increased benefits, then automatic cost-of-living adjustments were added to benefits in payment status in 1972.

The number of pension plans grew dramatically during World War II. High income taxes and war-time limits on wages (but not on future pension benefits) made pensions more attractive as a form of compensation. By 1945, pensions covered 6.5 million employees up from 2 million in 1938. Other developments include the rise of union pensions for blue-collar workers. A 1949 Supreme Court decision facilitated this trend (Inland Steel Company vs. National Labor Relations Board), stating that pensions were a mandatory subject of bargaining. By 1960, pension coverage of the private work force was 40 percent, and pension participation increased to 45 percent by 1970.

As the private pension system matured, gaps appeared. Lack of vesting requirements, chronic underfunding, and financial self-dealing resulted in a disproportionate number of pension participants retiring without benefits. After Congress enacted several modest measures to resolve some of these problems, it passed the comprehensive Employee Retirement Income Security Act (ERISA) in 1974. ERISA established minimum participation, as well as vesting requirements, fiduciary standards, break-in-service rules, survivor benefit requirements, and an insurance program for defined benefit pensions.

Legislative efforts to ensure that workers receive the pensions promised from their company plans have continued since 1974. Congress enacted legislation making it more likely that lower-paid workers will receive benefits from their pensions; expanding benefit rights of widowed and divorced spouses; shortening vesting periods; limiting the effect of taking Social Security into account when calculating the pension amount; and requiring that older workers be included in pensions and that their benefits continue to grow.

Normal retirement age: international

The normal "retirement age" is a twentieth century concept that is relevant in the developed parts of the world. It is the age, as established by a pension plan, at which retirement benefits can be received without a reduction being taken because of age. Because most workers around the world do not participate in either a social security program or private pensions, the concept does not apply to them.

For most workers for whom the concept is relevant, the concept is closely tied to the mini-

mum or normal retirement age in social security programs. In western Europe, however, the normal retirement age in private pensions tends to be lower than the earliest retirement age through social security, with most workers retiring before the minimum age at which social security retirement benefits can be received. In Belgium, France, Germany, and Luxembourg, only one in three or four older workers (and a considerably smaller number in the Netherlands) retire at or after the minimum age for social security benefits. Developed countries that had a minimum retirement age for social security benefits of sixty-five or older at the start of the twenty-first century, or had set such an age in social security law for a future date, include Australia, Germany, Iceland, Ireland, the Netherlands, New Zealand, Norway, Switzerland, and the United Kingdom.

Not surprisingly, the normal retirement age tends to be lower in countries where the life expectancy is lower. Thus, it tends to be lower in poor countries than in rich countries, with some exceptions. In Yemen, workers can retire with social security benefits at age forty-five with twenty years of experience. In Lebanon, both men and women can receive social security benefits at any age with twenty years of experience. As populations age and the old-age burden grows, one policy countries can adopt to alleviate social security financing problems is to raise the normal retirement age. This has been done in Germany, Italy, and Sweden.

The economic relevance of the normal retirement age is lessened in many social security systems and in many pension plans by these plans providing benefit increases when workers postpone retirement, and by the possibility of workers retiring at younger ages than the normal retirement age. If benefits are actuarially adjusted for postponements in retirement age, then whether a worker retires earlier or later than the normal retirement age would not change the lifetime cost to the social security system for workers whose life expectancy is the same as the actuarial life expectancy for the population.

Normal retirement age: United States

Americans did not retire during the eighteenth and nineteenth centuries; they merely reduced their responsibilities on the farm or with the family business as they aged. As the country became industrialized and pensions were established, the age at which a worker left the work force and began drawing retirement benefits became an issue.

Before Social Security was established, pensions had a variety of eligibility requirements, often containing an age sixty-five retirement age provision. The B&O Railroad plan, for example, provided for retirement at sixty-five after ten years of service, but workers could collect a disability pension at age sixty. Often, plans had maximum retirement ages of seventy, and this was the standard in the railroad industry. The U.S. Steel pension plan had one of the youngest retirement ages—workers had to be sixty to collect benefits.

The Committee on Economic Security, while considering what features should be in a U.S. social insurance system, looked at historical precedent for establishing the normal retirement age at sixty-five. The Committee looked to Germany's social insurance system; the precedent set by the Civil War pension board in 1890; the 1910 Massachusetts Commission on Old Age Pensions definition; the post office letter-carriers retirement eligibility; and railroad pension eligibility; all of which had age sixty-five standards for the payment of benefits.

Once the age sixty-five eligibility for normal retirement benefits in Social Security was set, many private pension plans also adopted it as the retirement standard. In 1961, when Social Security was amended to provide that men could collect early retirement with reduced benefits at age sixty-two, private plans were influenced by this change as well. Pensions often contain provisions that provide for early retirement benefits to begin at age sixty-two and many allow retirement at age fifty-five with a minimum number of years on the job.

The Age Discrimination in Employment Act of 1967 (ADEA) originally allowed employers to set a mandatory retirement age of seventy. A 1986 amendment to the ADEA now prohibits the establishment of a mandatory retirement age in retirement plans, with some exceptions.

Amendments to the Social Security Act in 1983 included a provision to increase the age for unreduced retirement benefits to sixty-seven. This increase will be gradual, begin-

ning with those who were born in 1938, reaching age sixty-seven for individuals born in 1960 or later.

AMY R. SHANNON
JOHN A. TURNER

See also ESTATE PLANNING; INDIVIDUAL RETIREMENT ACCOUNTS; RETIREMENT PLANNING; RETIREMENT; RISK MANAGEMENT AND INSURANCE.

BIBLIOGRAPHY

COSTA, D. L. *The Evolution of Retirement: An American Economic History, 1880–1990*. Chicago: The University of Chicago Press, 1998.

DAILEY, L., and TURNER, J. "U.S. Pensions in World Perspective, 1970–89." In *Trends in Pensions 1992*. Edited by J. Turner and D. Beller. Washington, D.C.: U.S. Government Printing Office, 1992. Pages 11–34.

GILLION, C.; TURNER, J.; BAILEY, C.; and LATULIPPE, D. *Social Security Pensions: Development and Reform*. Geneva, Switzerland: International Labour Office, 2000.

SASS, S. A. *The Promise of Private Pensions: The First Hundred Years*. Cambridge, Mass.: Harvard University Press, 1997.

World Bank. *Averting the Old Age Crisis*. Oxford, U.K.: Oxford University Press, 1994.

PENSIONS, PLAN TYPES AND POLICY APPROACHES

The U.S. retirement income system is analagous to a three-legged stool. The first leg is the public Social Security system, which covers virtually all workers and provides benefits based on lifetime earnings at sixty-five, and reduced benefits at sixty-two. The second leg consists of employer-provided supplementary pensions, which cover roughly half the workforce. These tax-subsidized plans are sponsored by private employers, by the federal government for its employees, and by state and local governments for their workers. The third leg consists of individual saving, which occurs in tax-subsidized Individual Retirement Accounts or directly in nonsubsidized forms. Those sixty-five and older currently receive roughly half of their non-earned income from Social Security, one quarter from employer-provided pensions, and one quarter from private saving. Social Security accounts for virtually all retirement income at the low-end of the income scale; employer-sponsored pensions are important for middle- and high-income individuals.

Private pension plans in the United States date from 1875, but the early plans were financially vulnerable and most were bankrupted in the 1930s by the Great Depression. Contemporary U.S. pension plans, both private and public, are rooted in the desire for financial security that became part of the national psychology after the onset of the Depression. Although World War II initially consumed much of the nation's resources that might have been directed toward improved provisions for old age, wartime wage controls greatly stimulated the expansion of private plans. Since legal limitations on cash wages impeded the ability of employers to attract and hold workers in the tight civilian labor markets, the War Labor Board attempted to relieve the pressure on management and labor by permitting employers to bid for workers by offering attractive fringe benefits. Pension benefits cost firms little in view of the wartime excess profits tax and the ability to deduct contributions. The growth of new pension plans fell off markedly in the postwar period as employees focused on cash wages to recover ground lost during the period of wage stabilization, but by 1949 pension benefits again became a major issue of labor negotiation.

Coverage under private pension plans

The main expansion of today's pension system, in both union plans and nonunionized industries, began in the 1950s. The Korean War further stimulated the pension movement as employers once again competed for workers in the face of wage and salary controls and excess profits taxes. The growth in pensions continued in the 1960s. But much of the growth during that decade was due to expansion of employment in firms that already had pension plans as opposed to establishment of new plans. The percentage of the private workforce covered by any type of employer-sponsored retirement plan continued to increase until the late 1970s, but since then coverage has stagnated. In both 1979 and 1999, only 50 percent of nonagricultural wage and salary workers in the private sector between the ages of twenty-five and sixty-four were covered by a pension plan of any sort, even though 1979 was the end of a decade of stagnation and 1999 was the height of the longest expansion in the postwar period.

Pension coverage in the United States varies sharply by size of firm. In companies with one

hundred or more employees, 70 to 80 percent of the full-time workforce is covered by a pension. The figure drops to 37 percent for firms with less than one hundred employees. Small employers frequently cite uncertainty about future earnings and the expense of employer contributions as important reasons for not providing pension coverage. Small employers also mention high employee turnover, the preference of their employees for cash wages, and administrative burden. The low levels of pension coverage in small firms is an important policy concern since almost 40 percent of full-time workers are employed in firms with fewer than one hundred workers. In an effort to make it easier for firms to establish and maintain plans for their employees, the federal government has passed several pieces of legislation over the years to ease financial and reporting requirements. Despite this legislation, the discrepancy in coverage between large and small firms remains.

A shift to defined contribution plans

Although the percentage of the workforce covered by a pension plan has remained virtually unchanged since the late 1970s, the nature of pension coverage has changed sharply from defined benefit plans to defined contribution plans. Defined benefit plans provide retirement benefits—in the form of a lifetime annuity—generally calculated as a percentage of final salary for each year of service. For example, a worker with a final salary of $40,000 might receive 1.5 percent a year for thirty years of service, producing an annual pension of $18,000. This form of pension made it easy for employers at the time that they established their plans in the 1950s to grant retroactive credits for older workers for whom they had made little or no contributions. In contrast to defined benefit plans, defined contribution plans are like savings accounts. The employer, and sometimes the employee, contributes a specified dollar amount or percentage of earnings into the account. These contributions are usually invested in stocks and bonds. When the worker retires, the balance in the account determines the retirement benefit.

Within the defined contribution world, the fastest growing type of plan is the 401(k). The defining characteristics of 401(k) plans are that participation in the plan is voluntary and that the employee as well as the employer can make pretax contributions to the plan. These characteristics shift a substantial portion of the burden of providing for retirement to the employee; the employee decides whether or not to participate, how much to contribute, and how to invest the assets. Despite the fact that employees bear much of the risk in 401(k) plans, these plans have grown enormously for a number of reasons. They are less costly to operate than defined benefit plans. They do not require employer contributions. They are fully funded by definition, eliminating the work associated with funding requirements and pension insurance. They are easily portable so employees can take benefits with them, eliminating the need for employers to keep track of pensions for departed employees.

Given their popularity and growth, one would have thought that the introduction of 401(k) plans should have boosted pension plan coverage in the United States. But, as noted above, overall pension coverage has remained virtually unchanged. This means that the enormous expansion of defined contribution plans, especially 401(k)-type plans, has produced a sharp decline in coverage under traditional defined benefit plans. Between 1978 and 1997, active participants in defined benefit plans declined from 65 percent to 32 percent of total participants. This shift is reflected in the financial statistics for the two types of plans. Between 1978 and 1997, assets in defined benefit plans declined from 72 percent to about 49 percent of total pension assets; benefits paid by defined benefit plans declined from 67 percent to 42 percent of total benefits; and contributions to defined benefit plans declined from 67 percent to 17 percent of total contributions.

In the late 1990s, some employers converted their pensions to hybrid plans that have both defined benefit and defined contribution characteristics. The most popular of the hybrids are the so-called cash balance plans. Cash balance plans are defined benefit plans that express each participant's accrued benefit as a balance that is available for distribution as a lump sum. Unlike a defined contribution plan, however, the accrued benefit accumulates at a specified and guaranteed rate of interest, and benefits tend to accrue as a constant percentage of compensation. The plans are attractive because they provide visible and portable benefits like a defined contribution plan, and secure accrual and government insurance like defined benefit plans.

Federal regulation

The federal government has played a major role in the development of employer-sponsored plans through both the provision of favorable tax treatment and direct regulation.

The Internal Revenue Code. The approach of federal pension policy as far back as the 1940s has been to provide tax incentives that will encourage highly paid employees to support the establishment of employer-provided pension plans that provide retirement benefits to the rank and file. The tax incentives arise because under the Internal Revenue Code employer contributions to a pension plan are deductible as a business expense when made, but the employee is not taxed until receipt of pension benefits. In addition, the pension fund is not taxed on its earnings. These two provisions, which permit tax deferral on both employer contributions and the earnings on those contributions, are equivalent to exempting from taxation the earnings on the money that would have been invested after tax, assuming the employee remains in the same tax bracket. This tax provision reduces personal income tax revenues by roughly 10 percent each year.

Because pensions are tax-favored, the tax code limits the amount that can be saved through employer-sponsored plans. In the case of defined benefit plans, the maximum benefit cannot exceed 100 percent of final pay averaged over three years or an indexed amount that is $140,000 for 2001. In the case of defined contribution plans, contributions are limited to the lesser of 25 percent of compensation or a fixed ceiling that rises with inflation (the ceiling is $35,000 in 2001). For the purpose of this calculation, compensation cannot exceed a specified limit, $170,000 in 2001. In addition, employee contributions to 401(k) plans cannot exceed an indexed amount of $10,500 in 2001, and as with defined contribution plans generally, total employee and employer contributions are limited to the lower of $35,000 in 2001 or 25 percent of the participant's compensation.

Because of the favorable tax treatment, the tax code also restricts access to funds contributed to defined contribution plans generally, and to 401(k) plans in particular. Before age fifty-nine and a half, the employee can generally withdraw money without penalty only upon disability or death; otherwise, the employee must pay a 10 percent penalty in addition to income taxes. After fifty-nine and a half, the employee may withdraw funds without penalty. Participants do have limited access to their 401(k) funds without penalty through borrowing provisions that allow individuals to borrow the lesser of 50 percent of their holdings or $50,000.

In addition to contribution and access limits, pension regulations include nondiscrimination provisions stipulating that benefits for highly-compensated employees be given favorable tax treatment only if a high proportion of rank-and-file employees are also covered by the plan. The technical and complex regulations allow considerable leeway, however. They only require that the classification for participation be reasonable and that the level of participation from the highly compensated group be not too much greater than the level of participation from the remainder of the workforce. Employers can exclude from participation those with less than one year of service and those under twenty-one. Employers can also exclude specific groups of workers provided that excluded workers do not exceed 30 percent of the non-highly compensated workforce. In addition, benefits may be forfeited for failure to complete five years of service. Thus, the nondiscrimination requirements do not fully achieve the goal of including all rank-and-file workers.

Employee Retirement Income Security Act (ERISA). The federal government has also sought to protect pension benefits through the direct regulation of these plans, most notably through the Employee Retirement Income Security Act of 1974 (ERISA). ERISA's principle objective was to secure the rights of plan participants so that a greater number of covered workers would receive their promised benefits. It was a response to failings and abuses in defined benefit pension plans, which covered the majority of workers at the time. Before the legislation, some employers imposed such stringent vesting and participation standards that many of their workers reached retirement age only to discover that because of some layoff or merger they were not eligible for a pension. Even workers who satisfied their plans' requirements had no assurance that accumulated pension assets would be adequate to finance benefits. And a few pension plans were administered in a dishonest, incompetent, or irresponsible way. Others engaged in forms of financial manipulation such as concentrating investments in the stock of the plan-sponsoring company, which, while not illegal, also jeopardized the welfare of plan participants. The net ef-

fect of these problems was that in the pre-ERISA era plan participants were at the mercy of plan sponsors. ERISA was designed to change the balance of power.

Most observers agree that ERISA has been successful in meeting its stated objective of strengthening workers' claims on benefits. Participation and vesting standards enable workers to establish a legal right to benefits. The implementation of funding and fiduciary standards and the establishment of the Pension Benefit Guaranty Corporation, a mandatory pension insurance program for defined benefit pension plans, ensure that money will be available to pay these benefits. As a result, more workers covered by private sector–defined benefit programs received benefits, and many got larger benefits than they would have in the absence of ERISA.

Although the legislation was successful, its focus was limited. Questions of portability, inflation protection, and coverage were discussed during the deliberations, but they were either not addressed at all or addressed in a very limited fashion in the final legislation. Other issues such as cashing out of lump-sum benefits received almost no attention.

Major issues facing the pension system

The major issues facing the pension system today can be divided into those that affect the benefits of workers covered by a pension plan and those that affect the ability of workers to gain access to pension coverage.

Retirement protection for covered workers. Retirement protection for employees covered by pension plans depends on the extent to which accrued pension benefits are preserved. The preservation of benefits requires that the termination benefits of mobile employees be adequate, that job changers not spend their lump-sum payments, and that the value of pension benefits not be eroded by inflation after retirement.

Erosion of termination benefits. For workers who remain with one employer throughout their work lives, defined benefit plans have the advantage of offering a predictable benefit, usually expressed as a percent of final pay for each year of service. A problem arises, however, in the case of mobile employees, and this would arise even if all firms had identical plans and immediate vesting; mobile employees receive significantly lower benefits as a result of changing jobs than they would have received from continuous coverage under a single plan. This difference arises because final earnings levels usually determine pension benefits in defined benefit plans. The worker who remains with a plan receives benefits related to earnings just before retirement, but the benefits for mobile employees are based on earnings at the time they terminate employment. A simple example indicates that, if wages increased 4 percent annually, the pension of a worker who held four jobs would equal 61 percent of the pension of a worker who remained continuously employed by one firm. The more wages rise with productivity and inflation, the relatively lower the benefits received by the mobile employee.

This problem cannot be solved simply by improving *portability*. Literally, portability means nothing more than the ability of an employee to transfer the present monetary value of vested pension credits to a succeeding plan or central clearinghouse upon termination of employment. The key issue is the amount of money transferred. Employers are willing to keep their benefits up-to-date with wages, by basing benefits on final salary, for people who remain covered by their plan until retirement, but they resist doing so for terminated employees. Increasing benefits for terminated employees will increase employer cost and mean either lower benefits for remaining employees or lower wages for all employees. On the other hand, the erosion in the value of benefits for mobile employees under defined benefit plans is one factor behind the shift to defined contribution plans.

Cashing out lump-sum distributions. One issue not covered in the ERISA debates was the threat to retirement income security created by cashing out money received in a lump sum when an employee terminates employment. The availability of lump-sum distributions in both defined benefit and defined contribution plans has increased substantially over time. Less than half (47.8 percent) of pension plan participants had the option of a lump-sum distribution in 1983, compared with 71.5 percent ten years later (Scott and Shoven).

A 1996 survey of lump-sum payments from large pension plans revealed that among job changers a full 60 percent of distributions were cashed out and only 40 percent of distributions to workers changing jobs were rolled over into

other qualified retirement plans. Although the numbers are alarming, the trend is improving: the 40 percent rollover rate in 1996 can be compared with only 35 percent in 1993. Further, in 1996, 95 percent of distributions over $100,000 were rolled over compared to only 5 percent of distributions under $3,500. As a result, more than 75 percent of total dollars distributed were rolled over (Yakoboski).

Despite the improving trend, the numbers imply that roughly $20 billion per year leaks out of the private pension system. Moreover, small distributions currently being cashed out in large numbers could ultimately translate into a large loss of retirement income. Considering that the typical workforce entrant today will on average hold over eight jobs before reaching retirement, several small distributions over the working life could become the norm. Thus, the cashing out of lump-sum distributions is a serious problem.

Erosion of benefits after retirement. Private sector pension plans generally do not provide postretirement cost-of-living adjustments. Consequently, even moderate rates of inflation will erode the purchasing power of benefits fixed in nominal terms, noticeably lowering retirees' standards of living. When persistent inflation is combined with the trend toward earlier retirement, the value of nominal pension benefits declines significantly. Some employers have offered ad hoc increases, but these adjustments tend to offset no more than one-third of inflation's erosive impact. The lack of postretirement inflation adjustment has not received much attention lately because the inflation rate has been so low. But even at 3 percent inflation, the value of a $100 benefit declines to $64 after fifteen years, $55 after twenty years, and $48 after twenty-five years. Given that life expectancy at age sixty-five is about twenty years, this erosion remains an important problem.

While Congress discussed the issue of protecting the value of pensions against inflation during deliberations on ERISA, the legislation did not contain any guidelines about postretirement increases. The implicit decision was to continue to rely on ad hoc increases through unilateral employer action or the collective bargaining process. As a result, the erosion in the value of pension benefits remains a serious problem in defined benefit plans, particularly those in the private sector.

Coverage

As discussed above, only 50 percent of nonagricultural wage and salary employees in the private sector participate in a pension plan. Part of the coverage issue arises in firms where the employer offers a plan and employees are excluded or choose not to participate. The other part of the problem is that some firms—particularly small ones—do not offer pension plans. Surveys reveal that 29 percent of workers without pension coverage are employed by firms sponsoring pension plans, and 71 percent work for employers without plans.

The framers of ERISA recognized the lack of coverage as a serious problem, but shied away from mandating coverage in any way. Instead, they believed in encouraging the growth of employer-sponsored plans, and, for those workers whose employers did not provide a plan, authorized the individual retirement account (IRA). Historically, IRAs allowed individuals to accumulate $2,000 per year on a tax-preferred basis. The maximum rises to $3,000 in 2002 and will gradually increase to $5,000 in 2008, and thereafter increase inflation increments of $500. Recent data show that 28 percent of households have an IRA, but they are used primarily by upper-income households and appear to supplement conventional pension coverage, since nearly 50 percent of total households with IRAs also have pension coverage. This pattern means that only an additional 13 percent of households picked up coverage through IRAs, leaving a very large number of households with no pension provisions at all. It is not surprising that IRAs cannot solve the coverage problem. Low and moderate earners have too many pressing needs for current income to think about saving. Tax relief is also unlikely to affect their decisions since many low and moderate earners face low marginal tax rates.

The lack of pension coverage would not be a source of concern if Social Security provided enough income for workers to maintain their preretirement standard of living, but Social Security alone—even for lower paid workers—is inadequate when viewed either in terms of replacement rates or relative to poverty thresholds. The question is the extent to which the provision of pension income can be solved through the expansion of the existing employer-based system or whether some new program may be needed for those who cannot reduce their cash wages further in order to receive pension protection.

In any event, the lack of universal coverage for supplementary retirement benefits, like the erosion of termination benefits in defined benefit plans, the cashing out of lump-sum distributions, and lack of inflation protection, remains an unsolved problem.

ALICIA H. MUNNELL

See also CONSUMER PRICE INDEX AND COLAS; EMPLOYEE RETIREMENT INCOME SECURITY ACT; INDIVIDUAL RETIREMENT ACCOUNTS; RETIREMENT PLANNING; SOCIAL SECURITY.

BIBLIOGRAPHY

BODIE, Z., and MUNNELL, A. H., eds. *Pensions and the Economy: Sources, Uses, and Limitations of Data*. Philadelphia: University of Pennsylvania Press, 1992.

MCGILL, D. M.; BROWN, K. N.; HALEY, J. J.; and SCHIEBER, S. J. *Fundamentals of Private Pensions*, 7th ed. Philadelphia: University of Pennsylvania Press, 1996.

MUNNELL, A. H. *The Economics of Private Pensions*. Washington, D.C.: The Brookings Institution, 1982.

SASS, S. A. *The Promise of Private Pensions: The First Hundred Years*. Cambridge, Mass.: Harvard University Press, 1997.

SCOTT, J. S., and SHOVEN, J. B. "Lump-Sum Distributions: Fulfilling the Portability Promise or Eroding Retirement Study?" *EBRI Issue Brief 178*. Washington, D.C.: Employment Benefit Research Institute, 1996.

Social Security Administration. *Income of the Aged Chartbook, 1998*. Washington, D.C.: 2000.

U.S. Board of Governors of the Federal Reserve System. *Survey of Consumer Finances*. Washington, D.C.: 1998.

U.S. Department of Labor, Bureau of Labor Statistics. *Current Population Survey, March Supplement*. Washington, D.C.: 1980.

U.S. Department of Labor, Bureau of Labor Statistics. *Current Population Survey, March Supplement*. Washington, D.C.: 2000.

U.S. Department of Labor, Pension and Welfare Benefits Administration. *Private Pension Plan Bulletin* 9 (winter 1999–2000).

U.S. Department of the Treasury, Internal Revenue Service. *IRS Notice 2000-66*. Washington, D.C.: 2000.

U.S. Office of Management and Budget. *Budget of the United States Government, Fiscal Year 2001, Analytical Perspectives*. Washington, D.C.: Government Printing Office, 2000.

WOODS, J. R. "Pension Coverage among the Baby Boomers: Initial Findings from a 1993 Survey." *Social Security Bulletin* 57 (fall 1993): 12–25.

YAKOBOSKI, P. "Large Plan Lump-Sum: Rollovers and Cashouts." *EBRI Issue Brief 188*. Washington, D.C.: Employment Benefit Research Institute, 1997.

PENSIONS, PUBLIC PENSIONS

Distinction between government and private pensions

Employees in the public sector—those working for state and local governments and the federal government—are in a number of respects better situated with respect to employer-provided pensions than are employees in the private sector. Virtually all full-time public sector employees participate in employer-provided pension plans. This contrasts with the private sector, where only about half of the full-time workforce participates in a pension plan at any given time.

State and local government pensions are predominantly defined benefit pensions—few state and local employees participate in defined contribution plans. Until the mid-1970s, private pensions were also predominantly defined benefit pensions. Since then, defined contribution pensions have grown in importance, while defined benefit pensions have declined, and by the end of the twentieth century defined contribution plans were more prevalent in the private sector than defined benefit plans. This trend has not occurred in the public sector, creating a significant difference between pensions for public sector employees and those for private sector employees. The difference in pension type is important for employees because in defined benefit plans the employer bears the financial risk associated with their funding, while in defined contribution plans the risk is borne by employees.

As well as having less financial market risk for employees, pension plans for public sector employees tend to be more generous than plans in the private sector. Most employees in state and local government are covered by plans permitting retirement at age fifty-five or earlier, frequently with just five or ten years of service required. The majority of state and local govern-

ment employees (62 percent) are in plans that provide postretirement increases, most of which (73 percent) are provided automatically. These increases are intended to compensate retirees for increases in the Consumer Price Index (CPI), though they are typically capped at either a portion of the CPI change or an absolute ceiling. In contrast, only 7 percent of private sector plan participants in medium and large firms are in plans offering postretirement increases, and fewer than half of these participants are in plans where the increase is automatic. Public sector employees, however, usually pay part of the cost of defined benefit pension plans through their own contributions, which is uncommon in the private sector.

Differences in regulations covering public and private pensions

Private pensions are regulated by the federal pension law called the Employee Retirement Income Security Act of 1974 (ERISA). This complex law, which has been amended numerous times, is the second longest law in the United States—only the tax code is longer. It is administered by three federal agencies: the Labor Department, the Internal Revenue Service, and the Pension Benefit Guaranty Corporation. The Labor Department administers sections of the law relating to the fiduciary responsibilities of plan sponsors and service providers. The Internal Revenue Service administers sections relating to allowable and required contributions and to tax deductions for pensions. The Pension Benefit Guaranty Corporation administers sections relating to the pension benefit insurance it provides for defined benefit plans.

The only pension plans not covered by this law are those for government employees and employees of religious organizations. State and local government pension plans and pension plans for federal government employees are subject to considerably fewer regulations, and public sector employees consequently have different, and generally fewer, legal protections. Many attempts have been made to bring state and local government plans under federal jurisdiction through introduction of legislation that would establish a public sector equivalent to ERISA. State and local government pension plans, however, continue to be regulated primarily by individual state and local governments. They are not subject to the regulations administered by the Labor Department and the Pension Benefit Guaranty Corporation. Government employees are subject to restrictions administered by the Internal Revenue Service concerning maximum allowable contributions and maximum allowable benefits, but the limits are generally higher than for the private sector. While state and local government plans are not subject to ERISA's reporting requirements, they must follow the financial measurement and reporting requirements imposed by the Governmental Accounting Standards Board (GASB). Private sector plans must follow the accounting requirements imposed by the Financial Accounting Standards Board (FASB).

At least in one respect, many employees in public plans have greater legal protection than do employees in private plans. Approximately half the states have either a state constitutional provision, a statutory provision, or past court rulings stipulating the right that the future accrual of pension benefits cannot be reduced for current employees. This right is not provided to private sector employees or employees in the federal government, where pension plan provisions can be modified to reduce the future accrual of pension benefits. Because of this right for many state and local government employees, pension reforms in those sectors tend to result in tiered pension plans, where a reform only affects newly hired workers, with previously hired workers maintaining their participation in the nonreformed plan.

Because state and local government plans are generally subject to fewer restrictions, they can have features that are not allowed in private plans. Thus, they serve as a laboratory for experimentation in plan designs that would not be allowed under current federal laws for private sector plans. For example, the pension plans for public employees in the state of Indiana provide for a rate-of-return guarantee for the defined contribution plan that is backed by the fund of the defined benefit plan. Such an arrangement would not be allowed in the private sector because it would violate the ERISA requirement that defined benefit plan assets be used only for the purpose of providing benefits from that plan.

Unlike the private sector, where all workers (except employees of religious organizations) are automatically covered by Social Security, state and local governments have the option of not choosing Social Security coverage for their employees if their employees are already covered by

a state or local government retirement plan. State and local governments whose workers are currently not covered by Social Security can continue to exclude them from Social Security. For those workers, the public pension plan provided tends to be more generous than for private plans because it also replaces Social Security. State and local government employees not covered by a public retirement plan are automatically covered by Social Security. Since 1983, state and local governments can no longer terminate Social Security coverage for groups of employees already participating.

Types of plans for federal government workers

Federal government workers hired before 1983 are covered by a different retirement income system than are those workers hired later. The Civil Service Retirement System (CSRS) (for workers hired before 1983) consists primarily of a generous defined benefit plan. Retirement benefits are available at age fifty-five for workers with thirty years of service. Under special circumstances, workers may retire at age fifty with twenty years of service, taking a reduction in benefits of 2 percent per year for every year they are younger than age fifty-five. The retirement benefits are fully indexed for inflation after retirement, which is also done by Social Security but which is rarely, if ever, done by private sector pension plans. The CSRS was started in 1920, and thus predates the Social Security system, which began in 1937. Before the federal pension reform in 1983, federal government employees were the largest group of employees not covered by Social Security.

These workers may also participate in the Thrift Savings Plan, which is a defined contribution plan. They may contribute up to 5 percent of their salary to this plan, but they receive no matching contribution from the federal government. The Thrift Savings Plan has grown rapidly, and, because of the large size of the federal workforce, is expected to eventually be the largest pension plan in the United States.

Employees hired after 1983 receive retirement benefits structured similarly to those for employees of large corporations in the private sector, through a system called the Federal Employees Retirement System (FERS). They are covered by Social Security and contribute to it just as do private sector workers. Because they participate in Social Security, they are covered by a considerably less generous defined benefit plan than are federal workers hired earlier. However, they may contribute a higher percentage of their salary to the Thrift Savings Plan, and they receive an employer match for their contributions. Several other systems cover particular groups of employees, such as diplomats (State Department), intelligence operatives and researchers (Central Intelligence Agency), and central bankers (Federal Reserve Board).

Management and funding issues

State and local government retirement programs are typically administered by independent governmental agencies. A plan's board—made up of elected, appointed, and *ex officio* members—holds the fiduciary responsibility for the plan and manages it. The board's management responsibilities include hiring staff, approving expenditures, and ensuring that reporting requirements are met. The board also typically influences actuarial assumptions and investment policy.

Private pension plans are subject to funding rules set by federal law that govern the minimum and maximum allowable levels of funding. In contrast, the funding requirements of public plans are not governed by federal law, but may be set by state law. Public sector pension plans have typically been considerably less well funded than private pension plans, though there has been a long-term trend towards improved funding in the public sector. Public sector employers have less incentive to fund their plans, since they do not receive—or need—the tax deduction private employers receive for doing so. Public employers also have less need to fund their plans, since the pension plans are backed by the power of the public sector to tax, and public sector jurisdictions typically have little risk of bankruptcy. Given this security, employees have less incentive to monitor or urge improvements in plan funding. However, advance funding can lower the cost of the plan to the employer by allowing a share of benefits to be financed by investment earnings. Consequently, advance funding, at least for state and local governments, has come to be seen as a fiscally responsible policy.

Investment of public sector pension funds

At the end of 1999, state and local government employee pension funds held $3.0 trillion in assets. To put this figure in perspective, pri-

Table 1
State and Local and Private Pension Fund Investments, Fourth Quarter, 1999

Investment	State and Local Funds (%)	Private Funds (%)
Checkable deposits and currency	0.3	0.1
Time and savings deposits	0.2	0.6
Money market fund shares	- -	1.8
Security repurchase agreements	1.2	1.2
Credit market instruments	24.5	20.9
Open market paper	1.5	1.5
U.S. Government securities	12.3	12.0
Treasury	7.0	4.7
Agency	5.3	7.4
Municipal securities	0.1	Less than 0.5%
Corporate and foreign bonds	10.0	6.7
Mortgages	0.6	0.6
Corporate equities	67.0	50.0
Mutual fund shares	- -	15.1
Miscellaneous assets	6.8	10.4
Total	100.0	100.0

SOURCE: Board of Governors of the Federal Reserve System (2000)

vate-employee funds held $4.9 trillion, and life insurance companies held $3.1 trillion. Both private and public pension funds were invested primarily in credit market instruments and in corporate equities (see Table 1). The balance of these assets is different, however, with public funds holding 67 percent of assets in corporate equities, compared with 50 percent in private funds. The share of state and local plan assets held in equities has increased dramatically over the past several decades, rising from only 3 percent in 1960 and 17 percent in 1970.

A given plan's investment policy will reflect its objectives, applicable statutory restrictions (if any), and the board's control over investment decisions. For example, for many years West Virginia prohibited its state pension plans from investing in equities, and many plans continue to limit investments in various types of assets. However, since the 1980s, many state legislatures have replaced the restrictive "legal lists" of allowed investments with a more flexible standard of prudence. This trend allowed many plans to take advantage of the stock market's strong performance during the 1990s, reducing the effective cost of plan maintenance for sponsoring governments and contributing to many plans' current strong funding status.

Importance of states in affecting behavior of firms and stock market outcomes

The growth of state and local government pension assets has led to an appreciation of their economic and political power. Many state and local government employees' pension plans have consequently been active in *social investing*. This term refers to investment decisions where an investor or money manager factors in ethical or social priorities. Social investors are concerned with such issues as companies' environmental records, treatment of employees, behavior in foreign markets, and connection to controversial products such as tobacco.

Private sector pension plans are prohibited from making investments designed to further socially desirable purposes at the expense of the plan's rate of return. State and local government plans are not subject to this restriction and consequently have been more likely to engage in social investing. However, some social investors also believe that firms that behave ethically are likely to provide a better investment return than those that do not, and, indeed, returns in many social investment funds have exceeded those in many standard indices. Moreover, while state and local plans are not subject to the ERISA requirement that plan assets be invested using the "care, skill, and diligence" of a prudent individual acting "solely in the interest of plan participants," most public plans have adopted similar language.

Many institutional investors—prominently public pension plans, but private plans as well—are also concerned with the governance of publicly traded corporations. Governance concerns include the election and independence of directors, including the disclosure of sufficient information for investors to ascertain independence; the appointment and conduct of board committees; the allocation and exercise of shareholder voting rights; board composition and accountability to shareholders; and the level of director and management compensation. Many state and

local government plans pursue these and other governance concerns as a way to protect plan assets and increase return on their investments as part of their fiduciary obligations.

SOPHIE M. KORCZYK
JOHN A. TURNER

See also CONSUMER PRICE INDEX AND COLAS; EMPLOYEE RETIREMENT INCOME SECURITY ACT; PENSION, PLAN TYPES AND POLICY APPROACHES; RETIREMENT PLANNING.

BIBLIOGRAPHY

Board of Governors of the Federal Reserve System. *Flow of Funds Accounts of the United States: Flows and Outstandings, Fourth Quarter 1999*. Washington, D.C.: Board of Governors of the Federal Reserve System, 2000.

MITCHELL, O. S., and CARR, R. "State and Local Pension Plans." *NBER* Working Paper 5271. Cambridge, Mass.: National Bureau of Economic Research, 1995.

MITCHELL, O. S.; MCCARTHY, D.; WISNIEWSKI, S. C.; and ZORN, P. "Developments in State and Local Pension Plans." *PRC* Working Paper 99-4. Philadelphia, Pa: Pension Research Council, 1999.

PHILIPS, K. "State and Local Government Pension Benefits." In *Trends in Pensions 1992*. Edited by J. Turner and D. Beller. Washington, D.C.: U.S. Government Printing Office, 1992. Pages 341–392.

STEFFEN, K. "State Employee Pension Plans." *PRC Working Paper* 99-5. Pension Research Council, 1999.

U.S. Department of Labor, Bureau of Labor Statistics. *Employee Benefits in Medium and Large Private Establishments, 1995*. Washington, D.C.: U.S. Government Printing Office, 1998.

U.S. Department of Labor, Bureau of Labor Statistics. *Employee Benefits in State and Local Governments, 1994*. Washington, D.C.: U.S. Government Printing Office, 1996.

PERCEIVED HEALTH

Various criteria are used to assess a person's level of health. Objective measures can be noted and counted by a trained observer, while subjective measures of health depend exclusively on a person's self-evaluation. Objective measures include the presence of a disease or disorder, measuring of blood pressure, days spent in bed or in the hospital, or observation of the ability of the person to perform daily activities. A subjective measure of assessed health can be collected by simply asking a person if his or her health is excellent, good, fair, or poor. Both objective indicators and the subjective measure of self-rated health are designed to capture the health status of an individual, and there is a moderately strong relationship between the two measures. Most people report an evaluation of their health that matches or comes close to the objective indicator of a physician's diagnosis. In general, those with more functional disabilities are likely to rate their health less favorably. In addition, those with specific chronic conditions, such as heart disease, chronic lung problems and diabetes also report worse health.

However, one landmark study (Maddox and Douglass, 1973) reported that about a third of its sample perceived their health as being much better or much worse than a physician's objective rating. Instead of viewing self-rated health as a measure that is somewhat helpful in determining health status, though biased by psychological states, the researchers tested whether it offered any information beyond that provided by objective measures. One way of evaluating measures of health is to see how well they predict one's risk of death in a given period of time. Overall, people with objective indicators of health problems are at a greater risk of dying in the next few years than those who do not have health problems. To test whether self-rated health also predicts mortality, and if it provides any information beyond that of objective indicators, Mossey and Shapiro (1982) examined information about people's self-rated health, physicians' reports for each individual based on objective measures, and a record of whether or not each person died within the next six years. After being matched in terms of physician's health reports, those who rated their health as poor had a three times greater risk of dying in the next few years than those who rated their health as excellent. Furthermore, self-rated health was a more powerful predictor of mortality than the physician's objective measures.

Idler and Benyamini (1997) reviewed the international literature on self-rated health as a predictor of mortality for noninstitutionalized individuals. Overall, the results overwhelmingly supported the association between self-rated health status and mortality, even when other objective indicators of health status were considered. Several interpretations of such findings are

possible. First, it may be that self-rated health is a more accurate measure because it captures more than is possible by considering typical objective indicators. When rating one's health, a person may consider symptoms that are not yet diagnosed, weigh the severity of symptoms, or consider family history and expected longevity. Second, self-ratings of health may include not only one's current level of health, but also the trajectory of decline or improvement in health. In fact, when researchers have access to an individual's health status at various points in time, a change in health status predicts mortality, explaining part of the predictive power of self-rated health. Third, a person's perception of his or her health may influence or reflect health behaviors. A person with a poor perception of health may not bother with preventive measures such as diet and exercise, while people with good perceptions of health are more likely to engage in healthful behaviors. In this way, self-rated health may be a reflection of lifestyle. Fourth, self-rated health may represent a person's evaluation of resources available to deal with health problems, either from the social environment or from within themselves. An evaluation of poor health may indicate an underlying depression that is detrimental to the immune system.

In addition to being predictive of mortality, self-rated health also predicts other outcomes, such as decline in functional ability or a greater likelihood of entering a nursing home. Even after accounting for the seriousness of the disease and the level of functional ability when the self-evaluation of health was made, elderly persons who rated their health as less than excellent were more likely than those with excellent self-rated health to be disabled, institutionalized, or dead within the next six years (see Mor et al., 1994). Research by Idler and Kasl (1995) similarly found that older adults who rated their health as poor were two and a half times as likely as those with excellent self-rated health to experience a decline in functional ability. They noted that the risk of decline was greatest for elderly persons who were relatively younger and without disability and yet still rated their health as poor. Further analysis showed that it is not positive thinking that improves the condition of the disabled, but rather negative evaluations that are linked to a decline in functioning. Other researchers have found that the perception of control illuminates the relationship between self-rated health and mortality. Older adults who reported excellent health were more likely than those who reported poor health to perceive a sense of control over their lives and to use active strategies in dealing with difficulties. This suggests that elderly persons who evaluate their health as poor may give up and allow functional decline to occur, rather than actively practicing positive health behaviors and coping strategies.

Self-rated health is clearly a useful measure in assessing the health status of an individual. It is easy to collect with a simple, general question, and it seems to provide different and additional information, compared with objective measures of health. The mechanisms through which self-rated health predicts mortality still need to be explored, though it seems that the perception of control plays an important role.

ELLEN L. IDLER
JULIE MCLAUGHLIN

See also ASSESSMENT; CONTROL, PERCEIVED; HEALTH ATTITUDE; QUALITY OF LIFE, DEFINITION AND MEASUREMENT; SUBJECTIVE WELL-BEING.

BIBLIOGRAPHY

IDLER, E. L, and BENYAMINI, Y. "Self-Rated Health and Mortality: A Review of Twenty-Seven Community Studies." *Journal of Health and Social Behavior* 38 (1997): 21–37.

IDLER, E. L., and KASL, S. "Self-Ratings of Health: Do They Also Predict Change in Functional Ability?" *Journal of Gerontology: Social Sciences* 50B (6): S344–S353.

JOHNSON, R. J., and WOLINSKY, F. "The Structure of Health Status among Older Adults: Disease, Disability, Functional Limitation, and Perceived Health." *Journal of Health and Social Behavior* 34 (1993): 105–121.

MADDOX, G. L., and DOUGLAS, E. B. "Self-Assessment of Health: A Longitudinal Study of Elderly Subjects." *Journal of Health and Social Behavior* 14 (1973): 87–93.

MENEC, V. H.; CHIPPERFIELD, J. G.; and PERRY, R. P. "Self-Perceptions of Health: A Prospective Analysis of Mortality, Control, and Health." *Journal of Gerontology: Social Sciences* 54B, no. 2 (1999): P85–93.

MOR, V.; WILCOX, V.; RAKOWSKI, W.; and HIRIS, J. "Functional Transitions Among the Elderly: Patterns, Predictors, and Related Hospital Use." *American Journal of Public Health* 84, no. 8 (1994): 1274–1280.

MOSSEY, J. M., and SHAPIRO, E. "Self-Rated Health: A Predictor of Mortality among the Elderly." *American Journal of Public Health* 72, no. 8 (1982): 800–808.

PERIODIC HEALTH EXAMINATION

Origins

Two parallel cultures of health have existed since ancient times: healing (the traditional role of physicians), and staying healthy. Other than public health procedures (e.g., provision of a clean water supply, reduction of overcrowding), serious attempts to prevent illness by interventions on an individual level began only in the twentieth century. The *annual physical examination* was established as an attempt to detect and treat illnesses before they caused serious harm. The annual physical examination became increasingly complex and comprehensive, including the use of laboratory tests, X rays, and various procedures; culminating, in the 1960s and 1970s, with the *executive check-up*. Such procedures discovered numerous abnormalities (which occur more frequently, by chance, as the number of tests increases), yet failed to produce overall better health. With this realization, the concept of targeted preventive health care procedures emerged in the 1970s and evolved into the periodic health examination (PHE).

Epidemiologic studies have revealed the most common causes of death among older people to be cardiovascular diseases (especially heart attacks and heart failure), strokes, and malignant diseases (cancers). Disability is produced by a wide range of conditions, including complications of cardiovascular diseases, musculoskeletal disorders (arthritis, fractures), strokes, and problems with the special senses (i.e., hearing and eyesight). *Risk factors* are phenomena that are associated with disease. For example, tobacco smoking is strongly associated with lung cancer and heart disease. Risk factors may be modifiable (e.g., lowering blood pressure reduces the risk of stroke), or nonmodifiable (e.g., age, family history of certain diseases, genetic disorders). Knowledge of the epidemiology of diseases, their risk factors, and specific treatments has laid the foundation for the study of preventive health care.

The PHE evolved from the annual check-up. It consists of a list of procedures that target specific conditions or their risk factors, and it aims to reduce subsequent illness, disability, and premature death. While the PHE is offered to individuals who visit their personal physicians for the purposes of prevention, components of the PHE may be offered on other, opportunistic, occasions, such as counseling against smoking when an individual consults a physician for cough.

Components of the PHE

A wide range of tests and procedures may be offered as part of a PHE. Physicians and other health care workers have a responsibility to promote only those elements for which there is evidence of more benefit than harm. In North America, two parallel organizations, The Canadian Task Force on Preventive Health Care and the U.S. Preventive Services Task Force, use a rigorous process to weigh the scientific evidence, and they then recommend to physicians whether specific procedures should be included or excluded from the PHE. Other authoritative bodies and societies also issue recommendations, but conflicting recommendations can cause confusion among physicians and consumers of health care. The following elements are commonly included in the PHE.

Counseling. Counseling involves a discussion with an individual to provide advice and encouragement towards a particular behavior. Tobacco use is regarded as one of the most important modifiable risk factors for a wide variety of diseases, including lung cancer, chronic bronchitis, heart disease, strokes, and peripheral vascular disease. Counseling individuals about their smoking practices is effective for reducing the risk of subsequent illness. This advice may be supplemented by additional antismoking aids, such as the use of nicotine patches or gum.

Many individuals in North America, and in the Western world, have unhealthy diets. An excess of saturated fat and inadequate amounts of fibre and calcium are frequent. Counseling to take up a more prudent diet (total fat less than 30 percent of daily intake), increased consumption of fibre (more than 20 grams per day), and 1200–1500 grams of calcium per day is frequently part of the PHE. Advice may also be offered concerning the use of supplemental vitamins and minerals.

Many older individuals have an inactive lifestyle. There is ample evidence that even modest amounts of exercise improve well-being, muscle strength, bone integrity, and cardiovascular fitness. Individuals are therefore often advised to take up some form of aerobic exercise, such as walking, bicycling, or swimming. Counseling

Table 1
Elements of the Periodic Health Examination

Condition	PHE Procedure
Tobacco-related diseases (lung disorders, heart attacks)	Smoking cessation programs
Diet-related illness	Counseling on adverse nutritional habits (e.g., excessive fat, inadequate fibre, calcium)
Coronary heart disease	Dietary advice on fat and cholesterol
All-cause mortality and morbidity	Counseling on moderate physical activity
Motor vehicle injuries	Counseling on seat belt use, alcohol avoidance
Injuries in home	Counseling on hazards (e.g., scatter rugs, water temperature)
Problem drinking	Detection and counseling
Influenza	Inoculation
Pneumococcal infections	Inoculation
Hypertension	Blood pressure measurement
Diabetes mellitus	Blood-sugar tests
High cholesterol level	Blood test for cholesterol and other lipids
Breast cancer	Physical examination and mammography
Colorectal cancer	Stool testing for blood, endoscopy
Cancer of cervix	Pap smear
Skin cancer	Inspection, avoidance of excessive sunlight exposure
Prostate cancer	Blood test (PSA), digital examination of prostate
Diminished eyesight	Sight Card
Hearing impairment	Inquiry, Whispered Voice Test or audioscope
Osteoporosis, menopausal symptoms, heart disease	Counseling about estrogen hormone replacement
Frailty or physical disablities	Inquiry and/or physical measures
Memory problems	Inquiry of caregiver; memory questions
Osteoporosis	Inquiry about risk factors, bone density measurement
Abdominal aneurysm	Examination, abdominal ultrasound
Elder abuse/mistreatment	Inquiry

SOURCE: Author

about safety in driving a motor vehicle usually stresses the importance of wearing seat belts and avoidance of alcohol. While small amounts of alcohol have been shown to benefit cardiovascular health, excessive consumption of alcohol is injurious to health. Advice concerning judicious use of alcohol is usually offered together with questions to detect excessive drinking. The risk of injury in the home may also be discussed. Such risks can be minimized by eliminating objects on the floor (e.g., scatter rugs), ensuring correct hot water temperature (49°C, or 120°F) and adequate lighting on stairs and other hazardous areas.

Inoculations. Annual strain-specific influenza inoculations reduce the risk of influenza and reduce mortality and disability from this condition. Influenza inoculations are recommended for all older individuals. Pneumococcal inoculations reduce the risk of pneumonia and other infections caused by the pneumococcus bacteria. This inoculation is usually given every ten years. Although tetanus is very rare in older people, some physicians recommend maintaining immunity with periodic inoculations.

Risk factors for cardiovascular disease. Modifiable risk factors for cardiovascular disease include high blood pressure (hypertension), elevated levels of cholesterol and other lipids (fats), tobacco smoking, and elevated blood-sugar levels (diabetes mellitus). All older individuals should have their blood pressure measured regularly. Treatment for hypertension is usually initiated when the systolic (higher reading) is above 160 (and sometimes 140) or the diastolic (lower reading) is above 90. Older individuals who are at increased risk of heart disease (smokers, diabetics, and those with high blood pressure, strong family history, or symptoms of heart disease) should have blood tests to measure blood cholesterol and lipid levels. Individuals at high risk of diabetes (e.g., overweight, family history) will usually be offered a test for blood-sugar level. Not all of these tests will be required for every older person, and there is some disagreement among authorities about which tests are advisable.

Early detection of malignant diseases. Mammography (breast X rays) and physical examination of the breasts at regular intervals (usually two years) have been shown to reduce deaths from breast cancer. Screening for colorectal (bowel) cancer with stool testing for blood or

endoscopy (examining the bowel with a flexible instrument) can reduce the risk of deaths from cancer. Papanicolaou (Pap) test screening of the cervix (neck of the womb) can detect changes that may lead to subsequent cancer. Regular screening for these three cancers is recommended by almost all authorities. Examination of the skin is usually performed to detect changes that may develop into cancer. Tests to detect cancer of the prostate gland are also available, though it is not yet clear whether these tests should be regularly performed on older men.

Screening of special senses. Approximately one-third of older people have difficulty hearing, though they may not be aware of it. A hearing test is recommended as part of the PHE, as is a test of eyesight using a Sight Card (letters of diminishing size) viewed at a fixed distance.

Counseling about hormone replacement. There is mounting evidence that estrogen hormone replacement for women after menopause reduces the risk of osteoporosis, menopausal symptoms, and possibly Alzheimer's disease. Balanced against these benefits is a very slight increased risk of breast cancer with prolonged use of estrogens. There is conflicting evidence on the effects of estrogen replacement on the risk of heart disease. The PHE should therefore include a discussion of hormone replacement therapy and assessment of individual risk prior to a shared decision being made by a woman and her physician.

Miscellaneous conditions. Early detection of physical disabilities (e.g., difficulties walking, climbing stairs, dressing) may be beneficial, as appropriate therapy and additional supports may reduce subsequent disability. Simple tests to detect physical disability are available. Memory tests and inquiry of caregivers about memory problems may be included in the PHE, although the value of such screening remains debatable. For individuals at high risk of osteoporosis (e.g., family history, small frame, female gender, previous fractures), tests for bone density may be offered. Screening for abdominal aortic aneurysm (a swelling of the large artery in the abdomen) may be offered to older men and women with a family history of this condition or risk factor such as hypertension and smoking. Inquiry is sometimes made concerning symptoms of depression, and questions to detect any abuse or neglect by family or other caregivers may also be asked.

Requesting a periodic health examination

The PHE is offered by most primary care physicians. Individuals should feel free to discuss their request for a PHE with their physicians. Some components of the PHE may be offered at times other than during a special visit for prevention. For example, blood pressure will usually be taken during any visit to an emergency ward, and an inquiry will be made about immunization status at these times. Physicians should be willing to provide a PHE and be knowledgeable about the appropriate components as determined by the age and gender of the recipient.

Role of PHE in maintaining health

The PHE is only one component of maintaining good health. It does not replace episodic care (e.g., the usual treatments for acute or chronic conditions). Neither does it replace the responsibility of the individual to maintain a healthy lifestyle, although advice and counseling may reinforce health behaviors. While it is tempting to believe that preventive health care reduces health care costs by preventing illness, this does not appear to be the case, at least not in the short term. With increasing acceptance, and increasing demand by older individuals for preventive health care, benefits of improved health may eventually be followed by reduced health care expenditures.

CHRISTOPHER J. PATTERSON

See also BREAST; CHOLESTEROL; EYE; HEARING; HEART DISEASE; HIGH BLOOD PRESSURE; INFLUENZA; OSTEOPOROSIS; PROSTATE; SKIN.

BIBLIOGRAPHY

Canadian Task Force on the Periodic Health Examination. *Guide to Clinical Preventive Health Services*. Edited by R. B. Goldbloom. Ottawa: Canada Communication Group, 1994.

LAVIZZO-MOUREY, R.; DAY, S. C.; DISERENS, D.; and GRISSO, J. A. *Practicing Prevention for the Elderly*. Philadelphia. Hanley & Belfus, 1989.

PATTERSON, C. "Health Promotion, Screening and Surveillance." In *Oxford Textbook of Geriatric Medicine,* 2d ed. Edited by J. G. Evans, T. F. Williams, B. L. Beattie, J.-P. Michel, and G. K. Wilcock. Oxford, U.K.: Oxford University Press, 2000. Pages 1126–1135.

U.S. Preventive Services Task Force. *Guide to Clinical Preventive Services,* 2d ed. Alexandria, Va.: International Medical Publishing, 1996.

PERSONAL CARE

"Personal care" is one of several terms used to describe one-on-one assistance provided to individuals of any age who need help with daily living tasks on a long-term basis. The term can be used generically to describe assistance with daily living tasks regardless of the residential setting in which the care is provided, whether or not the provider of care and the care recipient are related to one another, and whether or not the care provider is paid. Most often, the term is used to describe services financed by a third party and provided to individuals living outside of institutional settings.

Usually the term "personal care" is used in situations in which some "hands-on" tasks are performed, notably assistance with mobility, dressing, bathing, using the toilet, transferring (e.g., getting out of a bed or chair), or eating. Commonly, personal care also includes other tasks, such as shopping, preparing meals, housekeeping, laundering, and escorting that do not require physical contact. When care at home does not involve "hands-on" assistance, the term "homemaker" or "housekeeper" service is more likely to be used.

When financed by a public agency, personal care services are typically classified as "unskilled" to indicate that workers do not require formal health care training. An indication of the fine line between "unskilled" care and health care is that personal care providers may not administer medications, but they may remind their clients to take their medications.

In the United States the term "personal care" is often used in association with an optional Medicaid benefit. Under Medicaid, states may or may not finance personal care services for those with disabilities who are not residents of an institution. Like other Medicaid services, the personal care benefit is income-conditioned; that is, eligibility is restricted to those with low incomes. The presence of a disabling condition must be certified by a physician who, in most instances, must also approve a plan of care. Medicaid will not provide reimbursement when care is provided by a "legally responsible relative." Spouses and parents of minor children are not eligible for Medicaid reimbursement when they provide personal care. Adult children, however, may be reimbursed as personal care workers for their parents.

The Medicaid personal care benefit originated as a resource for adults for whom the onset of disability preceded old age. It was designed especially for those with very serious mobility restrictions who needed extensive human assistance on a regular basis if they were to lead approximately normal lives. With the expansion of interest in community-based long-term care services for the elderly, the model has been extended or adapted in some participating states to serve older people.

In the year 2000, half of the states had the personal care option written into their Medicaid plans. States with large populations that offered the personal care option included New York, California, and Texas. Pennsylvania, Ohio, and Illinois are populous states that did not participate. Use of the personal care option has been most extensive in New York.

The Medicaid personal care option is only one of a number of sources of public financing for home- and community-based long-term care for the elderly. At least nominally, all states now finance some home- and community-based care through waiver programs. (Waivers relieve states of the usual requirement that Medicaid benefits be provided on a statewide basis to all who meet the eligibility requirements.) Waiver programs are intended to provide states with flexible means of financing services through Medicaid to those with low and moderate incomes who otherwise would qualify for institutional care. Waiver programs can finance a wide range of services that include, but are not limited to, the hands-on care associated with personal care. Waiver programs, for example, may finance household modifications, medical transportation, and adult day care. They are used by states to finance not only long-term care for the elderly but also services for younger populations. Some states use the waiver provision, for example, to finance care in group homes for adults with developmental disabilities.

Although Medicare is designed to be a source of financing of acute rather than long-term care, the Medicare-certified home health program is, in fact, a source of financing for some personal assistance for the elderly. Older people have a relatively high incidence of acute health problems from which recovery tends to be slow. Further, many older people suffer from multiple chronic health problems that require extensive surveillance by health professionals and intermittent intervention by health care providers. For some older people, chronic illness and disability

are linked. When Medicare beneficiaries are being treated for a health condition at home under a plan of care that is approved by a physician and supervised by a nurse, Medicare pays for visits by home health aides whose responsibilities can largely be described as personal care. The degree to which Medicare has been the source of financing for long-term home health services has varied over time. Originally, Medicare home health benefits were highly restricted, requiring prior hospitalization and limited in their duration and the number of visits authorized. Later, Medicare home health provisions were relaxed so that prior hospitalization was no longer required, and home health aide services could be provided as long as beneficiaries were responding to medical treatment. However, since the passage of the Balanced Budget Act of 1997, home health agencies have had strong financial incentives to restrict the home health aide services that they provide. Consequently, after 1997 Medicare was no longer a source of financing for long-term home health services.

Personal care is also financed by other public sources. The Veterans Administration provides cash benefits to veterans who qualify because they are severely disabled and live outside of institutions. The allowance is particularly generous for those with service-connected disabilities. Some states offer personal care services for the elderly funded through sources other than Medicaid. California, Massachusetts, Minnesota, and Illinois are states with relatively generous personal care programs for the elderly funded by sources other than Medicaid.

Private long-term care insurance is also a source of financing for some personal care. When they were introduced, long-term care insurance policies were designed only to be a source of financing for institutional care. More recently, policies have been designed to offer flexible benefits. Holders covered by newer policies with more flexible benefits have the option to use some or all of the benefits to finance personal care at home or in an assisted-living facility. Because less than 5 percent of older people are covered by private long-term care insurance policies, such policies are not yet an important aggregate source of financing for personal care.

Relatively little is known about personal care that is paid for out of pocket by consumers or their relatives. Some consumers hire personal assistants directly through newspaper ads or word-of-mouth recommendations, much as domestic workers are hired. In some cases, consumers hire personal assistants who are screened and perhaps trained by an agency.

For the public agencies that finance personal care, the major concerns are controlling expenditures, reaching those in greatest need, and maximizing efficiency in the use of public funds. Many state officials are wary of the Medicaid personal care option because Medicaid is an entitlement service. If states offer a personal care service option, they are obligated to provide services to all who qualify. States use a number of strategies to limit their expenditures when they offer the personal care option: restricting eligibility to those with the most severe disabling conditions, requiring periodic reviews of eligibility, imposing strict income eligibility criteria, setting limits on the hours of service that are funded, and limiting the rates at which personal care workers are paid.

In states that finance their own home care services, other measures are used to contain costs. Some states require co-payments on a sliding-fee basis. Some provide services only to the extent that family members are not available to provide care. Some also set limits on overall expenditures, with the result that service applicants may be placed on a waiting list until an opening can be found for them, or the volume of service provided to recipients expands and contracts according to the availability of funds.

The availability of high-quality personal assistants is a major issue in personal care. Because service recipients rely so extensively on workers for the full range of daily living tasks, workers must be reliable, competent, trustworthy, and responsive to client requests. The burden of responsibility carried by workers is particularly great because they almost always work out of sight of supervisors. Also, when clients live alone, they often look to workers as companions. Because personal care is considered to be unskilled work, workers are characteristically offered low wages, often the legal minimum. The field attracts individuals with minimal employment options. In much of the country, many of those who seek employment as personal care workers are immigrants from cultures very different from those of their clients. Cultural differences are often major barriers to the development of sound relationships between clients and their workers. Shortages of personal assistance work-

ers are common when a strong economy provides entry-level workers with more attractive employment alternatives.

Strategies that make more efficient use of available funds are of great interest to both consumers and funding sources. One approach provides consumers with cash rather than service benefits. Consumers then can hire workers directly under their own terms. In this way, some personnel administration expenditures may be eliminated. Control over the hiring, supervision, and termination of personal care workers has been of particular interest to younger people with disabilities.

An alternative approach to achieving greater efficiency in use of resources focuses on the physical environment. Carefully planned modifications in household design and the introduction of equipment that assists consumers in carrying out daily living tasks can reduce the need for personal care. Some assistive equipment is technically complex and expensive—especially when it is customized to unique consumer needs. Other assistive equipment is inexpensive; examples include easy-grip kitchen tools, shower chairs, and elastic shoe laces. Because personal assistance provided by paid personnel is expensive when the care is intensive and the duration of care is long, substantial investments in environmental changes may be cost-effective in the long run. An emphasis on environmental modifications is also particularly attractive when there are serious shortages of personal care workers.

Consumers who need personal care are well advised to seek expert information about the service resources available in the community. In the United States, the Older Americans Act requires that regional organizations designated as Area Agencies on Aging provide information to elders and their caregivers on a variety of matters, including personal care. The information and referral services funded through the Older Americans Act are particularly likely to be well informed about options for publicly financed services. In some cases, middle- and high-income elders who are expected to pay for care themselves are better served by seeking advice from private case managers than from publicly financed information services.

FRANCIS G. CARO

See also HOME ADAPTATION AND EQUIPMENT; HOME CARE AND HOME SERVICES; LONG-TERM CARE; MEDICAID.

BIBLIOGRAPHY

KANE, R. A.; KANE, R. L.; and LADD, R. C. *The Heart of Long-Term Care*. New York: Oxford University Press, 1998.

MORRIS, R.; CARO, F. G.; and HANSAN, J. E. *Personal Assistance: The Future of Home Care*. Baltimore: Johns Hopkins University Press, 1998.

ROWLAND, D., and LYONS, B., eds. *Financing Home Care: Improving Protection for Disabled Elderly People*. Baltimore: Johns Hopkins University Press, 1991.

PERSONALITY

"Personality" is a broad term that refers to a person's characteristic behaviors, actions, emotions, and thoughts. It is the distinctive way one approaches the world, as manifested in the typical actions, feelings, and cognitions that distinguish one person from another. Historically, scholars have conceptualized personality in three main ways: the trait, cognitive-behavioral, and psychodynamic approaches.

Approaches to personality

The trait approach focuses on relatively enduring dispositions that reside within a person. Traits are almost always defined as dimensions on which every person can be compared with other people. Examples include extroversion, neuroticism, and conscientiousness. This dimensional outlook has historically put a premium on high-quality measurement of traits among those who favor the trait approach, giving that approach a strong quantitative and psychometric flavor. The trait position has also put conceptual and empirical emphasis on demonstrating the stability of these dimensions over situations and time, thus buttressing the fundamental notion that they are long-lasting, internal dispositions that people bring to the situations and contexts they encounter through life.

By contrast, the cognitive-behavioral approach historically has focused on contextual, environmental, and situational determinants of behavior, thought, and feeling, deemphasizing within-person dispositions in favor of external explanations. Advocates of this approach have developed within-person constructs to explain behavior (e.g., self-efficacy, self-concept, mastery, coping strategies), but these are usually framed as variables that arise from experience, and generally involve interaction with the exter-

nal environment, thus preserving the fundamental viewpoint that external factors are key in understanding personality.

The third major outlook is the psychodynamic approach. It derives from the psychoanalytic theories of Sigmund Freud and his followers, and emphasizes unconscious mental processes as its cardinal theme. This particular approach to personality is aligned more closely with clinical psychology than are the other two positions. Examples of variables that come out of this approach include defense mechanisms and unconscious motives. Together, the trait, cognitive-behavioral, and psychodynamic approaches represent the strongest influences on personality, although others have emerged in recent years, most notably the evolutionary and cross-cultural approaches.

Measurement of personality

Regardless of which approach to personality is adopted, the most widely used method of measurement is self-report. (Other methods include life ratings, observer ratings, and objective tests). Most self-report personality instruments typically use questions or items. Usually these items have been subjected to psychometric analyses, and have been shown to have adequate reliability and validity. Self-report instruments for measuring various personality characteristics abound, although some are used more widely than others.

Some have criticized the reliance on self-report measures by those who study personality and personality development. Such critics argue that more objective means are necessary for the accurate assessment of personality. The chief alternative to self-report is other-report. This broad category includes reports or ratings by peers, spouses, friends, siblings, or trained observers. In other-reports, a subjective judgment is still rendered, but it is deemed more objective in some ways than self-reports, which can be biased by a person's unwillingness to admit faults or weaknesses. Spouse reports or friend reports also are subject to such biases, which makes observer reports attractive to many researchers. Observer reports are usually obtained by associates of the researcher who have been trained to evaluate particular behaviors or actions of the subjects under study, and to code them according to a predetermined scheme. Often, observer reports make use of videotaped behaviors.

Although most personality researchers use self- or other-reports of various kinds, an increasing number are making use of physiological, neurological, and other biological measurements. Assessments of heart rate, blood pressure, neurochemicals (dopamine, epinephrine), and immune system biomarkers (interleukin-1, interleukin-6) are being used by personality researchers with increasing frequency. Neuroimaging techniques have been utilized in a small number of studies of personality. Use of these measurement techniques is not surprising, given the evidence that many aspects of personality have a biological or genetic basis.

Personality stability and change

Together, the three main approaches to personality (trait, cognitive-behavioral, and psychodynamic) have given rise to wide-ranging definitions of personality, spurring confusion regarding the stability of personality over time. Some aspects of personality, such as traits, have been conceptualized as relatively stable over time. Other aspects have been described as malleable and changeable over the life span, including many cognitive-behavioral concepts, such as self-efficacy. To give structure to the issue of personality stability and change, especially in adulthood, Dan P. McAdams has proposed a three-tier model that separates the elements of personality that should remain stable over time from those which are likely to change. This model gained popularity during the 1990s, and by 2001 was a widely cited framework for understanding personality stability and change.

The first tier of the model is comprised of traits, which are defined as relatively enduring patterns of behavior and feelings. In the 1980s and 1990s, a trait model emerged that many consider definitive: the five-factor, or Big Five, model. Via the application of factor analysis (a statistical technique) to large pools of trait questionnaire items or descriptive adjectives, many psychologists concluded that the universe of personality traits can be subsumed under five broad dimensions. These five—extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience—generally make up the cornerstone of the first tier of McAdams's model. Variables at this level often have a physiological or genetic basis, and are hypothesized to change little, if at all, over long periods of time in adulthood.

The second tier is comprised of characteristic adaptations. This is a varied category that is made up of many different kinds of psychological constructs which in general are not as stable or biologically based as traits. Like traits, they are dispositions. However, they are more likely to change over comparable periods of time. Characteristic adaptations include such well-known constructs as coping strategies, goal orientations, defense mechanisms, self-efficacy, control beliefs, mastery, and optimism.

The third tier, life narrative, contains broad elements of personality, such as one's life story, autobiographical memory, and sense of identity. This is the level that most people think of when they contemplate their personalities. Few people see themselves in terms of traits or characteristic adaptations, but most think of their identities or their personal histories when asked to reflect on their personalities. The life narrative tier is hypothesized to change the most over time. As people live their lives, they constantly revise their autobiographies. One's sense of identity, which is often continuous over time, can be revised and modified to better fit one's life and experiences. Thus, at this level, personality should show more change over time than the other two levels (although such change has proven more difficult to assess).

This three-tier model is useful because it provides a framework for organizing the many types of personality variables that have been proposed, and because it allows one to think more clearly about which personality variables should be more stable and which should display more change. Traits should change the least, life narrative the most, and characteristic adaptations should fall in between.

However, there has been no research on stability and change at the life narrative level. Studies of characteristic adaptations have mostly examined stabilities over short periods (a year or less), mainly to establish test-retest reliability. Few studies have considered characteristic adaptations over the long term or have tried to estimate the extent to which they change or are stable.

Traits, on the other hand, have been studied extensively over the long term, with some studies following the same people for 30 years or more. These longitudinal investigations generally focus either on mean-level stability or rank-order stability. The former refers to constancy in the absolute level of a trait over a period of time, as assessed by the arithmetic mean. The latter indexes constancy over time in the relative ordering of people on a trait, and is usually assessed via the correlation coefficient (sometimes adjusted for the reliability of the measure). It gauges the extent to which people retain the same rank within the sample distribution. For example, everyone may decrease over time on a given trait, but if they all decline by roughly the same amount, then the rank ordering of people within the distribution will be preserved, hence giving rise to high rank-order stability. The higher the correlation coefficient between two points in time, the greater the level of preservation of the rank order over that period.

Mean-level stability. The literature focusing on mean-level stability generally has reported change in the Big Five traits over the course of adulthood. The means of extroversion, neuroticism, and openness usually decrease with age. The results with respect to agreeableness and conscientiousness are mixed. It is not clear whether agreeableness changes or not, because some investigations show increases; some, decreases; and others, no change. With regard to conscientiousness, most studies have documented increases, but some studies have shown no change over time.

Rank-order stability. There is a fair amount of consensus with respect to rank-order change. High correlations between measurements of personality on the same people over time means that the relative positions, or ranks, within the sample distribution remain the same. That is, if person A is higher than person B on extroversion at age 30, it is likely that A will still be higher than B at age 60 or 70. Most studies that have followed adults over long periods of time (five to thirty years) have found impressive rank-order constancy. However, these results depend on the length of the longitudinal follow-up period, as a meta-analysis of the literature on the rank-order stability of personality traits concluded (Robertson and Del Vecchio). The correlation coefficients tend to be in the range of .60 to .80 over short periods (less than seven years), but fall to .40 to .60 over longer periods of time (ten years or more). Nonetheless, even over periods of thirty years or more, investigators typically report impressive levels of rank-order constancy. Using extroversion as an example, this implies that a person who is extroverted at age thirty is likely

to remain extroverted at ages forty, fifty, sixty, and beyond.

However, the aforementioned meta-analysis concluded that rank-order stability is higher within samples of older adults when compared with samples of midlife or young adults. This would suggest that personality traits become more stable as people grow older. More specifically, relative positions within the distribution appear to become more fixed as older adulthood approaches. Personality traits, therefore, may be more likely to change during youth or middle age than in older adulthood. This does not mean that personality cannot or does not change during older adulthood; it simply means that it is less likely to do so.

Alternative ways of viewing trait stability and change

As valuable as they are, mean-level and rank-order methods often conceal the extent of individual differences in personality trait stability. A trait may show constancy in its mean over time and display strong rank-order consistency, but these statistics are based on groups and may mask change that occurs at the level of the person. Even if a correlation is strong between two time points, this does not mean that everyone retains the same rank order position over the time period. Some people may be changing even as others remain the same. This is essentially a question of individual differences in stability and change. Recently, researchers in this area have turned their attention to stability and change as manifested at the person level, and many are supporting the notion of personality stability and change as a phenomenon of individual differences. These investigators have argued that even if the majority of people show stability over time, not everyone does, and it is thus best to think of personality trait stability in an individual differences framework.

The idea of individual differences in stability and change is not a new one, and can be traced back to various conceptual works in life-span developmental theory, especially the writings of Paul B. Baltes and John R. Nesselroade. In particular, they and other life-span developmentalists have championed the concept of individual differences in intra-individual change. That concept combines the ideas of variability among people (individual differences) and of change that occurs within persons (intra-individual change). The latter requires the estimation of within-person change or stability. Historically, this has been difficult to study, hampered by a lack of adequate statistical techniques. However, beginning in the 1980s, such methods were developed, and by 2000 there were several approaches available to the researcher who wished to assess and analyze within-person change longitudinally.

These techniques are variously known as growth-curve modeling or random effects modeling, among other names. At their most effective, these models require that people be measured at a minimum of three time points, which allows the calculation of growth curves for each individual. The revolutionary aspect of these approaches is that the notion of individual growth curves allows conceptualization of a given trait within a given person as a personality trajectory. Previous research on personality stability and change (whether focusing on rank-order or mean level stability) typically considered only two time points (which allows calculation of only linear trajectories), yielding an impoverished representation of the possible complexity of individual differences in personality change. By the late 1990s, these shortcomings were apparent, and scholars in this area were turning their attention to the various models that allow estimation of trajectories.

The concept of the individual trajectory possesses theoretical relevance because it is the foundational metaphor of the developmental perspective. Before the advent of methods that allowed the estimation of individual trajectories, the basic building block of developmental research, including aging research, was the difference score. Difference scores are obtained by subtracting the score at one time from the score at another. However, difference scores are inherently limited as the basis for developmental analysis, and with techniques now available for modeling multiple occasions of measurement, the trajectory is replacing the difference score.

In addition, the notion of the trajectory allows scholars to link the idiographic and nomothetic traditions in the social sciences. The idiographic approach focuses on information about individual people to better understand unique persons, while the nomothetic position prefers data derived from samples of people in order to discover general laws. The tension between the two is partially resolved by the concept of the trajectory. Trajectories, such as growth

curves, can be estimated for large samples but also can be calculated for individuals, allowing for both idiographic and nomothetic analyses of data. Some have argued that the ideal personality theories are those which are broadly applicable to all persons, yet can still be used to explain the behavior of any single person, in essence integrating the idiographic and nomothetic approaches. The trajectory model may prove to be such an integrating force in the area of personality and personality development in the future.

By the late 1990s, investigators had begun applying trajectories techniques to longitudinal personality data. Trajectories can be studied in the aggregate (e.g., the overall trajectory for a sample), but are most interesting when applied to the study of multiple individuals, to permit an analysis of variation among people in trajectories. The key focus, as noted by Baltes and Nesselroade, is the question of interindividual differences in intra-individual change. Persons can differ on trait trajectories in the average level (how much of the trait a person has), the rate of change, and the direction of change. In a small number of studies, investigators have shown that there are significant differences in trajectories among individuals with respect to a number of personality dimensions, including traits. Some people have trait trajectories that rise; some, that fall; and some, that stay stable. Investigators have even found evidence of significant variability in trajectories among older adults. Thus, even as the rank-order stability of personality traits becomes higher among older adults, studies have shown that the ability to change remains. Even if the majority of people remain the same, or at least retain the same relative position within the distribution, it appears that many people do not. Trajectory modeling thus has shed valuable light on the issue of personality trait stability and change. Some people remain stable; others change. Investigators in this area have begun to search for the reasons why some people change and others remain stable.

DANIEL K. MROCZEK
AVRON SPIRO, III

See also DEVELOPMENTAL PSYCHOLOGY.

BIBLIOGRAPHY

BALTES, P. B., and NESSELROADE, J. R. "The Developmental Analysis of Individual Differences on Multiple Measures." In *Life-Span Developmental Psychology: Methodological Issues*. Edited by J. R. Nesselroade and H. W. Reese. New York: Academic Press, 1973. Pages 219–251.

BALTES, P. B.; REESE, H. W.; and NESSELROADE, J. R. *Life Span Developmental Psychology: Introduction to Research Methods*. Monterey, Calif.: Brooks Cole, 1977.

CASPI, A., and ROBERTS, B. W. "Personality Continuity and Change Across the Life Course." In *Handbook of Personality: Theory and Research*, 2d ed. Edited by L. A. Pervin and O. P. John. New York: Guilford Press, 1999. Pages 300–326.

COSTA, P. T., and MCCRAE, R. R. "Four Ways the Five Factors are Basic." *Personality and Individual Differences* 13 (1992): 653–665.

COSTA, P. T., and MCCRAE, R. R. "Set Like Plaster? Evidence for the Stability of Adult Personality." In *Can Personality Change?* Edited by T. F. Heatherton and J. L. Weinberger. Washington, D.C.: American Psychological Association, 1994. Pages 21–40.

JOHN, O. P. "The 'Big Five' Factor Taxonomy: Dimensions of Personality in the Natural Language and in Questionnaires." In *Handbook of Personality: Theory and Research*. Edited by L. A. Pervin. New York: Guilford Press, 1990. Pages 66–100.

JONES, C. J., and MEREDITH, W. "Patterns of Personality Change Across the Life-Span." *Psychology and Aging* 11 (1996): 57–65.

LAMIELL, J. T. "Individuals and the Differences Between Them." In *Handbook of Personality*. Edited by R. Hogan, J. A. Johnson, and S. R. Briggs. San Diego: Academic Press, 1997. Pages 120–150.

MCADAMS, D. P. "Can Personality Change? Levels of Stability and Growth in Personality Across the Life Span." In *Can Personality Change?* Edited by T. F. Heatherton and J. L. Weinberger. Washington, D.C.: American Psychological Association, 1994. Pages 299–314.

MCADAMS, D. P. "Personality, Modernity, and the Storied Self: A Contemporary Framework for Studying Persons." *Psychological Inquiry* 7 (1996): 295–321.

ROBERTS, B. W., and DEL VECCHIO, W. F. "The Rank Order Consistency of Personality Traits from Childhood to Old Age: A Quantitative Review of Longitudinal Studies." *Psychological Bulletin* 126 (2000): 3–25.

PETS

Pet ownership and animal companionship have become increasingly prevalent in the United States. In 1996, there were 111.9 million cats and dogs in the United States, with these animals living in nearly 60 percent of American households. In addition, more than 4.5 million homes had pet birds and 6.3 percent of homes had pet fish. Less common pets, such as rabbits, ferrets, hamsters, gerbils, turtles, snakes, and lizards could be found in 1.5 to 2.3 percent of all homes. While pets are most commonly found in homes of families with small children, dogs and cats can also be found in about one-third of the homes of people age sixty and over. Among seniors, pets are more commonly found in the homes of married couples, though pet attachment has been found to be stronger among people who live alone.

There are advantages and disadvantages to having a companion animal, many of which may be more acutely experienced by older people. Having a pet has been shown to have many beneficial social, emotional, physical, and physiological effects for people, but there are also costs involved in caring for and nurturing animals.

Benefits of animal companionship

Companion animals have been found to improve the physical, emotional, and social well-being of people, though many reported benefits are anecdotal or correlational. Compared to those without pets, animal guardians have been found to report less extensive medication-taking and fewer minor health problems, including indigestion, constipation, insomnia, cold sores, and headaches. They also tend to make fewer trips to the doctor and have shorter hospital stays when hospitalization does occur. Pet guardians over age sixty-five tend to have higher scores on measures of activities of daily living (ADLs) than those without pets. Furthermore, over the period of one year, older people who do not have pets tend to experience a greater decline in their ADL scores than people who do.

People with animal companions have been found to have fewer risks for heart disease—including lower blood pressure, lower cholesterol levels, and lower serum triglyceride levels—compared to non-pet-owners. While pets do not guarantee protection against heart disease, in a classic study by Erika Friedmann (1980), pet guardians who had suffered a heart attack were found to have higher survival rates after one year than those without pets. Pet owners tend to be more active than non-pet-owners, though many of the physical benefits provided by companion animals hold even when owners do not walk or exercise their pet.

In addition to physical benefits, a variety of psychological, emotional, and social benefits have been associated with pet companionship. Compared to non-pet-owners, people with animal companions have been found to experience less loneliness and isolation, to have lower rates of depression, and to have a greater sense of psychological and emotional well-being.

Contact with animals has been found to have a soothing effect on people. Whether measured by self-report or by physiological response, lower levels of anxiety have been found in the presence of a friendly animal. These effects are present in a variety of situations, including daily, routine activities and stress-provoking activities such as visits to the dentist. During exceptionally high stress periods, such as loss of a spouse, animal companions can act as a "stress buffer" (Siegel, 1990). In Alzheimer's disease nursing-home units, residents with regular contact with dogs have been found to be more calm and less agitated than residents without dog contact. Additionally, caregivers of persons with Alzheimer's fare better on some measures of psychological health when they own pets.

Having a pet can also combat feelings of uselessness. The tasks involved in daily animal care can make a person feel needed, as well as motivate a person to maintain stability and routine in his or her life. When a person's identity goes through transitions—at retirement, for instance—having a pet can provide a new or anchoring status. This in turn can promote human social bonding with other people with a similar status.

Other types of human social interaction are also promoted through animal companionship. Animals have been said to act as a "social lubricant" or "ice-breaker" in human interactions. In public spaces, being accompanied by an animal elicits friendly smiles and conversation from both strangers and acquaintances. When visiting pets are in a nursing-home setting, not only do residents and employees interact with the animal and the animal handler, but more interactions also occur between and among patients and staff.

The increasing amount of evidence regarding the physical, emotional, and social benefits of companion animals is having an effect on institutional residential facilities for older people. The Delta Society's Pet Partners Program, the Pets On Wheels program in Maryland, Therapy Dogs International, and various local humane societies have volunteer programs in which they bring trained pets (including dogs, cats, guinea pigs, and even llamas) into nursing homes to visit with the residents. Other programs, such as The Eden Alternative, attempt to provide an enriched environment in residential institutions, which includes not only incorporation of permanent pet residents, but also flower and vegetable gardens, interaction with young children, and other enhancing stimuli. Nursing-home director Bill Thomas founded The Eden Alternative as an attempt to combat boredom, helplessness, and loneliness in residential institutions. Eighteen months after altering the habitat of the first Eden Alternative home, the residents there were found to take fewer psychotropic medications and have lower mortality rates than similar older people in a more traditional nursing home environment. Thomas believes that within the Eden Alternative homes that now exist across the United States and Canada, the residents' commitment to caring for the animals provides them with a reason to continue living.

Costs of animal companionship

As much as animal companionship offers to the owner, there are also financial and emotional costs to pet ownership, as well as the possibility of physical costs. Animal bites are responsible for 1 percent of all emergency room visits. Animals can host and spread a large number of infectious and parasitic diseases, and even the healthiest and most well-behaved animals can produce allergic reactions in their human companions.

There are several financial costs of pet ownership, including housing costs, pet acquisition costs, veterinary care, and food. Costs can vary according to where the pet guardian lives, the type and size of animal, and the quantity and quality of care provided. Only around 5 percent of rental housing allows for pets, and pet owners who rent can expect to pay both a monthly fee and an up-front pet deposit to keep their pet with them. Acquiring a cat or a dog can cost as little as $15 at an animal shelter, or as much as $1,500 from a registered breeder. To spay or neuter a pet generally costs between $30 and $150. Besides the initial costs, there are annual costs to pet ownership: for a medium-sized dog, food costs can range from $200 to $400 a year; annual examinations and vaccinations can run between $50 and $200 every year. Other costs, such as grooming, toys, treats, leashes, collars, and bedding, can range from $150 to $1,200 annually. Furthermore, these pet-care costs assume a healthy animal; a sick or injured animal can incur extensive medical costs. As with older humans, older animals often demand increasingly frequent and costly health care; but there are no governmental and few private organizations that can help offset the costs of animal health care.

There are a few programs that can help to offset the costs of pet care for older Americans. For instance, the San Francisco SPCA's Pet-A-Care program provides a variety of services to persons over age sixty-five who have limited incomes, including free adoption, free and low-cost veterinary care, and, working with Meals-On-Wheels, free pet food.

While the routine of pet care can help to provide a focused distraction from other stresses in living, animal attachment provides its own sets of stresses and worries. Seniors may worry about who will provide care for their animal if they became unable to do so through physical or mental incapacity or as the result of a change in residence. While federal law allows for pet ownership by seniors (and the disabled) in public housing, many privately owned residential facilities and institutional environments do not allow pet ownership. Fear of recommended residential relocation to a place that does not allow pets has led some seniors to avoid their own health care and physician visits.

Loss of an animal companion can have similar effects to the loss of a human companion. People who become separated from their animal companions through moving into a facility that does not allow pets have been found to feel more negatively about the move, to have more difficulty making friends in the facility, and to have more difficulties sleeping in the new facility. When a pet dies, its guardian can experience grief in ways that mirror bereavement following the loss of a human loved one.

As increasing information and awareness becomes available about the negative consequences of losing a pet, attempts are being made to eliminate or mitigate this kind of loss. Groups like the

American Veterinary Medical Association (AVMA) and Humane Society of the United States (HSUS) are working to achieve relaxation of housing restrictions on pet ownership through legislative action and through programs like HSUS's Pets for Life program, which helps educate landlords about responsible pet ownership. In addition, pet bereavement hot lines and support groups, sponsored by humane societies, veterinary schools and organizations, and other groups are available through out the United States, Great Britain, and Canada.

While there are a variety of programs designed to help older people in maintaining companionship with animals, one area in which assistance is sorely lacking is in the area of daily pet care. Many independently living seniors have occasional difficulties with the care of their pets. Volunteer organizations could fill this gap by providing dog walking or animal grooming services, as well as transportation to the vet or store to obtain pet-care services and items. Organizations could also provide short-term emergency care for pets if the owner is temporarily hospitalized, as is done by the innovative U.K. organization Animals in Distress.

Older pet guardians may also worry about who would provide pet care in the case of the owner's death. Humane societies and veterinary associations recommend that all pet owners make arrangements for the care of their pets in the case of their own temporary or permanent incapacitation. In addition to discussing such arrangements with friends or family, pet owners can specify a caretaker in their will and earmark a portion of their estate to be provided for the care of the pet.

When there is no person available to take responsibility for a pet, the pet owner could consider other alternatives, such as animal sanctuaries that provide for the lifelong physical and social needs of pets when they lose their owners through death or disability. For example, owners are able to enroll their pets in the Home For Life's Angel Care program through a one-time program contribution of between $400 and $1700, depending on the contributor's age.

Animal companionship provides a variety of physical, emotional, and social benefits, but it is a responsibility that comes with a cost. A great number of older people prefer noninvolvement with pets, often because of the responsibility pet ownership entails. However, for people who do desire pets, the ability of companion animals to enhance the quality of life should be recognized and supported in medicine, housing, and legislation.

JENNIFER KAY HACKNEY

See also FRIENDSHIP; LONELINESS; QUALITY OF LIFE, DEFINITION AND MEASUREMENT; SOCIAL SUPPORT.

BIBLIOGRAPHY

ALLEN, K. *Companion Animals and Elderly People*. Renton, Wash.: Delta Society, 2001. Available at www.deltasociety.org

American Veterinary Medical Association. *U.S. Pet Ownership and Demographic Source Book*. Schaumburg, Ill.: AVMA Statistical Research Group, Division of Membership and Field Service, 1997.

ANDERSON, W. P.; REID, C. M.; and JENNINGS, G. L. "Pet Ownership and Risk Factors for Cardiovascular Disease." *Medical Journal of Australia* 157 (1992): 298–301.

Delta Society. "Pet Loss and Bereavement." Available at www.deltasociety.org

FRIEDMANN, E.; KATCHER, A. H.; LYNCH, J. J.; and THOMAS, S. A. "Animal Companions and One Year Survival after Discharge from a Coronary Care Unit." *Public Health Reports* 95 (1980): 307–312.

FRITZ, C. L.; FARVER, T. B.; HART, L. A.; and KASS, P. H. "Companion Animals and the Psychological Health of Alzheimer's Patients' Caregivers." *Psychological Reports* 78 (1996): 467–482.

HAUGHIE, E.; MILNE, D.; and ELLIOTT, V. "An Evaluation of Companion Pets with Elderly Psychiatric Patients." *Behavioural Psychotherapy* 20 (1992): 367–372.

MCNICHOLAS, J.; COLLIS, G.; and MORLEY, I. E. "Psychological and Physical Effects of Enforced Pet Loss on Older People Entering Residential Care." *Journal of the Society for Companion Animal Studies* 5 (1993).

MUGFORD, R. A., and M'COMISKY, J. G. "Some Recent Work on the Psychotherapeutic Value of Caged Birds with Old People." In *Pets, Animals and Society*. Edited by R. S. Anderson. London: Bailliere Tindall, 1975. Pages 54–65.

Newpet.com. "Know the Costs." Available at www.newpet.com

RAINA, P.; WALTNER-TOEWS, D. BONNETT, B.; WOODWARD, C.; and ABERNATHY, T. "Influence of Companion Animals on the Physical and Psychological Health of Older People."

Journal of the American Geriatric Society 47 (1999): 323–329.

San Francisco Society for the Prevention of Cruelty to Animals. "Pets and Older People Programs." San Francisco: SFSPCA, 2001. Available at www.sfspca.org

SIEGEL, J. M. "Stressful Life Events and Use of Physician Services Among the Elderly: The Moderating Effect of Pet Ownership." *Journal of Personality and Social Psychology* 58 (1990): 1081–1086.

ZASLOFF, R. L., and KIDD, A. H. "Loneliness and Pet Ownership among Single Women." *Psychological Reports* 75 (1994): 747–752.

PHYSICAL THERAPY FOR THE ELDERLY

Physical therapy has an important role in health care delivery, and is connected with maximizing function, preventing decline, decreasing pain, and treating physical illnesses. For elderly individuals, who often have decreased physical reserve, any medical illness can lead to decline. Inactivity and bedrest, a common consequence of illness, contributes to and intensifies muscle weakness, causing deterioration in walking and loss of function. Illnesses, such as Parkinson's disease, fracture, or stroke, can affect walking and balance directly. Chronic diseases, such as arthritis, may cause pain or restriction of movement. Exercise, activity, and other physical therapy interventions can therefore have a profound effect on overall health, restoring an individual's ability to perform the daily activities required to live independently in the community.

Assessment

Evaluation begins with a patient interview to determine the individual's perception of the problems and their goals for treatment, and then proceeds to a physical exam. Typically, a physical therapist will assess a wide array of abilities, including strength, balance, transfers (rise from a chair), and walk.

Assessment of muscle strength, through manual muscle testing, can determine whether the strength of a particular muscle, graded from five (normal) down to zero (completely dysfunctional). Muscle weakness is commonly associated with problems walking and climbing stairs, as well as falls. Appreciating the relationship between strength and function can clarify the expected degree of difficulty an individual will have with daily tasks. Other areas evaluated include sensation, range of movement, coordination, and muscle tone (i.e., a measure of ability to relax when an extremity is passively moved).

Pain is another common problem that limits abilities. If pain is present, it is important to determine the duration of pain, describe what exacerbates and relieves the pain, get an indication of severity, and formulate a comprehensive treatment plan for pain control.

Impaired balance will affect the ability to walk safely and can contribute to falling. By observing an individual in the sitting or standing position, static balance can be determined. Dynamic balance, or balance during movement, can be assessed by watching an individual's ability to react to perturbation and displacement.

Physical therapists will judge walking safety, evaluate gait patterns and posture, and appraise a person's ability to transfer safely from bed or chair to a standing position. Transfer and gait can be described by the amount of assistance that is needed to safely accomplish these tasks and can be grossly classified as independent needing assistance (of one or more people), or unable. A specific gait pattern may point to a medical diagnosis, such as Parkinson's disease, stroke, or uncontrolled pain.

Sometimes home safety assessments can delineate problems in the environment that predispose the patient to falling. Common problems include scatter rugs, poorly lit areas, low chairs, and clutter.

Assessment tools are frequently used to standardize evaluation and measure treatment outcomes. These tools allow the physical therapist to record and communicate information in a consistent fashion. For example, both the Berg Balance Scale (scored from 0–56 with 56 being the optimal score) and Functional Reach Test (ability to reach forward, calculated in inches) measure balance. Mobility scales include the Elderly Mobility Scale (scores a person's ability to transfer, stand, reach, and walk) Timed Up and Go (amount of time required for a person to rise from a chair, walk 3 meters, turn and return to a seated position in the chair), and a 6-Minute Walk Test (measure of the distance a person can walk in this time). There are many activities of daily living scales (Barthel Index and Lawton Brody) that can be used to document a person's abilities to carry out basic tasks (i.e., dressing, bathing, walking, hygiene).

Functional ability is important as it affects quality of life, emotional status, and ability to remain independent.

Treatment

Treatment must be tailored to the physical and functional problems identified during the assessment. Muscle weakness and lack of strength can be treated with resistance exercise. An exercise technique known as high-intensity resistance training (HIRT) can be used in different clinical settings, from nursing homes to community programs. Research shows that high-intensity resistance training is safe, well tolerated, and can increase muscle strength by as much as 113 percent. Even people who are very weak are able to tolerate and benefit from this form of exercise.

Pain control is essential to achieve optimal function and quality of life. Mechanical aspects of pain can be helped with sketching, the use of an aid or orthotic, or activity modification to achieve joint protection. Exercise can remediate pain, as is the case in osteoarthritis. Pain associated with inflammation or swelling can be treated with the use of modalities such as ice, heat, transcutaneous electrical stimulation (TENS), ultrasound, or acupuncture. Medications can be used adjunctively when necessary.

Gait and balance training is an integral part of treatment. Gait training is aimed at improving postural alignment, gait pattern, speed, safety, and endurance. A walking aid, such as a cane or walker, an orthotic, or appropriate footwear may be recommended. To help with stability, balance responses are practiced to promote appropriate reactions. Weight-shifting exercises and functional activities, such as reaching, can be helpful.

Aerobic conditioning can improve cardiovascular function and endurance and is an especially important component of a cardiac rehabilitation program.

These interventions often improve an individual's physical condition and restore function. Sometimes, physical problems cannot be entirely alleviated, but usually therapy can help an individual adapt to disabilities, allowing for increased independence and improved safety.

Interdisciplinary approach

The physical therapist typically works closely with other health care professionals, such as nurses, physicians, social workers, and occupational therapists, in order to refine both diagnosis and treatment. This interdisciplinary approach allows for integration of all domains of health to more fully address the needs of the elderly.

Conclusion

For the elderly population, illness can quickly affect physical stability and cause deterioration in walking. Alternatively, a decline in physical function can cause deterioration in health and quality of life. Therefore, physical therapy interventions are an essential aspect of health care delivery. Exercise and other therapeutic treatments provide options to address inactivity, muscle weakness, and specific physical and medical problems. Using these techniques, the physical therapist is able to improve function, optimize safety, and ameliorate painful or dysfunctional conditions.

LAURIE HERZIG MALLERY
ANDREA MUNROE

See also BALANCE AND MOBILITY; FRAILTY; FUNCTIONAL ABILITY; HOME AND HOME SERVICES; MULTIDISCIPLINARY TEAM; OCCUPATIONAL THERAPY; WALKING AIDS.

BIBLIOGRAPHY

FIATARONE, M. A.; O'NEILL, E. F.; DOYLE, R. N.; CLEMENTS, K. M.; SOLARES, G. R.; NELSON, M. F.; ROBERTS, S. B.; KEHAYIAS, J. J.; LIPSITZ, L. A.; and EVANS, W. J. "Exercise Training and Nutritional Supplementation for Physical Frailty in Very Elderly People." *The New England Journal of Medicine* 330, no. 25 (1994): 1769–1775.

GUCCIONE, A. A. *Geriatric Physical Therapy*. St. Louis, Mo.: Mosby–Year Book, Inc., 1993.

TINETTI, M. E., and SPEECHLEY, M. "Prevention of Falls among the Elderly." *The New England Journal of Medicine* 320, no. 16 (1989): 1055–1059.

PHYSIOLOGICAL CHANGES

It is evident even from casual observation of physical activities, such as walking, that elderly people exhibit a deterioration of physiological processes. Moreover, the inability of athletes to continue peak performance when they reach their thirties or forties indicates that deteriora-

tion begins at a relatively young age and progresses in severity from that point on. Indeed, many studies have confirmed that most physiological processes deteriorate progressively after about thirty years of age, some functions more severely affected than others.

Most of the research on age-associated physiological deterioration has utilized cross-sectional studies; that is, subjects of different ages are studied at a given point in time (e.g., the calendar year 1990). These are called cross-sectional studies because the data are collected from a cross section of the population. Since this study design provides information quickly and relatively inexpensively, it is widely used. However, because of generational factors and selective mortality, the cross-sectional design can yield erroneous information about aging.

An example of how a generational factor may confound an aging study is illustrated by a hypothetical 1970 cross-sectional study of cognitive function in which Americans in the third decade of life were compared with those in the tenth decade. It is critical to note that the average number of years of schooling of Americans has increased markedly during the twentieth century. Therefore, if this study finds cognitive ability of those in the tenth decade of life to be less than in those in the third decade, it may be due to the difference in educational level or to age-associated deterioration or to a combination of both. Such a study will not show to what extent aging per se plays a role in the findings.

Selective mortality refers to the fact that with increasing age, there is a decrease in the fraction of a birth cohort still alive, and that, on average, those with risk factors for common fatal diseases will die at younger ages than the rest of the cohort. Take, for example, a blood substance known to be a risk factor for a fatal disease. If it is lower in the tenth decade than in the seventh decade, it probably results from the fact that most of the cohort with high levels died before reaching the tenth decade, and not because of an age-associated decrease in blood level of this substance.

In summary, in studies with a cross-sectional design, the findings define age differences within a population at a point in time. These differences may or may not be due to aging, and further studies are needed to assess the role of aging.

One approach for this assessment is the use of longitudinal studies in which the same subjects are studied repeatedly over extended periods of time, for example, ten or twenty years. Such studies circumvent some of the problems inherent in cross-sectional studies, but longitudinal studies are costly and time-consuming. Moreover, they require that most subjects participate throughout the lengthy study, and that their environment and lifestyle do not change during the entire study. In addition, the methodology (analytic methods, instrumentation and skills of the technical personnel) used in the physiological measurements must be stable over this prolonged period of time. One can see that it is difficult to meet the many requirements of a longitudinal study.

Another approach has been the use of a combination of cross-sectional and longitudinal study designs. The bottom line is that investigators must be alert to the possibility of confounders when using the cross-sectional design, and thus, they should be open to utilizing various other approaches in their assessment of the changes in physiological processes due to aging.

Diseases that do not occur until, or increase in frequency at, advanced ages are called age-associated diseases. Coronary heart disease, stoke, many types of cancer, osteoporosis, Alzheimer's disease, Parkinson's disease, and osteoarthritis are examples of such diseases commonly found in elderly people. Indeed, age-associated disease underlies much of the physiological deterioration of old age. However, many investigators have chosen to select subjects who are free of discernible disease in what they refer to as the study of "normal aging." Not surprisingly, such studies have shown remarkably little physiological deterioration in those elderly subjects who are free of disease. For example, Edward Lakatta and his colleagues at the National Institute on Aging in Baltimore have found little deterioration of cardiovascular function even at advanced ages in subjects screened for the absence of coronary heart disease by the sensitive thallium stress test. However, it must be emphasized that "normal aging" is atypical, and that age-associated disease is the rule rather than the exception at advanced ages. Moreover, the concepts of evolutionary biology point to age-associated diseases as an integral part of aging.

In 1969, Ewald Busse of Duke University proposed the concept of primary and secondary aging. Primary aging was defined as universal age-changes, including physiological changes,

that are not caused by disease or environmental influences. Secondary aging was defined as changes involving interactions between primary aging and environmental influences and disease. This concept is gradually being discarded because of advances in our knowledge of the evolutionary biology of aging and the recognition that most genes do not function in a vacuum; rather, their expression is clearly the result of gene-environment interaction.

In humans as well as in many other species, there is much individual variation in occurrence, magnitude, and rate of progression of deterioration of the physiological systems. John W. Rowe of Mt. Sinai Medical Center in New York City and Robert L. Kahn of the University of Michigan have proposed the concept of "successful aging" to refer to the elderly who exhibit little physiological deterioration. They believe that factors, such as exercise, diet, personal habits and psychosocial influences, play the major role in achieving "successful aging." This focus is unfortunate because it is the interaction between genes and environment that usually plays the major role in physiological functions rather than genes per se or environment per se. Another concern is the implication by Rowe and Kahn that advanced age culminating in death occurs without marked physiological deterioration in those undergoing "successful aging." The facts simply do not support this. Most centenarians exhibit much physiological deterioration, although any of these individuals would have been described in their ninth decade of life as having undergone "successful aging." It is perhaps more appropriate to say that aging occurs slowly in some people, rather than to say they have undergone "successful aging."

EDWARD J. MASORO

See also EVOLUTION OF AGING; SUCCESSFUL AGING; SURVEYS; THEORIES OF BIOLOGICAL AGING.

BIBLIOGRAPHY

LAKITTA, E. G. "Cardiovascular Regulatory Mechanisms in Advanced Age." *Physiological Reviews* 73 (1993): 413–467.

MASORO, E. J., ed. *Handbook of Physiology, Section 11, Aging*. New York: Oxford University Press, 1995.

MILLER, R. A. "Aging and Immune Response." In *Handbook of the Biology of Aging*, 4th ed. Edited by E. L. Schneider and J. W. Rowe. San Diego: Academic Press, 1996.

ROWE, J. W., and KAHN, R. L. *Successful Aging*. New York: Pantheon, 1998.

SPIRDUSO, W. W. *Physical Dimensions of Aging*. Champaign, Ill.: Human Kinetics, 1995.

TALLIS, R.; FILLET, H.; and BROCKLEHURST, J. C., eds. *Brocklehurst's Textbook of Geriatric Medicine and Gerontology*, 5th ed. London: Churchill-Livingstone, 1998.

PHYSIOLOGICAL CHANGES, FIBROBLAST CELLS

Fibroblasts have been used since the 1960s as a cell-culture model for the aging of organisms. Fibroblasts are cells that produce and maintain the connective elements, or stroma, of most tissues. The stroma provides structure and regulatory signals to the functional cells of tissues (the parenchyma). Fibroblast cultures have provided a wealth of information about basic cellular processes, such as cell-cycle control, and they have provided insights into neoplastic transformation and cellular stress responses, both of which are prominent in aged organisms. The apparent aging that cells undergo in culture is a complex process, some features of which are apparent in aging organisms. Nonetheless, it is not yet clear to what extent the aging of cells in culture reflects aging in multicellular organisms.

Fibroblasts in vivo

Fibroblasts secrete extracellular matrix components of the stroma, such as collagens and fibronectin. In response to a wound or a need for tissue remodeling, they can also secrete enzymes that degrade the extracellular matrix. In addition, fibroblasts secrete a variety of factors that can stimulate or inhibit cell proliferation, differentiation, inflammation, or angiogenesis, depending on the state or need of the tissue. Fibroblasts divide relatively infrequently in resting tissues, but readily proliferate in response to tissue injury. This proliferation is generally driven by growth factors released from platelets upon wounding.

Fibroblasts in culture

Fibroblasts were among the first cell type to be propagated in culture, largely because they grow so readily out of most tissue explants. Standard tissue-culture conditions, particularly the use of serum (which contains platelet factors), re-

semble a wounded environment, and favor the growth of fibroblasts. It is therefore principally for historic reasons that fibroblasts, as opposed to other cell types, have been most extensively used to study cellular aging—or, more accurately, cellular senescence—in culture.

In the early 1960s, Leonard Hayflick and colleagues carefully documented the fact that normal human fibroblasts do not divide indefinitely in culture. Working with human fetal tissues, Hayflick showed that fibroblasts that grew out of tissue explants initially proliferated well, with population doubling times of about twenty-four hours. He then allowed the cells to completely cover the culture dish (grow to confluence) before dispersing and reseeding them at low density. This process is called passaging the cells. With each passage, the cultures gradually accumulated nondividing cells. After fifty or so doublings, the cultures consisted entirely of nondividing fibroblasts. This phenomenon was termed the *finite,* or *limited, replicative life span* of cells. Hayflick was the first to connect this loss of proliferative potential with aging, and termed the process that limits cell division *cellular aging.* It has also, and perhaps more accurately, been termed *replicative senescence.*

Since the 1960s, many cell types from many vertebrate species have been shown to have a limited replicative life span. Many of these studies have used cells in culture, but several have followed cells *in vivo* or cells serially transplanted into animals. Nonetheless, much of our knowledge about the causes and consequences of replicative senescence comes from studies of human fibroblasts in culture.

The senescent phenotype

Fibroblasts undergo striking physiological changes upon replicative senescence. Three major features distinguish a senescent fibroblast from its presenescent (early passage) counterpart: (1) an irreversible arrest of cell-cycle progression, (2) resistance to programmed cell death (apoptosis), and (3) a shift in function such that the cells no longer maintain the stromal extracellular matrix. Together, these changes are termed the *senescent phenotype.*

Growth arrest. Senescent cells, whether fibroblasts or other cell types, irreversibly arrest growth with an unreplicated or G1 DNA content. This growth arrest is due to two types of changes in gene expression: repression of certain genes that are essential for cell-cycle progression, and overexpression of certain genes that inhibit the cell cycle. In the case of fibroblasts, examples of genes that are repressed include those encoding the FOS proto-oncoprotein and the E2F1 transcription factor. FOS is important for the ability of fibroblasts to progress from the resting, quiescence (G0) phase through the G1 phase of the cell cycle (when cells prepare to synthesize DNA). E2F1 is important for entry into the S phase (when DNA synthesis occurs). Among the growth-inhibitory genes that are overexpressed in senescent fibroblasts are those encoding the p21 and p16 proteins—p21 and p16 inhibit cyclin-dependent protein kinases, the activities of which are essential for G1 progression; p16 is a tumor suppressor gene and appears to be critical for maintaining the senescence growth arrest in many, if not all, cell types.

Resistance to apoptosis. Fibroblasts, and several other cell types (e.g., T lymphocytes and epidermal keratinocytes), are more resistant to certain, although not all, stimuli that normally induce apoptosis. Consequently, senescent cells are quite stable. They have been shown to persist for many months or longer in culture. In addition, they very likely also persist *in vivo,* and hence accumulate with age.

Altered morphology and functions. One of the most visible changes that occur when cells reach replicative senescence is a change in morphology. Cell size or volume increases, often reaching double (or more) the presenescent size, and the cells accumulate intracellular vesicles, many of which are lysosomes. Fibroblasts become flatter and more irregularly shaped, showing more prominent intracellular actin fibers. For most cell types, the senescent morphology is quite distinct from that of proliferating, quiescent, or terminally differentiated cells from the same lineage.

The striking change in cell morphology very likely reflects, at least in part, the functional changes that accompany replicative senescence. In the case of fibroblasts, upon senescence the cells switch from a matrix-producing phenotype to a matrix-degrading phenotype. Senescent fibroblasts produce less collagen and elastin, which form the major structural and elastic fibers of the stroma, than presenescent cells. The decline in collagen and elastin production is not due to a general decline in matrix production,

because fibronectin, a cell-associated matrix molecule, increases. In conjunction with the decline in collagen and elastin, senescent cells overexpress several matrix metalloproteinases. These enzymes degrade the stromal fibers and extracellular matrix. Senescent fibroblasts also secrete pro-inflammatory cytokines and a variety of epithelial cell growth factors. Thus, senescent fibroblasts, despite their inability to divide, adopt a phenotype that at least partially resembles a wounding response. As discussed below, senescence-associated functional changes may have a greater impact on the aging organism than the loss of cell division potential.

Causes of the senescence response

The senescent phenotype was first, and most thoroughly, described for those fibroblasts that reached replicative senescence. During the 1990s, several lines of evidence showed that cells sense the number of divisions they have completed by the length of their telomeres. Telomeres shorten with each round of DNA replication owing to the biochemistry of DNA synthesis, and the fact that most normal somatic cells, including fibroblasts, do not express the enzyme telomerase. Fibroblasts, and many other cell types, arrest growth with the senescent phenotype when they acquire one or more critically short telomere.

During the late 1990s, it became apparent that a number of stimuli other that short telomeres also induce fibroblasts and other cells to arrest growth with a senescent phenotype. These stimuli include certain levels and types of DNA damage and the expression of certain oncogenes. In addition, conditions or agents that decondense chromatin, which causes silenced genes to be expressed, induce a senescence response in normal human fibroblasts. These stimuli induce a senescence response independent of cell division and telomere shortening, and the process that leads to the senescent phenotype has thus been termed *cellular senescence*. Thus, replicative senescence is a special example of the more general process of cellular senescence. Short telomeres, DNA damage, oncogene expression, and loss of gene silencing have all been implicated in the initiation or promotion of cancer. For this and several other reasons, cellular senescence is thought to be important for suppressing tumorigenesis.

Cellular senescence in vivo

Several lines of evidence suggest that senescent cells, including fibroblasts, exist and accumulate with age in at least some mammalian tissues in vivo. First, progressive telomere shortening, a hallmark of replicatively senescent human cells, occurs in some human tissues and cells (e.g., segments of the aorta and T lymphocytes) with increasing age. Second, some—but not all—studies show that fibroblasts from older donors have shorter replicative life spans than fibroblasts from younger donors. The discrepancy among studies may be due to genetic variation among individual donors or, more likely, the variation within even a single tissue in replicative history of the small regions that are sampled in biopsies. Indeed, there is substantial scatter in the data from even the most convincing studies showing an inverse correlation between donor age and replicative life span of fibroblasts from skin biopsies. That is, in all the studies, there are some cultures from young donors that senesce quickly, and some cultures from old donors that proliferate for many doublings. Third, in the mid-1990s a marker enzyme was described that increased when cells were induced to senesce by a variety of stimuli. Cells expressing this marker increased with age in some human and primate tissues. This marker enzyme, termed the senescence-associated beta-galactosidase (SA-Bgal), is expressed by replicatively senescent fibroblasts, epithelial and endothelial cells, and other cell types in culture. It is also expressed by fibroblasts induced to undergo a senescence arrest in response to DNA damage, oncogene expression, and agents that decondense chromatin. Fibroblasts and keratinocytes expressing SA-Bgal increase with age in human and monkey skin biopsies. In addition, retinal pigmented epithelial cells expressing this marker increase with age in the human retina. Together, these findings suggest that senescent cells, whether induced by cell division or other stimuli, progressively accumulate in at least some mammalian tissues.

Role of fibroblasts in aging stroma

The role of fibroblasts in aging tissue has been most extensively studied in mammalian skin. The skin is composed of two primary layers: the epidermis, which contains the major epithelial cells of the skin (epidermal keratinocytes), and the dermis, which is the stromal layer of the skin.

As with other stroma, the dermis is maintained in large part by fibroblasts, which secrete dermal collagens, elastin, and other extracellular matrix components. When the skin is wounded, fibroblasts secrete proteases to degrade the wounded matrix, and then synthesize new matrix. The fibroblasts also secrete growth factors to stimulate the keratinocytes to proliferate and close the wound and cytokines to attract macrophages to engulf and degrade debris.

Young skin is characterized by thick epidermal and dermal layers and relatively efficient wound healing. The epidermis contains numerous invaginations, or rete ridges, and the dermis contains dense collagen. Old skin, by contrast, is characterized by a thinner epidermis that contains fewer and shallower rete ridges. The dermis also becomes thinner, showing a marked loss of collagen and other fibers. Changes in the dermis are in large measure responsible for the loss of elasticity and wrinkling that is the hallmark of aging skin. In addition, wound healing slows with age. Aging is particularly sensitive to environmental influence in the skin: skin exposed to the sun (ultraviolet light) ages much more rapidly than sun-protected skin.

As discussed above, senescent fibroblasts appear to increase with age in human dermis, and senescent fibroblasts constitutively secrete factors that, ordinarily, are secreted only transiently during wound healing. These factors include interstitial collagenase and elastase, which are matrix metalloproteinases that degrade dermal collagens and elastin. Ultraviolet light can also induce these metalloproteinases, as well as cellular senescence, in fibroblasts. Thus, some of the hallmarks of aging skin, such as wrinking and loss of dermal elasticity, are likely due, at least in part, to the secretion of metalloproteinases by fibroblasts, which, in turn, may be due to cellular senescence and/or environmental exposure to ultraviolet light. Senescent and ultraviolet-damaged fibroblasts also secrete enzymes that degrade the basement membrane, the dense matrix onto which the epithelial cells are organized. This may contribute to the age-dependent thinning of the epidermis and the loss of rete ridges, as the basement membrane is critically important for the proper organization and function of epithelial cells.

Age-dependent changes in fibroblast physiology may also contribute to the increased incidence of cancer that is a hallmark of mammalian aging. Several lines of evidence suggest mutations and loss of normal tissue structure synergize to generate the exponential rise in cancer that occurs with age. Tissue structure and integrity are critically dependent on an intact stromal and basement membrane, both of which are disrupted by senescent or damaged fibroblasts. In addition, senescent fibroblasts secrete epithelial growth factors, which can stimulate the growth of epithelial cells that have acquired potentially oncogenic mutations.

In summary, fibroblasts undergo physiological changes with age. These changes are induced by environmental and intrinsic factors, and disrupt the integrity of the stroma and basement membrane. Both these structures are critical in order for epithelial cells, and hence tissues, to carry out their normal functions. These structures are also important for suppressing the progression of cancer.

JUDITH CAMPISI

See also CANCER, BIOLOGY; CELLULAR AGING; SKIN.

BIBLIOGRAPHY

CAMPISI, J.; DIMRI, G. P.; and HARA, E. "Control of Replicative Senescence." In *Handbook of the Biology of Aging,* 4th ed. Edited by E. Schneider and J. Rowe, New York: Academic Press, 1996. Pages 121–149.

CRISTOFALO, V. J., and PIGNOLO, ROBERT J. "Replicative Senescence of Human Fibroblast-like Cells in Culture." *Physiological Reviews* 73 (1993): 617–638.

DIMRI, G. P.; LEE, X.; BASILE, G.; ACOSTA, M.; SCOTT, G.; ROSKELLEY, C.; MEDRANO, E. E.; LINSKENS, M.; RUBELJ, I. ; PEREIRA-SMITH, O.; PEACOCKE, M.; and CAMPISI, J. "A Biomarker that Identifies Senescent Human Cells in Culture and in Aging Skin In Vivo." *Proceedings of the National Academy of Sciences USA* 92 (1995): 9363–9367.

DONJACOUR, A. A., and CUNHA, G. R. "Stromal Regulation of Epithelial Function." *Cancer Treatment Research* 53 (1991): 335–364.

HAYFLICK, L. "Human Cells and Aging." *Scientific American* 218 (1968): 32–37.

MARTIN, G. M.; SPRAGUE, C. A.; and EPSTEIN, C. J. "Replicative Life Span of Cultivated Human Cells. Effect of Donor's Age, Tissue, and Genotype." *Laboratory Investigations* 23 (1970): 86–92.

MAYS, P. K.; MCANULTY, R. J.; CAMPA, J. S.; and LAURENT, G. J. "Age-related Alterations in

Collagen and Total Protein Metabolism Determined in Cultured Rat Dermal Fibroblasts: Age-related Trends Parallel Those Observed in Rat Skin In Vivo." *International Journal of Biochemistry and Cell Biology* 27 (1995): 937–945.

YAAR, MINA. "Molecular Mechanisms of Skin Aging." *Advances in Dermatology* 10 (1995): 63–75.

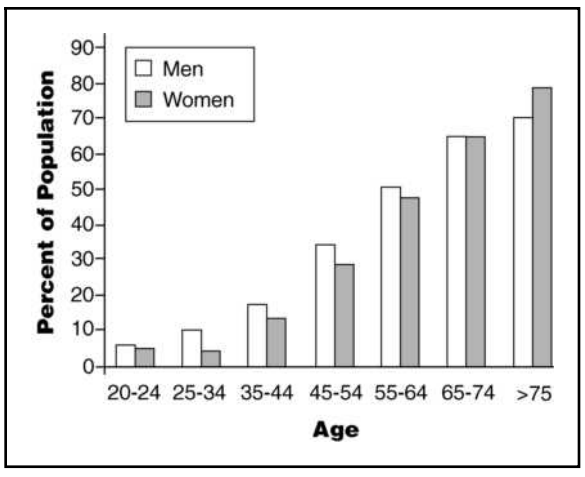
PHYSIOLOGICAL CHANGES: ORGAN SYSTEMS, BONE

See OSTEOPOROSIS

PHYSIOLOGICAL CHANGES, ORGAN SYSTEMS: CARDIOVASCULAR

The cardiovascular system undergoes a large number of changes with advancing age, some of which occur in the apparent absence of disease; and many of which are either caused by, or exacerbated by, disease. Cardiovascular diseases comprise a group that accounts for nearly one-half of all deaths in the United States. The incidence of noncongenital cardiovascular maladies, e.g., congestive heart failure, increases dramatically with advancing age (see Figure 1). Cardiovascular diseases conspire with advancing age and a number of unhealthful lifestyle factors (e.g., smoking, physical inactivity, high-fat diet) to create the dangerous scenario that leads to a high incidence of cardiovascular events (heart attack, stroke) in older persons. To understand how aging contributes to cardiovascular disease and dysfunction, it is necessary to define the changes that occur "naturally" with advancing age in apparently healthy individuals without detectable cardiovascular disease.

Figure 1
Estimated prevalence of cardiovascular diseases in Americans age 20 and older by age and sex from 1986 to 1994.



SOURCE: NHANES III (1986–1994), Centers for Disease Control/National Center for Health Statistics, and the American Heart Association

Heart structure and function at rest

Changes in heart size and shape with advancing age. The left ventricle (LV) is the largest heart chamber in terms of muscle mass and pumps blood, under pressure, to the entire body (see Figure 2, Panels A and B). Studies of volunteer subjects without cardiovascular disease, indicate that, at rest, the LV cavity size at enddiastole (filled) and end-systole (emptied), increases moderately with age in healthy, normotensive, sedentary men, but does not vary with age in women. The LV wall thickness increases progressively with age in both sexes. The age-associated increase in left ventricular wall thickness is caused mostly by an increase in the average size of cardiac myocytes (muscle cells). An increase in the amount of, and a change in the physical properties of, collagen (a protein that holds the myocytes together) also occurs within the myocardium with aging. In summary, the heart of a normal healthy older individual is somewhat larger, and slightly stiffer, than that of a younger person.

There is an increase in elastic and collagenous tissue in all parts of the heart's conduction system with advancing age (see Figure 2C). Fat accumulates around the sinoatrial (SA) node, sometimes producing a partial or complete separation of the node from the atrial musculature. Beginning by age sixty, there is a pronounced decrease in the number of pacemaker cells in the SA node, and by age seventy-five less than 10 percent of the pacemaker-cell number found in the young adult remains. A variable degree of calcification of the left side of the cardiac skeleton, which includes the aortic and mitral annuli, the central fibrous body, and the summit of the interventricular septum, occurs with aging. Because of their proximity to these structures, the

Table 1
Seated Rest—Changes in cardiac output regulation between 20 and 80 years of age in healthy humans

• Cardiac Output[1,2]		no change
• Heart Rate	⇓	(10%)
• Stroke Volume[1,2]	⇑	(10%)
Preload		
EDV[1,2]	⇑	(12%)
Early filling	⇓	
Late filling	⇑	
Afterload		
Compliance	⇓	
Reflected waves	⇑	
Inertance	⇑	
PVR		no change
Contractility		no change
• Ejection Fraction (EF)		no change
• LV mass	⇑	

[1] Corrected for body size
[2] Females differ from males - see text.

EDV—end-diastolic volume; PVR—peripheral vascular resistance; LV—left ventricle. Definitions: Cardiac output—amount of blood pumped by the heart per minute. Heart rate—number of beats per minute. Preload EDV—the amoung of blood in a ventricle at the beginning of contraction. Afterload—the amount of force resisting the pumping action of the heart. Contractility—the strength of the heart muscle contraction. Ejection fraction—the percentage of the EDV that is ejected on each beat.
SOURCE: Author

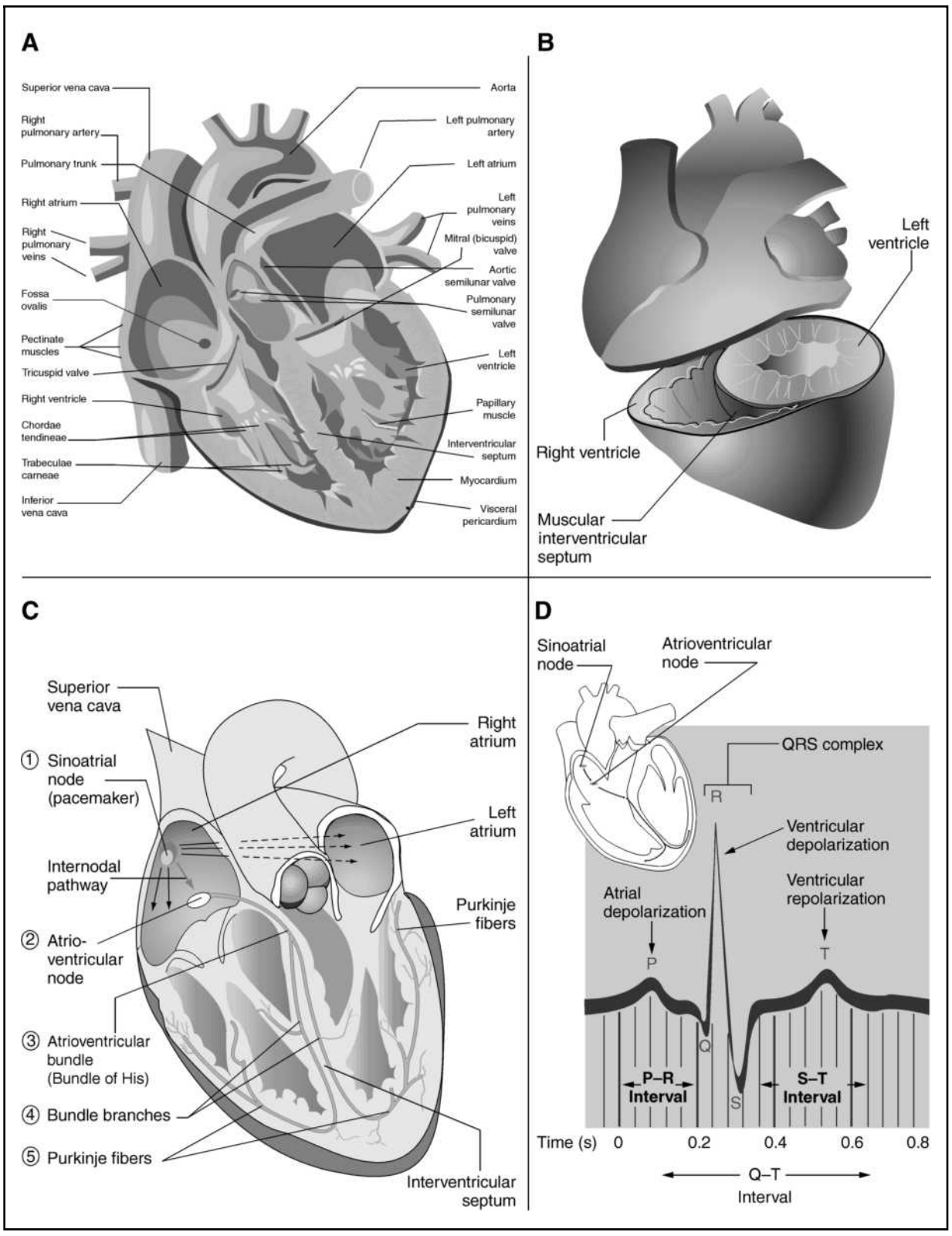
atrioventricular (AV) node, AV bundle, bifurcation, and proximal left and right bundle branches may be affected by this process. These structural changes in the cardiac conduction system are associated with a number of functional changes that can be observed in the electrocardiogram of an elderly person.

Age-associated changes in heart function at rest. When a person is in the sitting position, the resting heart rate decreases slightly with age (in both men and women). Tiny beat-to-beat variations in resting heart rate are normal, and become diminished with advancing age. This decreased heart-rate variability is likely related to changes in the parasympathetic and sympathetic nervous systems as an age. The P-R interval is the time it takes for the signal that initiates the heartbeat to travel from the conduction system in the heart (the AV node and the AV bundle). A modest prolongation of the P-R interval (see Figure 2D) of the electrocardiogram occurs with aging in healthy individuals, and is localized to the proximal P-R interval, probably reflecting delay within the atrioventricular junction. An increase in the number of premature beats occurs in healthy older men and women compared to their younger counterparts. These changes in the regulation of the heartbeat by the nervous system and the cardiac conduction system are observed in normal healthy individuals as they age, and although they do not by themselves interfere with heart function, they are associated with an increased risk of adverse heart events. More severe changes in the cardiac conduction system are associated with diseases and are often treated by implanting an artificial pacemaker.

The peak rate at which the LV fills with blood during early diastole is reduced by 50 percent between the ages of twenty and eighty. The time course of early myocardial relaxation becomes prolonged by 40 percent with adult aging in both men and women, probably due to alterations in LV wall structure and collagen properties and changes in the relaxation phase of cardiac muscle contraction. Different parts of the ventricle relax at different rates in hearts of older individuals, and this contributes to the reduction in the filling rate. The age-associated reduction in the early filling rate does not result in a reduced end-diastolic volume in healthy older individuals, because greater filling occurs later in diastole, particularly during the atrial contraction. The enhanced atrial contribution to ventricular filling with advancing age is associated with left atrial enlargement, and a more forceful atrial contraction. So, although ventricular filling in a resting older person is accomplished differently, it is as adequate as ventricular filling in a younger person.

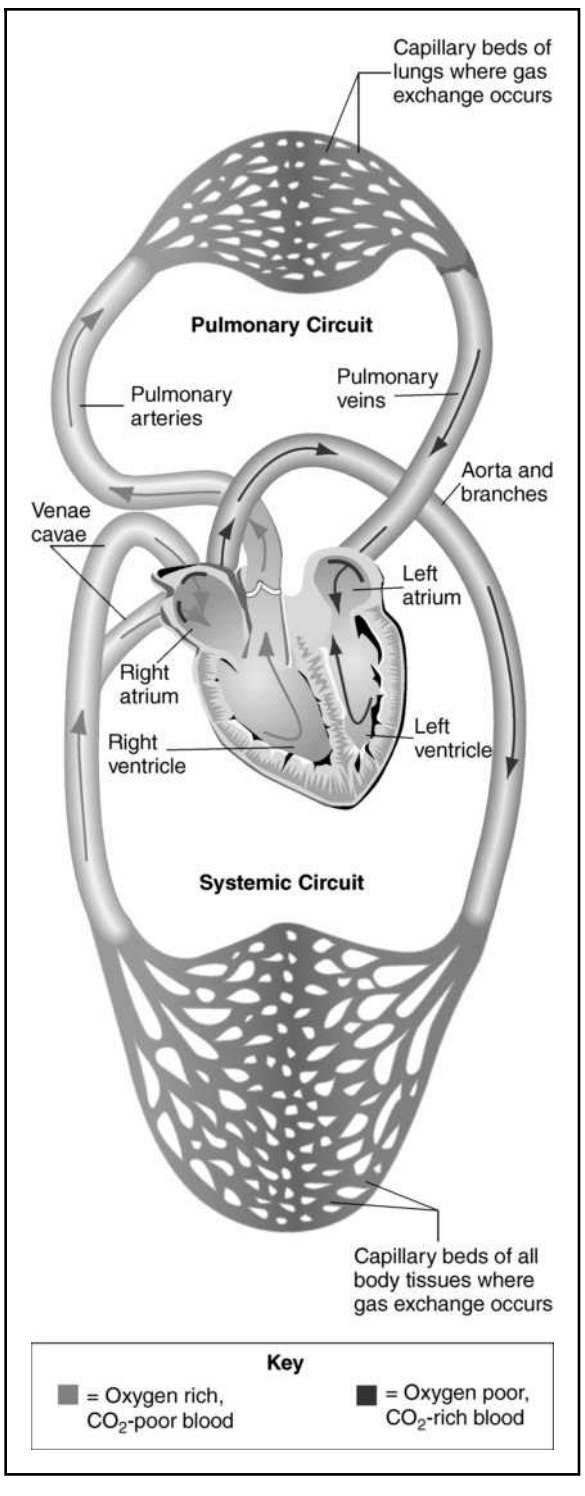
The *contractility,* or strength, of heart muscle contraction is not reduced at rest with age in either healthy men or women. The LV ejection fraction (EF) is also not altered with aging in healthy men or women at rest. The *stroke volume index* (SVI; amount of blood pumped per beat/body surface area) is increased in males, due to a slight increase in the LV end-diastolic volume. Thus, in healthy older men, the *cardiac output* (amount of blood pumped per minute) is not reduced, because the stroke volume index is increased, due to end-diastolic enlargement Cardiac output at rest is slightly decreased in

Figure 2
Basic anatomy of the heart and its conduction system. For a complete description of this figure, see "Figure Legend: Figure 2" at the end of the essay.



SOURCE: Adapted from: Marieb, Elaine. *Human Anatomy and Physiology.* San Francisco: Benjamin Cummings, 2001.

Figure 3
The pathway of blood through the heart and body.



SOURCE: Adapted from: Marieb, Elaine. *Human Anatomy and Physiology.* San Francisco: Benjamin Cummings, 2001.

older women (compared to younger healthy women) as neither the resting *end-diastolic volume* (EDV) nor SV increases with age to compensate for the modest reduction in heart rate. These gender differences appear to be an artificial effect of differences in body composition—the proportion of body fat increases with age in women to a greater extent than in men. If one compares the younger and older heart at any point during the resting heartbeat, the older heart contains more blood. Therefore, at rest, the heart of an older healthy individual pumps blood as well as the heart of a younger person, but does so in a slightly different manner.

Reserve capacity of the heart

At rest, the heart of an average person pumps approximately five liters of blood per minute (cardiac output). The cardiac output can increase dramatically when demand for blood flow increases during physical activity. During maximal exercise, the cardiac output can be as high as thirty-five liters per minute. This tremendous capacity of the heart to increase its pumping ability is accomplished by increasing the heart rate and stroke volume and is termed the *reserve capacity* of the heart. The heart rate and stroke volume can be measured during exercise to assess the reserve capacity of the heart, and the overall capacity of the body to exercise is assessed by measuring the maximal rate of oxygen consumption (VO_2 max). The reserve capacity of the body is important for two reasons. First, it allows an individual to meet the needs required by physical work and play. Second, the reserve capacity of the heart provides a margin of safety that allows one to survive the effects of cardiovascular diseases.

Exercise response. The peak work rate and oxygen consumption of healthy, sedentary men and women during upright, seated, bicycle exercise, declines by approximately 50 percent with advancing age between twenty and eighty years of age. This is attributable to approximate declines of 25 percent in cardiac output and 25 percent in oxygen utilization (the ability of the skeletal muscles to extract oxygen from the blood and the ability of the vascular system to deliver blood [$(A\text{-}V)O_2$ difference, see Table 2]). The age-associated decrease in cardiac output is during peak exercise is due entirely to a reduction in maximal heart rate, as the stroke volume index does not decline with age in either men or

Table 2
Exhaustive upright exercise—changes in aerobic capacity and cardiac regulation between ages of 20 and 80 years in healthy men and women
SOURCE: Author

• Oxygen Consumption (VO^2)	⇓	(50%)
• $(A\text{-}V)O_2$ Difference	⇓	(25%)
• Cardiac Output[1]	⇓	(25%)
• Heart Rate	⇓	(25%)
• Stroke Volume		no change
Preload		
EDV	⇑	(30%)
Afterload	⇑	
Vascular (PVR)[2]	⇑	(30%)
Cardiac (ESV)	⇑	(275%)
Cardiac (EDV)	⇑	(30%)
Contractility	⇓	(60%)
• Ejection Fraction (EF)	⇓	(15%)
• Plasma Epinephrine and Norpeinephrine	⇑	
• Cardiac and Vascular Responses to ß-Adrenergic Stimulation	⇓	

[1] Corrected for body size
[2] Females differ from males - see text.

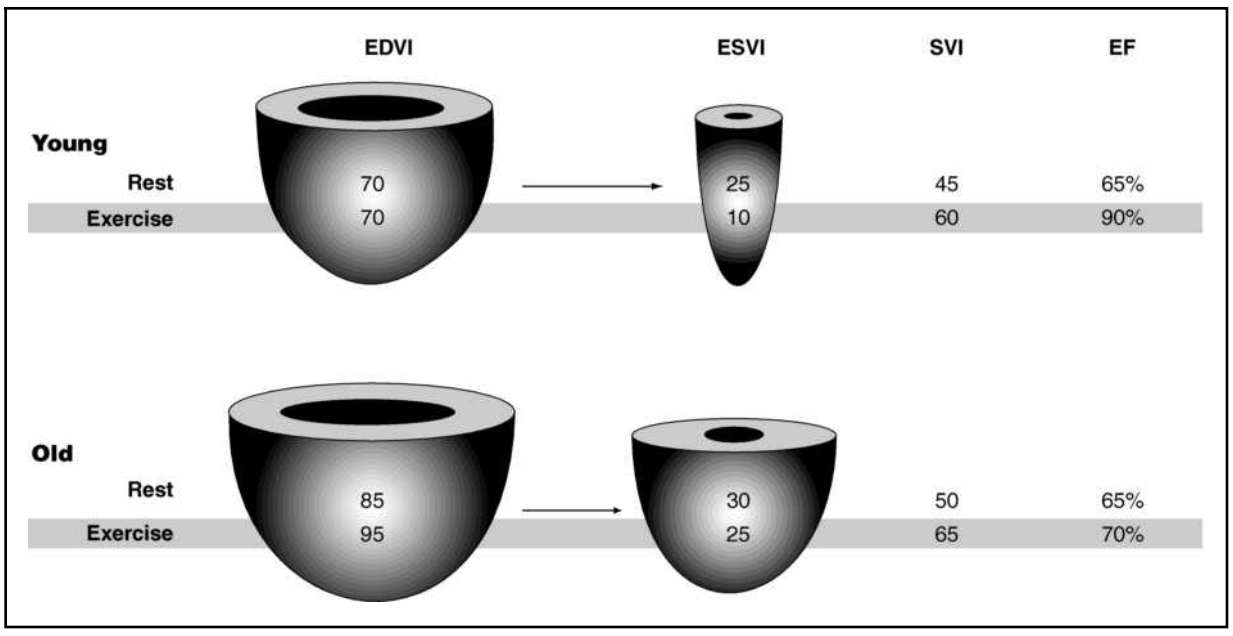
Abbreviations: A-V—aterial-venous; PVR—peripheral vascular resistance; ESV—end-systolic volume; EDV—end-diastolic volume. Definitions: Oxygen consumption (VO_2)—the maximum rate at which the body can use oxygen (a measure of overall fitness that reflects both cardiovascular and peripheral components). $(A - V)O_2$ Difference—the difference in arterial and venous oxygen content (reflects how well the skeletal muscles extract oxygen from the blood). Cardiac output—amount of blood pumped by the heart per minute. Heart rate—number of beats per minute. Stroke volume—amount of blood pumped with each beat. Preload EDV—the amount of blood in a ventricle at the beginning of contraction. Afterload—the amount of force resisting the pumping action of the heart. Contractility—the strength of the heart muscle contraction. Ejection fraction—the percentage of the EDV that is ejected on each beat. Epinepherine and noreepinepherine (adrenaline and nonadrenaline) are substances released by the nervous and endocrine systems during crises and during exercise; they act by binding to a β-adrenergic receptors in the heart and blood vessels, thereby increasing the speed and strength of heart contractions and contracting the blood vessels,

women. However, the manner in which stroke volume is achieved during exercise varies dramatically with aging. The EDV increases during vigorous exercise in older, but not younger, men and women (see Figure 4). But, because the end-systolic volume (ESV) in older persons fails to become reduced to the same extent as in a younger individual, the percentage of the total blood ejected per beat (EF) decreases, and the SV is not greater, in older persons. In other words, while the Frank-Starling mechanism (a unique property of the heart that results in a stronger heartbeat when more blood is present in the heart at the beginning of a contraction) is utilized in older persons during exercise, its effectiveness is reduced because the LV of an older person does not empty to the extent to which it does in younger individual. Thus, the older heart, while contracting from a larger preload (amount of blood in the ventricle at beginning of contraction) than the younger heart at all levels of exercise, delivers a stroke volume that equals that of the younger heart.

The deficiency in the ability of the old heart to "squeeze down" and reduce LV end-systolic volume during exercise in healthy older individuals likely results from increased stiffness of the arteries, from decreased contractility of the heart muscle, and from a decline in the response of the heart to the sympathetic nervous system (β-adrenergic responsiveness).

β-Adrenergic modulation of cardiovascular performance. During exercise, excitement or stress, the sympathetic nervous system becomes activated and releases norepinephrine and epinephrine (commonly referred to as adrenaline). Norepinephrine and epinephrine act in the heart by binding to β-adrenergic receptors and increases both the heart rate and the strength of contraction. β-adrenergic receptors mediate the effects of the hormones/neuro-transmitters norepinephrine and epinephrine (commonly referred to as adrenaline). They are important in regulating the heart rate and strength of each beat. Without β-adrenergic receptors, the adrenaline produced by the nerves and adrenal gland, would have no effect on the heart. One of the most prominent changes in the cardiovascular response to exercise stress that occurs with aging in healthy individuals, is a reduction in the ability of norepinephrine and epinephrine to activate the β-adrenergic system of the heart, thereby limiting the maximum heart rate and the strength of contraction in the aging heart. Resting sympathetic nervous activity increases progressively with aging, as does the sympathetic response to any perturbation from the resting state. Plasma levels of epinephrine and norepinephrine increase with age, due to enhanced

Figure 4
Illustration of age-associated dilatation of the left ventricle. All volumes are indexed to body surface area and given in ml/m². EDVI is the acronym for end systolic volume index; SVI, stroke volume index; EF, ejection fraction. The young subjects were between 20 and 30 years old, and the old subjects were between 80 and 90 years old.



SOURCE: Adapted from: Fleg, J. L.; O'Connor, F. C.; Gerstenblith, G.; Becker, L. C.; Clulow, J.; Schulman, S. P.; and Lakatta, E.G. "Impact of Age on the Cardiovascular Response to Dynamic Upright Exercise in Healthy Men and Women." *Journal of Applied Physiology* 78 (1995): 890–900

spillover into the circulation and to reduced clearance. The increased spillover does not occur from all body organs, but is increased within the heart, and is thought to be due, in part at least, to a reduced reuptake by the nerve endings following release. The net result is likely an enhanced post-synaptic receptor occupancy by neurotransmitter, leading to β-adrenergic receptor desensitization. Deficits in β-adrenergic signaling with aging are attributable, in large part, to changes in enzymes and proteins that relay the signals from the β-adrenergic receptor to the molecules inside the heart muscle cell that control the rate and force of contraction.

Vascular structure and function at rest

Vascular changes occur with aging among sedentary volunteers who are considered to be otherwise healthy. The large elastic arteries exhibit an increase in wall thickness and become dilated. Age-associated changes within the vessel media (middle muscular layer of the artery wall), which account for the increase in the diameter of conduit arteries, result from many factors including a relative decrease of elastin (a structural protein with elastic properties) and an increase of collagen (a rigid structural protein). Many chemical properties of elastin deteriorate and the elastin fibers become frayed, resulting in an increased stiffness of the arteries.

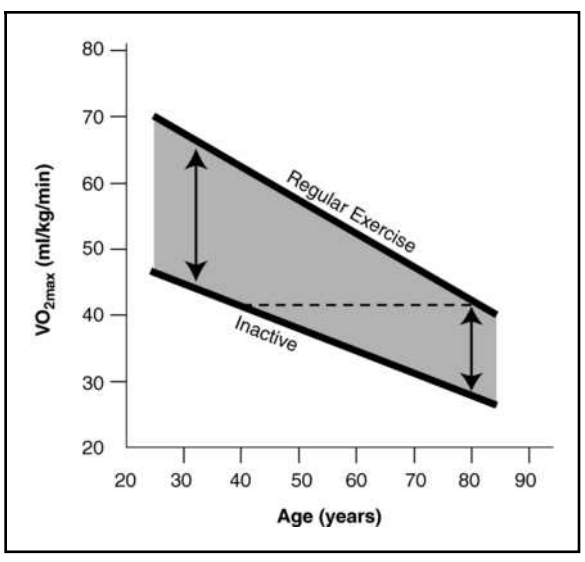
With advancing age, the increased pulse-wave velocity, due to increased arterial stiffness, causes pulse-wave reflections from distal arterial branch points to arrive back at the origin of the large arteries prior to closure of the aortic valve, imparting a late augmentation of the systolic pressure and the pulse pressure (the difference between systolic and diastolic pressures). The diastolic pressure amplification due to the normal occurrence of the reflected waves in diastole is reduced in older individuals, and this is associated with a poorer prognosis for patients with cardiovascular diseases.

As a result of arterial stiffening and early reflected pulse waves, the average systolic blood pressure within a healthy, normotensive population increases (within the normal range) with aging, whether measured in a cross-sectional study design or longitudinally. Many individuals show little or no longitudinal increase in systolic pressure, and age-associated increases in blood pressure are therefore neither universal nor inevitable. The average increase in diastolic pressure with aging is modest and is not as marked as the average increase in systolic pressure. An increase in peripheral vascular resistance (PVR; opposition to flow) accompanies aging in some, but not all, individuals, and may be secondary to a reduction in skeletal muscle mass with aging and its a concomitant reduction in capillary density. In healthy men PVR, measured at rest, increases minimally with aging, and it increases moderately in women.

Effects of regular exercise

Regular aerobic exercise impacts cardiovascular function directly by improving the reserve capacity of the heart. The exercise capacity of both inactive persons and highly trained athletes declines with age at a similar rate (see Figure 5). While regular exercise does not prevent aging, individuals at any age can improve their cardiovascular fitness to the same extent by engaging in a program of regular aerobic exercise. For example, a highly trained and fit seventy-five year-old may achieve a maximal oxygen consumption (VO_{2max}) similar to that of a thirty-five year-old inactive individual. Physical inactivity is a major risk factor for cardiovascular diseases in industrialized countries—it has been estimated that 250,000 Americans die prematurely from improper diet and lack of exercise each year. Thus, older individuals may benefit from regular aerobic exercise as much as, or even more than, younger persons.

Figure 5
Maximal oxygen uptake (VO_{2max}) declines in linear fashion for both trained and untrained individuals. Lines for individuals that engage in regular exercise and inactive persons are based on norms established from cross-sectional data of Heath et al. Longitudinal data from individuals studied over a twenty-year span confirm both the linearity and slope (Pollack et al.). Individuals may move vertically within the gray area by increasing or decreasing their levels of regular exercise training (Schulman et al., Trappe et al., Pollack et al.). Longitudinal studies suggest the upper line (individuals who exercise regularly) may be parallel, less steep, or more steep in men, while the most compelling data suggests that the upper line declines at a steeper rate for women (Tanaka et al., Fitzgerald et al.).



SOURCE: Numerous journal articles were used to create this figure. Please consult the bibliography for this essay to locate all of the articles cited in the caption above.

Figure 2: figure legend

Figure 2 shows the basic anatomy of the human heart and its conduction system. Here is a more detailed version of the caption that accompanies that image: Panel A shows the front view of the heart cut vertically. Panel B shows a front view of the heart cut horizontally. Panel C is a front view of the heart cut vertically to show how the signal to begin a heart beat is initiated in the sinoatrial node and conducted to the rest of the heart by the atrioventricular node and bundle, the bundle branches, and the purkinje fibers. Panel D is an electrocardiogram showing how electrical events in the cardiac conduction system relate to P, QRS, and T waves.

MARVIN O. BOLUYT
EDWARD G. LAKATTA

See also EXCERCISE; HEART DISEASE; HIGH BLOOD PRESSURE.

BIBLIOGRAPHY

FITZGERALD, M. D.; TANAKA, H.; TRAN, Z. V.; and SEALS, D. R. "Age-Related Declines in Maximal Aerobic Capacity in Regularly Exercising vs. Sedentary Women: A Meta-Analysis." *Journal of Applied Physiology* 83, no. 1 (1997): 160–165.

FLEG, J. L.; O'CONNOR, F. C.; GERSTENBLITH, G.; BECKER, L. C.; CLULOW, J.; SCHULMAN, S. P.; and LAKATTA, E. G. "Impact of Age on the Cardiovascular Response to Dynamic Upright Exercise in Healthy Men and Women." *Journal of Applied Physiology* 78 (1995): 890–900.

HEATH, G. W.; HAGBERG, J. M.; EHSANI, A. A.; and HOLLOSZY, J. O. "A Physiological Comparison of Young and Older Endurance Athletes." *Journal Applied Physiology* 51 (1981): 634–640.

KANNEL, W. B., and BELANGER, A. J. "Epidemiology of Heart Failure." *American Heart Journal* 121 (1991): 951–957.

LAKATTA, E. G. "Cardiovascular Regulatory Mechanisms in Advanced Age." *Physiological Reviews* 73 (1993): 413–467.

POLLOCK, M. L.; MENGELKOCH, L. J.; GRAVES, J. E.; LOWENTHAL, D. T.; LIMACHER, M. C.; FOSTER, C.; and WILMORE, J. H. "Twenty-year Follow-Up of Aerobic Power and Body Composition of Older Track Athletes." *Journal Applied Physiology* 82 (1997):1508–1516.

SCHULMAN, S. P. et al. "Continuum of Cardiovascular Performance Across a Broad Range of Fitness Levels in Healthy Older Men." *Circulation Research* 94 (1996): 359–367.

TANAKA, H.; DESOUZA, C. A.; JONES, P. P.; STEVENSON, E. T.; DAVY, K. P.; and SEALS, D. R. "Greater Rate of Decline in Maximal Aerobic Capacity with Age in Physically Active vs. Sedentary Healthy Women." *Journal of Applied Physiology* 83 (1997): 1947–1953.

TRAPPE, S. W.; COSTILL, D. L.; VUKOWICH, M. D.; JONES, J.; and MALHAM, T. "Aging Among Elite Distance Runners: A 22-Year Longitudinal Study." *Journal of Applied Physiology* 80 (1996): 285–290.

WHITE, M.; RODEN, R.; MINOBE, W.; KHAN, M. F.; LARRABEE, P.; WOLLMERING, M.; PORT, J. D.; ANDERSON, F.; CAMPBELL, D.; and FELDMAN, A. M. "Age-related Changes in β-Adrenergic Neuroeffector Systems in the Human Heart." *Circulation* 90 (1994): 1225–1238.

PHYSIOLOGICAL CHANGES, ORGAN SYSTEMS: SKELETAL MUSCLE

Forty percent of the body mass is made up of some three hundred and fifty skeletal muscles with each muscle composed of hundreds of thousands of cells, termed fibers. Each fiber consists of overlapping thick and thin protein filaments organized longitudinally in repeating patterns. Muscle fibers have the unique capacity to utilize energy in the form of adenosine triphosphate (ATP) to force the thick and thin filaments to slide past one another and contract, or shorten (Vander et al.). The fibers in each muscle are organized in motor units composed of a motor nerve and the branches of the nerve to individual muscle fibers. Motor units range in size from only a few fibers for units required for fine motor control of fingers or eyes to many hundreds of fibers for control of large movements of arms, legs, or torso. Within a single motor unit, all of the fibers are of the same type: slow-fatigue resistant (SFR), fast-fatigue resistant (FFR), or fast-fatigable (FF). The designation of motor units as fast or slow is based on the velocity of shortening of the fibers with FF units contracting four times faster than SFR units and FFR units intermediate between the other two (Kadhiresan et al.). Consequently, for a given mass of muscle, FF units are four times as powerful as units.

The fatigability of fibers is a function of the rate of energy use (power) and the rate of energy production. For muscle fibers, the mitochondrial density in a fiber and the rate of delivery of oxygen to the fiber determines the rate of energy production (ATP). FF fibers fatigue quickly, because they develop high power, but have low rates of energy production. SFR fibers have a high level of endurance (low fatigability) with low power, but relatively high energy production. FFR fibers are intermediate in both categories. The contractions of individual muscles are controlled in intensity and duration by signals, termed action potentials, from the motor cortex of the brain (Vander et al.).

From birth to maturity, skeletal muscles become larger, stronger, more powerful, and more resistant to fatigue. These dramatic changes occur with no change in fiber number, but an increase in the fiber length, cross-sectional area of fibers, and the type of myosin in the thick filaments. During adulthood, atrophy and weakness

may develop due to physical inactivity, immobilization by casting, bed rest, or diseases of muscle, such as muscular dystrophy (Grimby; Svanborg). Throughout the life span, an increase in physical activity will overcome the consequences of physical inactivity, but beyond forty years of age, even physically active people experience some degree of muscle atrophy, weakness, increased fatigability, and an increased susceptibility to injury (Faulkner et al.). After sixty-five years of age, the rate of decline accelerates dramatically. The losses in the structure and function of muscles associated with aging appear to be largely immutable in their progression and irreversible. In fact, beyond forty years of age the rates of decline in a wide variety of performances by highly conditioned athletes and unconditioned subjects show similar rates of decline (Holloszy).

For healthy eighty and ninety year olds, the decrease in muscle mass of approximately fifty percent results from a loss in the total number of fibers per muscle as well as a decrease in the mean cross-sectional area (CSA) of the remaining fibers (Lexell; Nair). Aging involves the progressive loss of whole FF motor units and denervation and subsequent loss of fibers in both FF and FFR motor units. Some of the denervated fast fibers are reinnervated by slow axons. For SR units, no change occurs in the number of motor units, but the number of fibers within SR motor units increases several-fold in old animals (Kadhiresan et al.). As a result of the motor unit remodeling, the proportion of slow to fast fibers increases considerably in muscles of old animals. The cause of the loss in motor units or the loss of fibers from within motor units is not known, but the immutable loss of fibers, frequently coupled with fiber atrophy, explain the loss of muscle mass with aging. Conditioning programs that maintain, or even increase, mean CSA of the remaining fibers can slow the atrophy to some extent (Grimby).

Maximum isometric force is developed by maximal activation of a muscle held at optimum length for force development. Maximum specific force (kN/m^2) is the maximum force normalized by the total muscle fiber cross-sectional area (CSA). The specific force developed by control muscles of adult animals is ~280 kN/m^2 (Faulkner et al.). For muscles of the oldest-old, compared with adult rats, the maximum force has decreased by 65 percent and the specific force by 46 percent. A lower *specific force* indicates a greater loss in force than in CSA. The weakness of muscles in old animals results in part from the presence of denervated fibers, as well as fibers with impaired force development. Less direct data on human beings are consistent with the data on rodents. The cause of the impaired force developed within single fibers of old animals has not been fully explained (Faulkner et al.). Absolute and normalized (watts/kg of muscle mass) power, a function of both force and velocity, are impaired to an even greater extent than force alone. For muscles in old compared with young animals, the greater impairment in power than in force alone arises from the greater proportion of slow fibers in muscles of old animals.

Muscles can be injured by their own contractions. Activities that require muscles to be stretched during contractions are most likely to injure muscles. The initial injury, which is mechanical in nature, is followed by a more severe inflammatory and free radical damage that result in *late onset muscle soreness* (Faulkner et al.). Throughout the life span, skeletal muscles are constantly undergoing contraction-induced injury of varying severity. In young active animals, muscle fibers are relatively resistant to injury and following injuries recover effectively, whereas fibers in muscles of old animals are more easily injured and recovery may be incomplete resulting in loss of fibers, muscle atrophy, and weakness (Faulkner et al.). Most activities include some stretching of muscles during contractions, but even in old animals, conditioning can protect muscles from injury.

With aging, skeletal muscle atrophy, weakness, fatigability, and injury impair performance of the activities of daily living, increase the incidence of falls and accidents, and impact the quality of life of old people (Holloszy). The degree to which these specific conditions are preventable or treatable is not known. Despite the lack of definitive answers to many questions regarding these conditions, the longer people can be motivated to maintain a physically active lifestyle, including brisk walking and the lifting of modest free weights, the higher will be the quality of their life in old age (Holloszy).

JOHN A. FAULKNER
SUSAN V. BROOKS

See also AGE-RELATED DISEASES; EXERCISE; FUNCTIONAL ABILITY; MOTOR PERFORMANCE; PATHOLOGY OF AGING, HUMANS.

BIBLIOGRAPHY

FAULKNER, J. A.; BROOKS, S. V.; and ZERBA, E. "Muscle Atrophy and Weakness with Aging: Contraction-Induced Injury as and Underlying Mechanism." *Journal of Gerontology* 50 (1995): 124–129.

GRIMBY, G. "Muscle Performance and Structure in the Elderly as Studied Cross-sectionally and Longitudinally." *Journal of Gerontology* 50A (1995): 17–22.

HOLLOSZY, J. "Sarcopenia: Muscle Atrophy in Old Age." *Journal of Gerontology* 50A (1995A): 1–161.

KADHIRESAN, V. A.; HASSETT, C.; and FAULKNER, J. A. "Properties of Single Motor Units in Medial Gastrocnemius Muscles of Adult and Old Rats." *Journal of Physiology* (London) 493 (1996): 543–552.

LEXELL, J. "Human Aging, Muscle Mass, and Fiber Type Composition." *Journal of Gerontology* 50A (1995): 11–16.

NAIR, K. S. "Muscle Protein Turnover: Methodological Issues and the Effect of Aging." *Journal of Gerontology* 50A (1995): 107–112.

SVANBORG, A. "A Medical-social Intervention in a 70-year-old Swedish Population: Is It Possible to Postpone Functional Decline in Aging?" *Journal of Gerontology* 48 (1993): 84–88.

VANDER, A.; SHERMAN, J.; and LUCIANO, D. *Human Physiology: The Mechanisms of Body Function,* 8th ed. New York: McGraw Hill, 2001.

PHYSIOLOGICAL CHANGES: ORGAN SYSTEMS, SKIN

See SKIN

PHYSIOLOGICAL CHANGES: STEM CELLS

The process of aging is controlled by a variety of cellular and molecular mechanisms. This process is a continuum of events that are initiated during embryonic development, are genetically determined, and continue throughout all of life. There is a genetic program that controls how and where arms and legs form in the embryo, how much these appendages grow after birth and how much bone will be lost as a person becomes older. Interestingly, *old* in this context means "after skeletal maturity," which occurs in a person's early thirties. Assuming this genetically controlled continuum between embryology and the aging process, it is important to understand the process of tissue formation, the process of tissue expansion, and how tissue is maintained throughout life. Considered here is a class of tissues that form from the middle layer of the three-layered embryo, the *mesodermal layer*; this class of tissue is summarily referred to as *mesenchyme,* and includes bone, cartilage, muscle, tendon, ligament, fat, and other connective tissues.

Embryonic development and mesengenesis

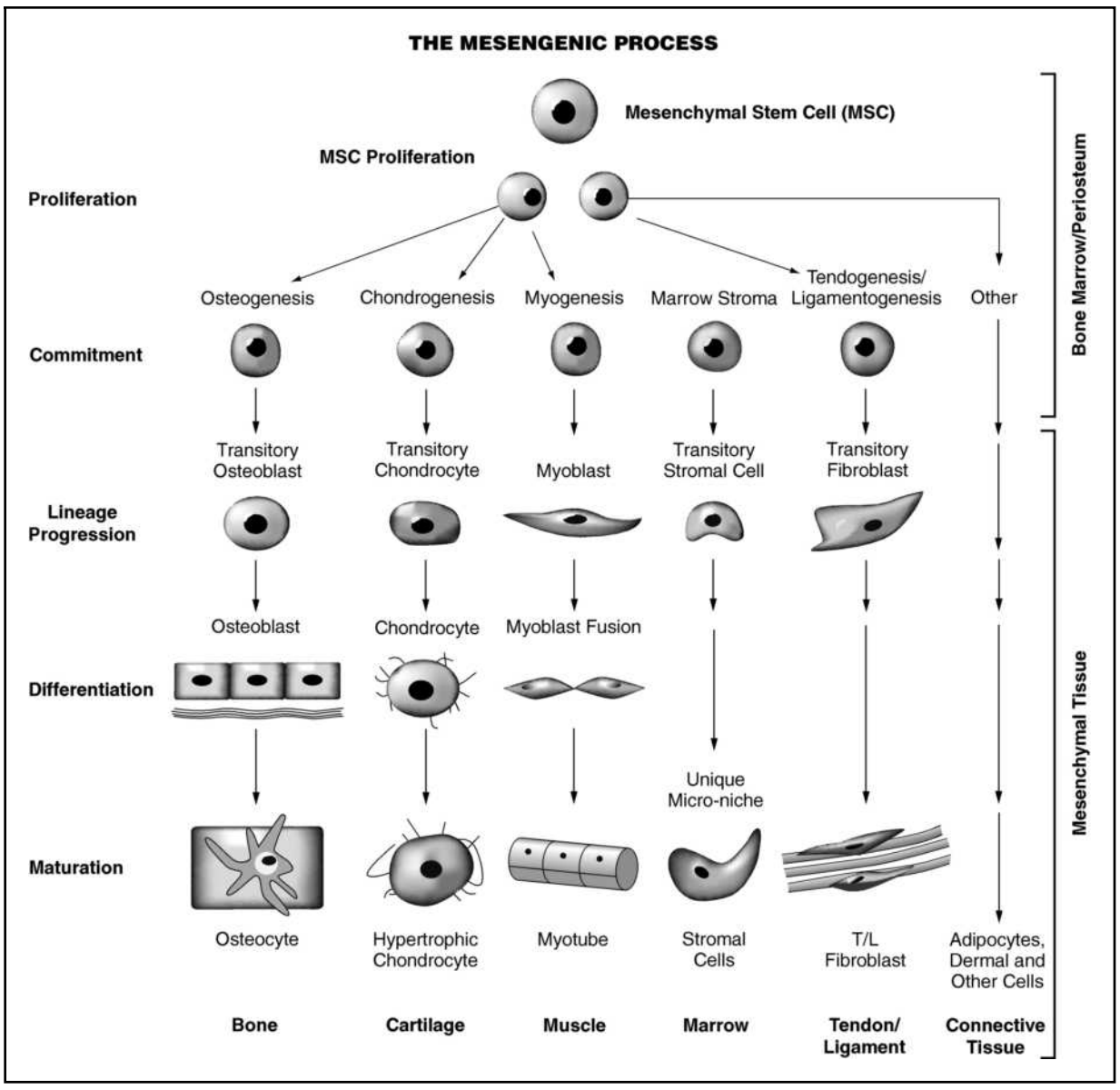
The mesodermal layer in the embryo is composed of cells that will divide many times as an organism grows, and the cellular descendants will eventually differentiate into unique cell types that fabricate very diverse mesenchymal tissues. Thus, from a uniform population of mesenchymal cells, unique differentiation pathways give rise to mesenchymal tissues which differ greatly in morphology and function. In addition, these tissues have unique shapes and unique chemistries. The important aspects of the complex molecular signaling that determines the shapes and sizes of various tissues will not be considered here, but the concept of a multichoice differentiation pathway—for example, bone versus cartilage—is essential to understand with respect to neonatal and adult life.

In the embryo, as in the adult, a common mesenchymal progenitor cell gives rise to either bone or cartilage. This cell could also become any other differentiated mesenchymal cells, and is thus called a *mesenchymal stem cell.* The local molecular microenvironment controls whether mesenchymal stem cells divide, whether they go down one differentiation pathway or another (e.g., bone versus cartilage), whether they are quiescent, or whether they expire. This global scheme has been called *mesengenesis,* and it is pictured in Figure 1, with the mesenchymal stem cell at the top and each differentiation pathway separated and depicted in an over-simplified sequence of lineage steps. The molecules and microenvironments that control these events in the embryo and in the adult are not fully known.

Adult tissues

Skeletal maturity is observed in the early to mid-thirties in modern, well-nourished humans. However, the process of growth that has occurred into the thirties from embryology occurs on a backdrop of continued tissue replacement

Figure 1
Mesengenesis.



SOURCE: Author

or rejuvenation, referred to as *tissue turnover*. In bone, for example, there is a constant destruction of bone tissue followed by refabrication of the lost bone to the extent that the entire skeleton is replaced every two to ten years, depending on the age of the individual. This is in addition to the continued growth or expansion of bone that occurs from birth through the teenage years. Thus, in early life, the process of bone formation far exceeds the process of bone loss. Importantly, osteoblasts, the bone-forming cells, form sheets of many cells that fabricate layers of new bone. The extent of such bone formation is directly related to how many osteoblasts are in this formative sheet. These osteoblasts also have a genetically fixed life span—a week to two weeks for most humans. Thus, while sheets of osteoblasts are fabricating bone in various locations within the body, some osteoblasts are dropping dead. Their place in the fabrication sheets is taken by newly born

osteoblasts—it takes two or three generations of osteoblasts to fill the holes in the bone formed by the natural bone-destruction process. Therefore, mesenchymal stem cells must be present in sufficient numbers to provide descendants that traverse the differentiation pathway to become newly born osteoblasts. In adults, these mesenchymal stem cells are in the bone marrow in close proximity to bone and are associated with blood vessels that nourish bone.

Another way of stating that skeletal maturity peaks in a person's thirties is to say that the process of bone destruction becomes equal to the process of bone fabrication. As a person progresses in age past the thirties, the destructive process exceeds the formative events, resulting in cumulative bone loss, which is referred to as *osteoporosis* when the bone structure becomes fragile and susceptible to fracture. Although osteoporosis is considered a disease of the aged, the extent of bone loss and severity is dependent on the bone stock present in a person's thirties and the relative balance of bone formation versus destruction thereafter. Clearly, a key variable in this complex process is the number of mesenchymal stem cells in a particular location—and the number of their progeny that are cued into the bone-forming pathway at any one time.

Bone repair

In adults, when a bone breaks, the repair process involves a dramatic shift in the balance of bone formation compared to bone destruction toward a process that strongly favors bone formation. The bone repair process involves the flooding of the break site with mesenchymal stem cells, which span and connect the broken ends of the bone. If the broken ends are stabilized by a physician or by nature, the mesenchymal stem cells differentiate directly into bone-forming cells (osteoblasts) that are oriented into fabrication sheets by the neighboring blood vessels. If the break is not stable, the mesenchymal stem cells differentiate into a spanning plug of cartilage and connective tissue that serves to stabilize the break site, allowing an outer layer of bone to form around the plug bridging the broken ends of the bone; this bone-cartilage composite tissue is called the repair *callus*. The cartilage on the inside of the callus further develops into what is called *hypertrophic cartilage*, and these individual end-stage cartilage-producing cells expire.

As the hypertrophic chondrocytes are expiring, they produce and release chemicals that eventually signal blood vessels and new mesenchymal stem cells to enter this site. This combination of new mesenchymal stem cells and blood vessels creates the microenvironment for the formation of bone where cartilage had previously been located. These events have led to the erroneous generalization that cartilage is replaced by bone, when actually cartilage is replaced by blood vessels and a new batch of mesenchymal stem cells, which later form bone. Eventually, the callus is remodeled and sculpted so that scarless bone is located at the site of the original break and is wholly integrated into the pre-existing bone.

The speed at which these repair events occur is directly dependent on the number of mesenchymal stem cells that come to reside in and form the initial callus. It is observed that a person ten years of age and a person ninety years of age repair bone breaks at different rates. One cause for these rate differences is that the number of mesenchymal stem cells in the vicinity of the bone breaks is vastly different. Thus, bone formation, bone growth, bone homeostasis, and bone repair are all dependent on the number and receptive signaling capacity of mesenchymal stem cells.

Mesenchymal stem cell numbers

Mesenchymal stem cells are in bone marrow, are associated with blood vessels, are present in the connective tissue of muscle, and are in a number of anatomical locations. Because mesenchymal stem cells are located throughout the body, it is currently impossible to accurately determine the total number that exist during life. One approach to providing an estimate is to determine the number of mesenchymal stem cells in a standard portion of bone marrow. A number of laboratories have attempted to provide such estimates throughout life. At the Skeletal Research Center, at Case Western Reserve University, scientists isolate and purify mesenchymal stem cells and encourage them to attach to and grow on petri dishes, in which the cells form colonies, each of which is derived from one cell. They have developed the technology for isolating, purifying, and expanding mesenchymal stem cells in culture dishes without the mesenchymal stem cells entering any of the differentiation pathways. Based on this technology, Skeletal Research Center scientists have processed fresh bone marrow specimens from hundreds of individuals ranging in age from newborns to people

in their eighties and nineties. The rate of cell division and the sensitivity to agents that cause differentiation into the mesengenic lineage pathways appear to be identical among all of these cell preparations, independent of the age of the individual providing the bone marrow specimen. Thus, young and old mesenchymal stem cells appear to be identical in cell culture.

Again, emphasizing that colony counts per sample of bone marrow are crude estimates of the frequency of mesenchymal stem cells in marrow, it is clear that large age differences in the numbers of mesenchymal stem cells exist, from very high levels in newborns (about one in ten thousand nucleated marrow cells) to levels tenfold to one hundred-fold less in older individuals. Thus, when a frail eighty-year-old woman breaks a bone, the slowest step in the repair process is the accumulation of enough mesenchymal stem cells at the break site to form a proper callus. When bone is fabricated around the callus to bridge the broken ends, this bone forms, per osteoblast, about as rapidly as in younger individuals. Thus, both mesenchymal stem cell and osteoblast functioning in older individuals appear to be quite similar; what is quite different is the distribution of, and probably the total number of mesenchymal stem cells available to the repair site. This is in contrast to the number of hematopoietic progenitor or stem cells, which stays relatively constant throughout life at about one per ten thousand nucleated cells. Thus, the process of aging appears to involve a decrease in the number of responsive mesenchymal stem cells, not a decrease in function.

In the context of evolution, those individuals who can maintain the highest concentrations of mesenchymal stem cells throughout life will enjoy a selective advantage with age. This advantage involves the rate of tissue repair (as in the case discussed above for bone), and also is related, in part, to the balance between tissue formation and tissue turnover events. The thesis advanced here is that the embryo has the highest tissue levels of mesenchymal stem cells, and that these levels decline with age. The individuals who can maintain high mesenchymal stem cell levels will be able to maintain high tissue fabrication levels and more effectively balance the natural destructive activities observed in almost every mesenchymal tissue. Since both muscle tissues and the dermis of skin are derived from the same small sectors of somites in embryos, it is interesting to note that the loss of muscle mass with age is correlated with texture changes in the skin. One wonders whether this is because both dermal and muscle cells are on the same biological clock, or because the local titers of mesenchymal stem cells, or their reactivity, is decreasing with age.

Mesenchymal stem cells and future aging therapies

If one of the major causes of mesenchymal tissue aging is the decreased availability of mesenchymal stem cells, an obvious quick-fix would be to obtain some marrow, and then isolate and culture-expand the mesenchymal stem cells. It has been shown that mesenchymal stem cells can be culture-expanded one billion-fold without affecting their differentiation potential. With this large number of cells, it would seem possible to merely add these cultured mesenchymal stem cells back to blood-stream marrow and other sites serviced by the blood supply, and thereby raise the body level of mesenchymal stem cells. However, although some mesenchymal stem cells that are put back into the blood stream do make it back into the marrow compartment, relatively few do so. Consequently, increasing the body's load of mesenchymal stem cells requires understanding how the cells target to particular locations along the blood-vessel pathways, and then to efficiently transport the cell through the wall of the blood vessel into the tissue. Alternately, by genetically adjusting the mesenchymal stem cells in culture to fix or replace mutated genes, it may be possible to improve the fabrication capacity of the differentiated progeny to maintain tissue integrity and counteract aging-related tissue destruction. Even if these therapeutic approaches fail, it is clear that management of mesenchymal stem cells can have profound effects upon the aging process.

ARNOLD I. CAPLAN

See also BLOOD; CELLULAR AGING; CELLULAR AGING: CELL DEATH; OSTEOPOROSIS.

BIBLIOGRAPHY

CAPLAN, A. I. "Mesenchymal Stem Cells." *J. Ortho. Res.* 9 (1991): 641–650.

CAPLAN, A. I. "The Mesengenic Process." In *Clinics in Plastic Surgery* 21 (1994): 429–435.

HAYNESWORTH, S. E.; GOLDBERG, V. M.; and CAPLAN, A. I. "Diminution of the Number of

Mesenchymal Stem Cells as a Cause for Skeletal Aging.'' In *Musculoskeletal Soft-Tissue Aging: Impact on Mobility.* Edited by J. A. Buckwalter, V. M. Goldberg, and S. L-Y. Woo. Rosemont, Ill.: American Academy of Orthopaedic Surgeons, 1994. Pages 79–87.

HAYNESWORTH, S. E.; REUBEN, D.; and CAPLAN, A. I. ''Cell-based Tissue Engineering Therapies: The Influence of Whole Body Physiology.'' *Advanced Drug Delivery Review* 33 (1999): 3–14.

PICK'S DISEASE

See FRONTO-TEMPORAL DEMENTIA

PLASTICITY

For at least a century, the term *plasticity* has been used in a variety of circumstances pertaining to the scholarly study of human development. Although varying in certain conceptual aspects and practical applications, the fundamental meaning of the term may be found in its numerous appearances across several developmental literatures and historical decades. In its most enduring and generalized sense, plasticity refers to the capability of, or susceptibility to, being molded, shaped, modified, or otherwise changed. As such, the concept of plasticity has occupied important positions in theories of ontogenetic development, phylogenetic evolution, neuronal development and adaptation, and psychological aging. This article focuses on the latter two areas of scholarship.

The concept of plasticity

The term *plasticity* first appeared in the psychological and biological literature over a century ago. For example, in the 1901 *Dictionary of Philosophy and Psychology,* James Mark Baldwin and E. B. Poulton defined plasticity as ''that property of living substance or of an organism whereby it alters its form under changed conditions of life'' (Baldwin and Poulton, p. 302). Several well-developed characteristics of human plasticity were annotated. These included the following still-relevant points: (1) seemingly fixed organic structures may exhibit some plasticity; (2) the plasticity of the brain and nervous system may allow ''newer. . . intelligent accommodations'' (p. 303); (3) there are limits to plasticity in certain realms; and (4) plasticity underlies much motor and cognitive learning.

In the intervening century, plasticity has been a featured element of several perspectives on human functioning and change. Two of the broadest reviews of plasticity were published in the 1980s. In an edited volume entitled *Developmental Plasticity* (1981), E. S. Gollin invited scholars to discuss plasticity in the domains of biological and psychological development. Gollin's own contribution referred to plasticity in terms of the range of possible variations that can occur throughout individual development. R. M. Lerner's 1984 monograph, *On the Nature of Human Plasticity,* covered plasticity as it functions in development at the biological, neurological, psychological, and social levels of analysis. Here, plasticity referred to changes in either structure or function, and could occur throughout life.

Plasticity at the neuronal level

If the Gollin and Lerner volumes reflect watershed reviews of broad applications of plasticity, Bryan Kolb's *Brain Plasticity and Behavior* (1995) served a similar function for the rapidly expanding study of neurological plasticity. According to Kolb, ideas that had germinated a century before, and that had been propelled by D. O. Hebb (1949) at midcentury, had now become a core principle of the neurosciences. Specifically, contemporary technology and accumulating evidence had confirmed that a variety of brain structures can grow or otherwise be modified as a function of experience and in response to behavioral demands. Moreover, this growth can occur in adult brain structures that have otherwise completed the early-life neurological development phase. Indeed, the number of structural changes associated with experience is continuing to increase: Notable changes include ''increases in brain size, cortical thickness, neuron size, dendritic branching, spine density, synapses per neuron, and glial numbers'' (Kolb and Whishaw, 1998, p. 47).

In addition, changes in the human brain may have a beneficial effect at the behavioral level. Brain plasticity is thus linked to a variety of compensatory and other recovery mechanisms at the brain and behavioral levels—given a manageable degree of damage resulting from normal aging, an injury, or neuropathogenic disease, one or more compensatory or restitutive mechanisms operating at the neuroanatomical level may function to reduce the associated behavioral deficit. From this perspective, much basic and

applied research in cognitive neurorehabilitation has examined such themes as spontaneous recovery, functional reorganization, enriched environment, and cognitive training. In a 1999 article, Robertson and Murre provided a comprehensive review of how the concept of cerebral plasticity may be used to generate guided rehabilitative processes for recovery from brain damage. Among the notable predictors of successful recovery are severity of original injury (lesion) and age at which the lesion is sustained. Briefly, the greater the severity and the older the age of onset, the lower the probability of recovery of function. All other things being equal, older adults may have more difficulty recovering function from cerebral damage than younger adults.

Plasticity in human aging

Plasticity is a principal theoretical issue in life-span developmental psychology. A rationale for its relevance to life-span theory was offered by Baltes, Staudinger, and Lindenberger (1999, p. 480), who concluded that an emphasis on plasticity "highlights the search for the potentialities of development, including the upper and lower boundary conditions. Implied in the idea of plasticity is that any given developmental outcome is but one of numerous possible outcomes, and that the search for the conditions and range of plasticity. . .is fundamental to the study of development." Implications of these ideas are especially pertinent to the study of decremental processes in aging, for they suggest that the decline may be reversed if enhancing experience (e.g., training, practice) is provided.

Accordingly, plasticity has been identified as a core theoretical issue in the study of adult cognitive development. Plasticity implies that some normal aging-related cognitive decline may be reversible. Indeed, research providing experience-enhancing interventions to older adults has produced results linking specific experience to particular behaviors and skills, ranging from intelligence and memory to leisure or professional expertise. Older adults who are provided with task-related experience (e.g., practice, strategies) in some domains may maintain or develop higher levels of performance than would have otherwise seemed possible. Phenomena of plasticity are relevant to theories of cognitive aging. Similarly, empirical evidence for plasticity provides fertile soil from which everyday interventions for normal aging-related losses may be generated.

Plasticity is a concept of considerable importance to understanding how human beings change as they become older—and how they could change given certain experiences. Applied to both biological and psychological aging, it offers a cautiously optimistic perspective, for it illustrates that there is both a neurological and psychological basis for guided interventions designed to enhance adaptation in late life.

ROGER A. DIXON
ANNA-LISA COHEN
STUART W. S. MACDONALD

See also LIFE SPAN DEVELOPMENT; MEMORY TRAINING; NEUROTRANSMITTERS.

BIBLIOGRAPHY

BALDWIN, J. M. *Dictionary of Philosophy and Psychology*. New York: The Macmillan Company, 1901.

BALTES, P., B. "Theoretical Propositions of Life-Span Developmental Psychology: On the Dynamics Between Growth and Decline." *Developmental Psychology* 23 (1987): 611–628.

BALTES, P. B.; STAUDINGER, U. M.; and LINDENBERGER, U. "Lifespan Psychology: Theory and Application to Intellectual Functioning." *Annual Review of Psychology* 50 (1999): 471–507.

DIXON, R. A., and BÄCKMAN, L. "Concepts of Compensation: Integrated, Differentiated, and Janus-Faced." In *Compensating for Psychological Deficits and Declines: Managing Losses and Promoting Gains*. Edited by R. A. Dixon and L. Bäckman. Mahwah, N.J.: Lawrence Erlbaum Associates, 1995. Pages 3–19.

DIXON, R. A., and HERTZOG, C. "Theoretical Issues in Cognition and Aging." In *Perspectives on Cognitive Change in Adulthood and Aging*. Edited by F. Blanchard Fields and T. M Hess. New York: McGraw-Hill, 1996. Pages 25–65.

ERICSSON, K. A., and CHARNESS, N. "Expert Performance: Its Structure and Acquisition." *American Psychologist* 49 (1994): 725–747.

GOLLIN, E. S. *Developmental Plasticity: Behavioral and Biological Aspects of Variations in Development*. New York: Academic Press, 1981.

HEBB, D. O. *The Organization of Behavior*. New York: Wiley, 1949.

KOLB, B. *Brain Plasticity and Behavior*. Mahwah, N.J.: Lawrence Erlbaum Associates, 1995.

KOLB, B., and WHISHAW, I. Q. "Brain Plasticity and Behavior." *Annual Review of Psychology* 49 (1998): 43–64.

LERNER, R. M. *On the Nature of Human Plasticity*. Cambridge, U.K.: Cambridge University Press, 1984.

LURIA, A. R. *Restoration of Function After Brain Injury*. New York: Macmillan, 1963.

ROBERTSON, I. H., and MURRE, J. M. J. "Rehabilitation of Brain Damage: Brain Plasticity and Principles of Guided Recovery." *Psychological Bulletin* 125 (1999): 544–575.

STUSS, D. T.; WINOCUR, G.; and ROBERTSON, I. H., eds. *Cognitive Neurorehabilitation*. Cambridge, U.K.: Cambridge University Press, 1999.

VERHAEGHEN, P.; MARCOEN, A.; and GOOSENS, L. "Improving Memory Performance in the Aged Through Mnemonic Training: A Meta-Analytic Study." *Psychology and Aging* 7 (1992): 242–251.

PNEUMONIA

Pneumonia is an infection involving the lungs. It may be caused by bacteria, viruses, or parasites. There are more than one hundred microbial causes of pneumonia. However, most cases of pneumonia are due to the following bacteria: *Streptococcus pneumoniae, Haemophilus influenzae, Staphylococcus aureus,* and *Morayella* (*Branhamella*) *catarrhalis*. Clinically, pneumonia is characterized by a variety of symptoms and signs. Cough, which may be productive of purulent (yellow or green), mucopurulent (white with flecks of yellow or green), or "rusty" sputum (reddish-brown due to blood mixed in sputum), is common. Fever, chills, and pleuritic chest pain are other manifestations. Extrapulmonary symptoms such as nausea, vomiting, or diarrhea may occur. There is a spectrum of physical findings—the most common of which is crackles (sounds heard on listening with a stethoscope). Other findings that may be present include dullness to percussion, increased tactile and vocal fremitus, bronchial breathing, and a pleural friction rub. It is important to remember that pneumonia in the elderly may present with a paucity of respiratory symptoms and signs and instead may manifest as delirium. Delirium or acute confusion was found in nearly half of elderly patients with pneumonia studied by Riqueleme and colleagues compared with less than one-third of age- and sex-matched control subjects. Older patients with pneumonia complain of fewer symptoms than do younger patients with pneumonia.

Epidemiology

Pneumonia is a common and often serious illness. It is the sixth leading cause of death in the United States. About 600,000 persons are hospitalized with pneumonia each year and there are sixty-four million days of restricted activity due to this illness. One study shows that hospitalization for pneumonia is thirty times more likely among nursing home residents compared to adults living in the community.

Risk factors for pneumonia and predictors of outcome

Some of the risk factors for community-acquired pneumonia (CAP) in the elderly include alcoholism, asthma, and immunosuppression. For nursing home–acquired pneumonia, common risk factors include profound disability, old age, and male gender among others. Prognosis is especially poor for patients who are bedridden prior to the onset of pneumonia, those with a swallowing disorder or acute renal failure, or those with a respiratory rate greater than thirty breaths per minute. The mortality rates from pneumonia in elderly persons can be very high. The overall mortality rate for persons requiring admission to hospital for treatment of pneumonia ranges from 8 to 20 percent. The one-year mortality rate among nursing home patients following an episode of pneumonia is up to 40 percent. The major reason for these high mortality rates is due to the presence of various comorbid illnesses. For many elderly persons who have advanced Alzheimer's disease, strokes, and other illnesses, pneumonia is often the terminal event.

There is a high incidence of silent aspiration in elderly persons with community-acquired pneumonia. Kikuchi and colleagues examined the role of silent aspiration during sleep in elderly patients with CAP and found that 71 percent of the study patients aspirated compared with 10 percent of the control subjects. Just over 28 percent of patients with Alzheimer's disease and 51 percent of those with a stroke aspirated on videofluoroscopy. Croghan and others found that feeding tube placement in patients shown to aspirate on videofluoroscopy was associated with increased rate of pneumonia and death compared with those who aspirated but did not receive such a tube.

Diagnosis of the microbial etiology of the pneumonia

The signs and symptoms listed earlier suggest pneumonia to the physician. A chest radiograph is used to confirm the diagnosis (see

Chest radiograph of a nursing home patient with pneumonia. The white area in the lung is the pneumonia. The white area in the middle and on the left is the heart and major blood vessels. (Courtesy of the author.)

accompanying images). The next step is to determine the microbial cause of the pneumonia. To do this a blood sample is collected for culture. Only 6 to 10 percent of these cultures will be positive. If a sputum sample can be coughed up it is submitted to the laboratory for culture. When examined under the microscope sputum contains many white blood cells and few squamous epithelial cells (these are cells that line the mouth). Examination of the sputum under the microscope can often suggest the infecting microorganism. For example, if only pairs of small round cells that stain with a common solution are seen in a sputum specimen with lots of white blood cells, then the most likely cause of the pneumonia is *Streptococcus pneumoniae*.

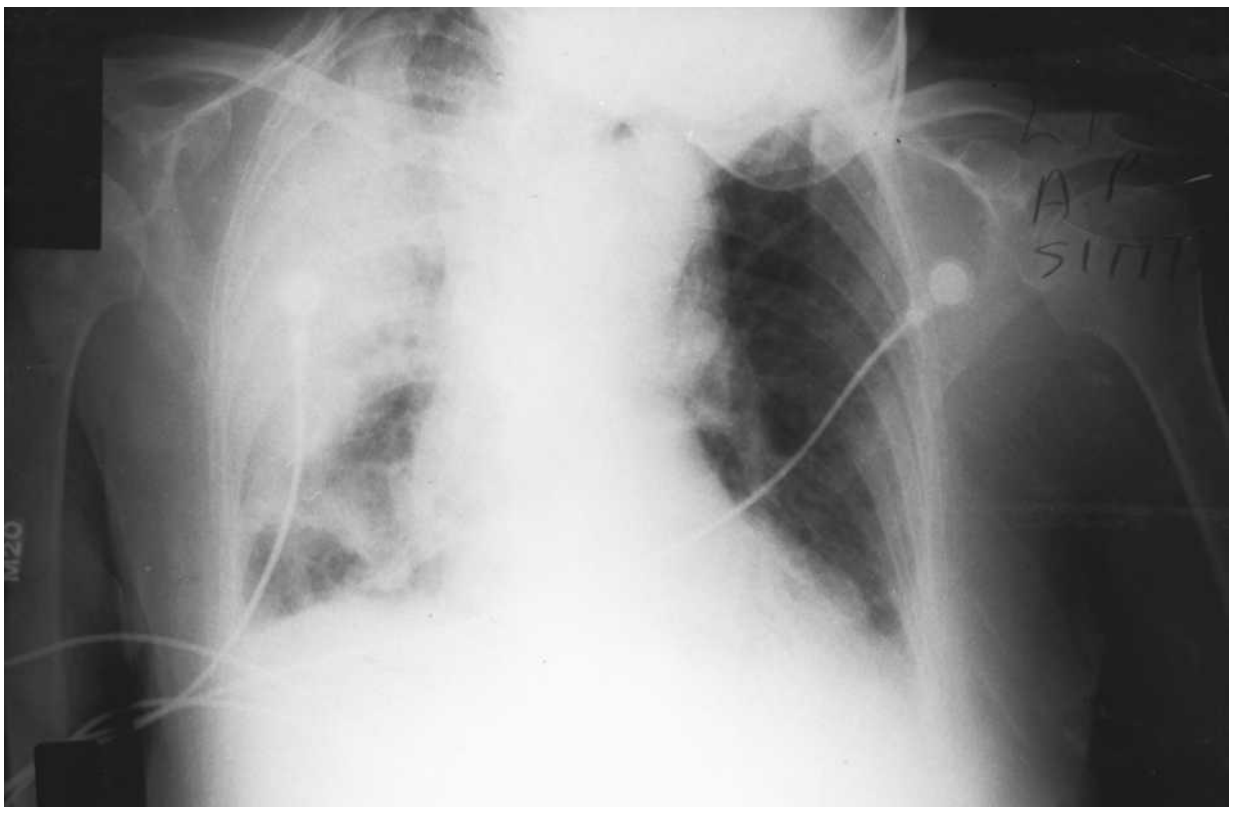
Culture of the sputum and identification of the microorganisms isolated usually requires two to three days. Isolation of a specific microorganism allows the physician to select an antibiotic that will be most effective against this microorganism. Unfortunately most elderly persons cannot produce a sputum specimen for culture. Under these circumstances the attending physician has to choose antibiotics based on the most likely cause of the pneumonia. Some patients who are critically ill as a result of the pneumonia may have a diagnostic bronchoscopy. Here a small tube is passed down the trachea to the bronchi and samples of respiratory secretions are aspirated for culture. Occasionally a lung biopsy is necessary for diagnosis. Other tests that can be used in the diagnosis of pneumonia include a urine sample to detect *Legionella* antigen.

Antibodies can be detected to a variety of microorganisms that cause pneumonia. Two samples of blood are obtained, one early on in the course of the illness and the other two to six weeks later. Such tests are currently used to diagnose infection with *Mycoplasma pneumoniae, Chlamydia pneumoniae, Legionella* species, and a variety of viral infections. A four-fold or more increase in the amount of antibody against a specific microorganism between the acute and convalescent phase serum samples indicate that that microorganism caused the pneumonia.

Treatment of community-acquired pneumonia

There are several components to the successful treatment of pneumonia. The first step is to decide the most appropriate site of care—home, hospital ward, hospital intensive care unit, and, for those who reside in a nursing home, either the nursing home or a hospital. The severity of the pneumonia and or the severity of the comorbid illnesses drive the decision as to the care site.

Patients with pneumonia generally prefer to be treated at home provided they can be assured they are not going to die. In many instances it is obvious that a patient is so sick that he or she should be treated in hospital. There is a pneumonia severity of illness scoring system that can be used to help in the decision as to the site of treatment (Fine et al.). The single best indication of severe pneumonia in an adult (who does not have pre-existing lung disease) is a respiratory rate (counted for one minute) of thirty-two breaths per minute or higher. The second step is deciding what is the most appropriate antibiotic. A number of effective antibiotics are available for the treatment of pneumonia (Naughton et al.; Bartlett et al.). Once the pneumonia is improving in elderly persons a functional and men-



Chest radiograph of an elderly person with pneumonia due to Streptococcus pneumoniae. Almost all of the right lung is involved (white area). (Courtesy of the author.)

tal assessment should be carried out. The results of these studies guide the planning of discharge.

The final step is to arrange a follow-up chest X-ray and visit. Two percent of all persons presenting with pneumonia will have pneumonia as the first manifestation of cancer of the lung—the pneumonia is distal to an obstructed bronchus. If the pneumonia has not cleared on the sixth week follow-up chest X-ray, additional studies such as bronchoscopy may be required.

Prevention of pneumonia

Immunization with influenza vaccine once yearly and with pneumococcal vaccine every six years are important measures that can help prevent pneumonia. It is also important for those who smoke tobacco to stop smoking.

THOMAS J. MARRIE

See also DISEASE PRESENTATION; IMMUNE SYSTEM; INFLUENZA; LUNG, AGING; PALLIATIVE CARE; TUBE FEEDING; URINARY TRACT INFECTION.

BIBLIOGRAPHY

BARTLETT, J. G.; BREIMAN, R. F.; MANDELL, L. A.; and FILE, T. M. "Community-Acquired Pneumonia in Adults: Guidelines for Management." *Clinical Infectious Diseases* 26 (1998): 811–838.

CROGAN, J. E.; BURKE, E. M.; CAPLAN, S; and DENNMAN, S. "Pilot Study of 12-Month Outcomes of Nursing Home Patients with Aspiration on Videofluroscopy." *Dysphagia* 9 (1994): 141–146.

FINE, M. J.; AUBLE, T. E.; YEARLY, D. M.; et al. "A Prediction Rule to Identify Low-Risk Patients with Community-Acquired Pneumonia." *New England Journal of Medicine* 336 (1997): 243–250.

KIKUCHI, R.; WATABE, N.; KONNO, T.; SEKIZAWA, K; and SASAKI, H. "High Incidence of Silent Aspiration in Elderly Patients with Community-Acquired Pneumonia." *American Journal of Respiratory and Critical Care Medicine* 150 (1996): 251–253.

LOEB, M.; MCGEER, A.; MCARTHUR, M.; WALTER, S.; and SIMOR, A. S. "Risk Factors for Pneumonia and Other Lower Respiratory Tract Infec-

tions in Elderly Residents of Long-Term Care Facilities." *Archives of Internal Medicine* 159 (1999): 2058–2064.

MARRIE, T. J. "Epidemiology of Community-Acquired Pneumonia in the Elderly." *Seminars in Respiratory Infection* 5 (1990): 260–268.

NAUGHTON, B. J., and MYLOTTE, J. M. "Treatment Guidelines for Nursing Home–Acquired Pneumonia Based on Community Practice." *Journal of the American Geriatric Society* 48 (2000): 82–88.

RIQUELME, R.; TORRES, A.; WL-EBIARY, M.; MENSA, J.; ESTRUCH, R.; RUIZ, M.; ANGRILL, J.; and SOLER, N. "Community-Acquired Pneumonia in the Elderly." *American Journal of Respiratory Critical Care Medicine*. 156 (1997): 1908–1914.

POLITICAL BEHAVIOR

Older people generally resemble young and middle-aged adults in their political attitudes, partisan attachments, and behavior. There are more differences within age groups than between them. When age group differences do appear, they may reflect common traits and interests developed through the life-course processes of aging; or they may originate in the historical circumstances affecting a particular birth cohort; or, they may arise from social trends and events that affect all people during specific historical periods. Disentangling these life-course, cohort, and period effects in order to explain age group differences is difficult. Sometimes, all three types of these phenomena may be at work.

Political attitudes and orientations

People of all ages are deeply divided in their ideological and partisan orientations, but these divisions do not tend to pit older and younger people against each other. Although older people are commonly thought to be more conservative than younger people, most of the evidence refutes this notion. Studies in the United States and cross-nationally generally conclude that age group differences in political values are due primarily to cultural and environmental conditions affecting a cohort's socialization, and not to universal life-course changes.

Stability in political attitudes and orientations generally increases with age, and affiliation with a political party tends to remain firm throughout life. The distribution of partisan loyalties within a cohort of young adults generally persists as the cohort moves into old age. The historical circumstances present as a cohort becomes of voting age, coupled with partisan preferences that individuals acquire from their parents, primarily determine that partisan distribution.

Moreover, many older persons tend to have stronger or more intense partisan attachments than individuals in younger age groups (MacManus). A long-standing life-course hypothesis is that the longer individuals identify with a party, the stronger their partisanship. Yet, the relative strength of partisan attachment observed among the elderly in recent decades may be due to cohort effects rather than life-course phenomena. The baby boom cohort in the United States is less identified with the major political parties than preceding cohorts at comparable ages, and this is even more the case among post–baby boom cohorts (Alwin).

Voting behavior

Older people vote at higher rates than people in younger age groups. Studies of voting participation over several decades have shown that voter turnout is lowest among young adults, increases rapidly up to ages thirty-five to forty-five, and then continues to increase (more slowly), declining only slightly after the age of seventy or eighty in the United States (Miller and Shanks), and at somewhat younger ages in other industrial nations (e.g., see Myers and Agree). Consequently, the percentage of the total vote cast by older people in elections is greater than their proportion of the voting-age population. In the 1996 U.S. presidential election, for example, people age sixty-five and older made up 16.5 percent of the voting age population, but cast 20.3 percent of the vote; the turnout rates were 32 percent among those age eighteen to twenty-four, 49 percent among those age twenty-five and forty-four, 64 percent among those age forty-five to sixty-four, and 68 percent among those sixty-five years and older (Binstock, 2000).

Why do older people turn out to vote at higher rates than middle-aged and younger people? Although the connection between age and voting participation has been investigated a great deal, overall the reasons for this relationship remain a source of controversy. Alternative explanations for age group differences in turnout have helped to define the issues, but they have not resolved them.

Some scholars (e.g., Miller and Shanks) hypothesize that the relatively high voting rate of older Americans during the past several decades can be attributed to the movement of successive birth cohorts through the life course. They focus on the contrasting participation rates of the cohort that was first socialized to U.S. politics during the New Deal, and subsequent cohorts whose political attitudes and behavior have been shaped by the effects of historical periods and specific political events that they have lived through (e.g., Vietnam and Watergate) at different ages. Supporting this view is the fact that during these decades the rates of age-group participation have been dynamic, not static, as the various cohorts have entered different stages of the life course. From the 1972 election through the 1996 election, the participation rate of persons age sixty-five and older increased by 6.5 percent, while the rates for all other age groups declined—by 9 percent for those forty-five to sixty-four, 21.5 percent for those twenty-five to forty-four, and 34.7 percent for those eighteen to twenty-four years old (Binstock, 2000). But other analysts (e.g., Rosenstone and Hansen; Teixera) suggest that the contribution of cohort replacement to voting turnout rates may be overestimated. Moreover, a study of voting turnout in Sweden and Germany over four decades found age-group differences to be similar to those in the United States, despite the fact that cohorts in these three nations experienced different political events distinctive to their respective countries (Myers and Agree).

The alternative explanation is that age group differences in voting participation are attributable to life-course effects that correspond to changing characteristics, needs, and incentives of people as they grow older. One contributing factor is that interest in politics (as well as knowledge about it) increases with age and declines only slightly at advanced old ages (Strate, Parrish, Elder, and Ford; also see MacManus). Another contributing factor to the higher voting rate of older persons—related to interest in and knowledge about politics—is age-group differences in voting registration, an essential precursor to voting. Persons who are comparatively well informed about politics and public affairs are more likely to register and vote (Flanigan and Zingale). A study of voter registration and turnout in U.S. national elections (Timpone) found that increased age (from age eighteen to eighty-eight) is monotonically related to being registered and that another aging-related factor, length of residence in one's own home, also has a substantial influence. An additional explanation for the relatively high voting rates of older people is that as they reach old age they have more of a personal stake in government programs, such as Social Security, that provide old-age benefits. Still another contributing factor is the relatively strong partisan attachments of older people (discussed above), because there is a well-established connection between the strength of political party identification and higher rates of voting (Flanigan and Zingale; Rosenstone and Hansen).

Although older people vote at a high rate, they are as diverse in their voting decisions as any other age group, despite the frequent efforts of political candidates to sway them with campaign issues focused on government old-age programs. The votes of older people generally divide along the same partisan, economic, social, gender, and other lines as those of the electorate at large. Accordingly, the various cohorts of older Americans during the past fifty years, for example, have tended to distribute their votes among presidential candidates in roughly the same proportions as other age groups do; exit polls show sharp divisions within each age group, and very small differences between age groups (see Campbell and Strate; Binstock, 1997a). A great deal of empirical evidence indicates that the situation is similar throughout Europe (Walker and Naegele). One exception to this general pattern in the United States is that older partisans are less likely than younger ones to abandon their political party to vote for an independent candidate (Flanigan and Zingale) because of their comparatively stronger attachment to their parties than younger age groups. This tendency was clear in the 1980, 1992, 1996, and 2000 U.S. presidential elections, in which an independent received more than a negligible percentage of votes. The older the age group, the less heavily it voted for the independent candidate (Connelly).

Organized political action

In the second half of the twentieth century, developed nations throughout the world witnessed the establishment of old-age-based political organizations, and a tremendous expansion in their number, the size of their memberships, and their visibility. These have been stable and enduring organizations, and some of them have

substantial bureaucracies, in contrast, for example, with occasional ad hoc U.S. groups and movements that sought government income assistance for older Americans prior to the passage of the Social Security Act of 1935. In the United States alone, there are over one hundred national organizations focused on aging policies and concerns, sometimes referred to as the "gray lobby." These include mass membership groups representing older people in general or subgroups of the elderly, single-issue advocacy groups, and organizations of professionals and service providers (see Day; Van Tassel and Meyer). Although the United States has probably seen the largest number of older people organized into the most numerous and diverse array of such groups, aging-based political organizations have also emerged in Australia (Kendig and McCallum), Canada (Gifford), Japan (Campbell), and throughout Europe (Walker and Naegele).

The proliferation of stable old-age political organizations can be traced to several factors. First, the existence of policies on aging, in itself, tends to create old-age-based political organizations and action (Hudson). The expansion of old-age benefits that took place following World War II gave the elderly and those who serve them a substantial stake in protecting what they had gained. In the United States, for instance, perceptions that old-age benefit programs were in financial and political jeopardy in the late 1970s and early 1980s led directly to the formation of the National Committee to Preserve Social Security and Medicare (NCPSSM) and a broad coalition of old-age-based organizations, Save Our Security. Second, grants and contracts from government agencies, as well as foundations, have propelled the growth of existing interest groups and the emergence of new ones. And third, the stability and growth of these organizations have been effectively promoted by a variety of incentives that attract members and maintain political legitimacy.

Clark and Wilson's incentive systems theory of organizations—distinguishing among material, associational or solidary, and purposive incentives (which may overlap within a given organization)—provides a useful framework for distinguishing among types of old-age organizations. Among U.S. organizations that are primarily characterized by purposive incentives are NCPSSM and the United Seniors Association; a number of organizations focused on improving the status of elderly minority group members (e.g., the National Hispanic Council on Aging); trade associations of service-providers to older people (e.g., the National Association of Nutrition and Aging Services Providers); and the Alliance for Retired Americans, the Older Women's League, and the National Association of Retired Federal Employees.

The archetype of an old-age interest group that has been maintained and has grown primarily through material incentives that attract mass memberships is AARP (formerly the American Association of Retired Persons). For a $10 enrollment fee it provides publications, drug and travel discounts, assistance in filing taxes, and driver training programs, and offers its members insurance programs, investment funds, and a variety of other "affinity" products. With these incentives it achieved a membership of about 36 million and total revenues of $485 million in 1999 (AARP), and it is currently promoting membership enrollment internationally. AARP also provides associational incentives in the form of local chapters, but only 3 percent of the membership is involved in them (Day). In addition, it expends about 11 percent of its revenue on lobbying and public policy research (AARP). But the staff and volunteer leaders have long recognized that the organization's large membership is inherently diverse in political views. They try to avoid taking stands on what they regard as relatively divisive issues and, for example, have been largely inattentive to the needs of the poorest and most disadvantage elderly. Nonetheless, on several occasions in recent years the leadership's issues positions have generated angry dissent from members and substantial resignations (Binstock, 1997b).

Even as no one organization can fully represent the diversity of the elderly, the groups themselves are diverse in terms of constituencies, tactics, decision-making procedures, and are often divided on old-age policy issues. Coalition building, like that exemplified by the forty-organization Leadership Council of Aging Organizations in the United States, has been a political strategy for these organizations to help them cope, somewhat, with the problems of diversity. Yet the effectiveness of these coalitions tends to be limited because they often have internal divisions on a number of important issues (Day).

What has been the impact of old-age based organizations in bringing issues to the agenda and influencing their outcomes? Although there

is no credible evidence of old-age voting blocs or voting cohesion in the United States, the mass membership groups, in particular, do have some role in the policy process. Public officials find it both useful and incumbent upon them to invite such organizations to participate in policy activities. In this way public officials are provided with a ready means of having been "in touch" with tens of millions of older persons, thereby legitimizing subsequent policy actions and inactions. This also symbolically legitimizes the old-age organizations and gives them several types of power. First, they have easy informal access to public officials and their staffs. Second, they are able to obtain public platforms in the national media, congressional hearings, and national conferences and commissions dealing with old-age policy issues. Third, the mass membership groups can mobilize their members in large numbers to contact policymakers and register displeasure when changes are being contemplated in old-age programs. Fourth, and perhaps the most important form of power available to the old-age groups is the "electoral bluff." Although these organizations have not demonstrated a capacity to swing a decisive bloc of older voters, the perception of being powerful is a source of political influence. Incumbent members of Congress are hardly inclined to risk upsetting the existing distribution of votes that puts them and keeps them in office by calling the bluff of the elderly or any other latent mass constituency.

Nonetheless, these forms of power have been quite limited in their impact. The old-age interest groups have had little to do with the enactment and amendment of major old-age policies such as Social Security. Rather, such actions have been largely attributable to the initiatives of public officials who were focused on their own agendas for social and economic policy. Support in Congress for old-age benefits has been linked more to perceptions of need and deservingness than to group or constituency pressures (see Cook and Barrett). The power of old-age interest groups has been largely defensive, aimed at protecting existing programs. Even so, these organizations have not been able to prevent significant (though not radical) policy reforms that have been perceived to be adverse to the interests of an artificially homogenized constituency of "the elderly" (see Binstock, 1994; Day).

ROBERT H. BINSTOCK

See also COHORT CHANGE; CONSUMER ORGANIZATIONS IN AGING; GENERATIONAL EQUITY; GERONTOCRACY.

BIBLIOGRAPHY

AARP. *AARP Annual Report.* Available on the World Wide Web at www.aarp.org

ALWIN, D. F. "The Political Impact of the Baby Boom: Are There Persistent Generational Differences in Political Beliefs and Behavior?" *Generations* 22, no. 1 (1998): 46–54.

BINSTOCK, R. H. "Changing Criteria in Old-Age Programs: The Introduction of Economic Status and Need for Services." *Gerontologist* 34 (1994): 726–730.

BINSTOCK, R. H. "The 1996 Election: Older Voters and Implications for Policies on Aging." *Gerontologist* 37 (1997a): 15–19.

BINSTOCK, R. H. "The Old-Age Lobby in a New Political Era." In *The Future of Age-Based Public Policy.* Edited by R. B. Hudson. Baltimore, Md.: Johns Hopkins University Press, 1997b. Pages 56–74.

BINSTOCK, R. H. "Older People and Voting Participation: Past and Future." *Gerontologist* 40 (2000): 18–31.

CAMPBELL, J. C. *How Policies Change: The Japanese Government and the Aging Society.* Princeton, N.J.: Princeton University Press, 1992.

CAMPBELL, J. C., and STRATE, J. "Are Older People Conservative?" *Gerontologist* 21 (1981): 580–591.

CLARK, P. B., and WILSON, J. Q. "Incentive Systems: A Theory of Organizations." *Administrative Science Quarterly* 6 (1961): 219–266.

CONNELLY, M. "Who Voted: A Portrait of American Politics, 1976–2000." *New York Times.* (12 November 2000): wk4.

COOK, F. L., and BARRETT, E. J. *Support for the American Welfare State.* New York: Columbia University Press, 1992.

DAY, C. L. "Old-Age Interest Groups in the 1990s: Coalition, Competition, Strategy." In *New Directions in Old-Age Policies.* Edited by J. S. Steckenrider and T. M. Parrott. Albany, N.Y.: State University of New York Press, 1998. Pages 131–150.

FLANIGAN, W. H., and ZINGALE, N. H. *Political Behavior of the American Electorate,* 9th ed. Washington, D.C.: CQ Press, 1998.

GIFFORD, C. G. *Canada's Fighting Seniors.* Toronto: James Lorimer & Co., 1990.

HUDSON, R. B. "Conflict in Today's Aging Politics: New Population Encounters Old Ideology." *Social Service Review* 73 (1999): 358–379.

KENDIG, H. L., and MCCALLUM, J., eds. *Grey Policy: Australian Policies for an Ageing Society.* Sydney: Allen & Unwin, 1990.

MACMANUS, S. A. *Young v. Old: Generational Combat in the 21st Century*. Boulder, Colo.: Westview Press, 1996.

MILLER, W. E., and SHANKS, J. M. *The New American Voter*. Cambridge, Mass.: Harvard University Press, 1996.

MYERS, G. C., and AGREE, E. M. "Social and Political Implications of Population Aging: Aging of the Electorate." In *Proceedings of the International Population Conference, Montreal 1993*. Liege, Belgium: International Union for the Scientific Study of Population, 1993. Pages 37–49.

STRATE, J. M.; PARRISH, C. J.; ELDER, C. D.; and FORD, C., III. "Life Span Civic Development and Voting Participation." *American Political Science Review* 83 (1989): 443–464.

ROSENSTONE, S. J., and HANSEN, J. M. *Mobilization Participation, and Democracy in America*. New York: Macmillan, 1993.

TEIXERA, R. A. *The Disappearing American Voter*. Washington, D.C.: The Brookings Institution, 1992.

TIMPONE, R. J. "Structure, Behavior, and Voter Turnout in the United States." *American Political Science Review* 92 (1998): 145–158.

WALKER, A., and NAEGELE, G., eds. *The Politics of Old Age in Europe*. Philadelphia, Pa.: Open University Press, 1999.

VAN TASSEL, D. D., and MEYER, JIMMY ELAINE WILKINSON. *U.S. Aging Policy Interest Groups: Institutional Profiles*. New York: Greenwood, 1992.

POPULATION AGING

There were 420 million people in the world age sixty-five and older as of the year 2000, according to United Nations estimates (United Nations, 1998). If they all lived together under one flag, they would represent the third largest nation in the world. As a fraction of the total world population, the older population accounts for 7 percent, but this percentage varies considerably from one part of the world to another. For example, in the year 2000 only 19 percent of the total population of the world was living in more developed nations, yet 41 percent of the world's population age sixty-five or older was there, accounting for 14 percent of the total population of these wealthier countries. Still, that left the other 59 percent of people in the world age sixty-five and older living in the developing countries, even though the older population represented only 5 percent of those populations.

Between the years 2000 and 2010 the average annual rate of growth of the population age sixty-five and older in the world is projected to be 2.0 percent, compared to 1.2 percent per year for the total population (United Nations, 1998). That decade, however, represents the lull before the storm because the huge batch of babies born after World War II will have moved into the older ages in the following decade, between 2010 and 2020. During that decade, the population age sixty-five and older in the world will increase by 3.0 percent per year, while the total world population is projected to grow by only 1.1 percent. Furthermore, ever since 1970 the older population has been growing more quickly in less developed countries than in the more developed countries, even though the percent of the population that is sixty-five and older is still lower in those parts of the world. In 1970 the older population was almost evenly divided between more and less developed nations, but by the year 2020 we can expect there to be more than twice as many older people in the less developed nations as in the more developed. China contributed disproportionately to that number due to its large population size. In 2000, there were an estimated 89 million older people in China (one in five of all people in the world age sixty-five and older), even though they represented only 7 percent of China's population.

World's oldest and youngest populations

Using the percentage of the population age sixty-five and older as the index to an older population, the older populations of the world at the beginning of the twenty-first century are the wealthier countries of the world—those of North America and Europe, plus Japan. The list is led by Italy (18.2 percent in 2000), followed by Greece (17.2 percent), Sweden (17.2 percent), Belgium (17.1 percent), and Japan (17.0 percent) (National Center for Health Statistics). The United States is twenty-seventh on this list, with 12.7 percent of the population age sixty-five and older.

By contrast, the younger nations are located especially in the developing regions of Africa, western Asia, and southern Asia. Using the percent under age fifteen as the index of a youthful population, the youngest populations in the year 2000 were Uganda and Yemen (both with 49 percent), followed by Burkina Faso, Niger, Burundi, Angola, and the Democratic Republic of

the Congo (all with 48 percent). The forty youngest countries (all with more than 40 percent of the population under age fifteen) are in sub-Saharan Africa and the Middle East. In these countries, the population age sixty-five and older averages about 3–4 percent of the total. The obverse of that is that in the forty oldest countries of the world, the population under age fifteen tends to average only about 16–20 percent of the population.

Within the United States, the state of Florida exceeds all others in its percentage of the population that is sixty-five or older (18 percent in 2000), followed by West Virginia and Pennsylvania (both at 15.6 percent), Iowa (15.2 percent), and North Dakota (15.0 percent). At the other extreme, the youngest states are, in order, Alaska, Utah, Georgia, California, and Texas.

Age distribution of a population

As death rates drop and life expectancy increases, the older population increases partly because life expectancy goes up somewhat at the older age. However, the most important impact on aging is due to the fact that lower mortality increases the probability of surviving to old age. For example, in 1900 the life expectancy in the United States was lower than in almost every country in the world today. At birth a male could have expected to live an average of only 46.3 years, while the average was 48.3 for females. These life expectancies were about the same as England at the time, but lower than most Scandinavian nations. At this level of mortality, a male baby had only a 36 percent chance of surviving from birth to age sixty-five, and a female baby had a 41 percent chance of living that long. For those who reached 65, the pattern of mortality in 1900 produced a life expectancy at age 65 of 11.5 additional years for males, and 12.2 additional years for females. In that year only 4.1 percent of the U.S. population was age sixty-five and older, comparable to the countries of sub-Saharan Africa and the Middle East as of the year 2000.

Significant improvements in mortality occurred in the United States and other developed countries between 1900 and 1950, with female life expectancy in the United States increasing from 48.3 to 71.1 years. In concert with that, the percentage age sixty-five and older doubled to 8.2 in 1950. By the end of the twentieth century, life expectancy at birth for females in the United States had improved to 79.2 years—30.9 years more than at the turn of this century. Along with this, the percentage age sixty-five and older increased to 12.7 of the total. The century of improvement in life expectancy more than doubled the proportion of female babies surviving from birth to age sixty-five and has been a major reason for the increase in the number of older persons in the United States.

It is now commonplace for people to reach old age; so much so that long life is virtually taken for granted in richer nations. Furthermore, on reaching age sixty-five, females in the United States at the end of the twentieth century could expect to live an additional 19.2 years on average—an improvement of 7.0 years more beyond age 65 than was true a hundred years earlier, in 1900 (Anderson). This translates into more than a doubling of the proportion of women age sixty-five who will still be alive at age eighty. In 1997 in the United States, for example, more than two-thirds (68 percent) of the women alive at age sixty-five will still be alive at age eighty. The situation is not quite so favorable for males, but it has been improving for them, too.

Although declining mortality will always lead to an increase in the number of older people, the percentage age sixty-five and older will increase noticeably only if fertility also declines, as it always has historically in the context of the *demographic transition* (from low life expectancy and high fertility to high life expectancy and low fertility). Stable population models (Coale and Demeny) can be used to illustrate the percentage of the population that would be age sixty-five and older if a population maintained different combinations of mortality and fertility over time. For example, a country whose life expectancy was only thirty years would have 3.9 percent of the population age sixty-five and older if the total fertility rate (TFR) were five children per woman, and it would drop to 2.8 percent if the TFR went up to six. On the other hand, at a TFR of four or below at this low life expectancy, the population would be depopulating (because of fewer births than the number of deaths) so the percentage age sixty-five and older would be temporarily high, and then everybody would die off.

Stable population models show us that as life expectancy increases from thirty years to sixty years in a population where fertility remains at five children per woman, the percent age sixty-

five and older goes down slightly. This actually happened in Mexico. Mortality was declining in Mexico between 1950 and 1970, but fertility had not begun to decline and so the older population was declining as a percent of the total population. However, as mortality continues to decline, eventually it gets low enough that the percentage representing the older population begins to increase even if fertility does not change. At any given level of life expectancy, the lower the level of fertility, the higher is the percentage of the population that is sixty-five or older. The typical path followed by the percentage of the population that is older as a country passes through the demographic transition is that the percentage goes from about 2–3 in premodern societies to 20 percent or even higher as life expectancy reaches eighty years and as fertility drops below replacement level.

The impact of migration on the growth of the older population is more complex than the effect of either mortality or fertility. Younger people are more likely to migrate than the elderly, but there is no biological limitation to migration and so it is that, although in general migration tends to leave the older population behind, there are other times when older people move disproportionately to specific areas (such as Florida in the United States) in search of "amenity-rich communities with sunnier, warmer and recreationally more enjoyable environments" (Rogers, 1992, p. 3). Migration affects population aging most by what older people do not do—they do not migrate very much. Throughout the world, older people tend to age in place. As a consequence, the process of urbanization, which occurs in concert with the demographic transition, has left older people abandoned in the countryside by their children who migrate to the cities in search of work. In general, outmigration tends to increase the percentage of the population that is older in a region, whereas immigration has the opposite effect.

Racial/ethnic differences in population aging in the United States

The general patterns discussed above do not capture the variability that can exist within any given population. In the United States, for example, racial and ethnic groups tend to differ in their patterns of mortality, fertility, and migration, and therefore they differ with respect to population aging. For the year 2000, the percentage of those sixty-five and older in the United States was 12.7 percent overall, but U.S. Census Bureau data suggest that 14.8 percent of the non-Hispanic white population was sixty-five or older, compared to 8.4 percent for blacks, 7.7 percent for Asians and Pacific Islanders, 7.4 percent for American Indians, Eskimo, and Aleut, and 6.0 percent for Hispanics (U.S. Census Bureau, 2000). Recent immigrants, who tend to be young and who thus pull down the percentage of the population that is older, influence the low figure for both Hispanics and Asians, as does their higher fertility than the non-Hispanic white population. On the other hand, blacks and American Indians tend to have both higher fertility and higher mortality than non-Hispanic whites, thus lowering the percentage that is older compared to non-Hispanic whites. Overall in 2000, non-Hispanic whites comprised 83.5 percent of all persons in the United States who were sixty-five or older, followed by blacks (8.1 percent), Hispanics (5.6 percent), Asian and Pacific Islanders (2.4 percent), and American Indians, Eskimo, and Aleut (0.4 percent).

The demographics of the older population are expected to look quite different by midcentury. Census Bureau projections suggest that by 2050 more than one in five Americans (20.4 percent) will be sixty-five or older. The percentages are projected to be 24.7 percent for non-Hispanic whites, 18.7 percent for blacks, 16.4 percent for American Indian, Eskimo, and Aleut, 15.0 for Asians and Pacific Islanders, and 13.9 percent for Hispanics. In that year the older population will mirror the racial and ethnic diversity that could be seen in the shopping malls of many American cities in the year 2000, as the teenagers in the malls in 2000 grow into the older ages by 2050. This will amount to an older population that is 64.2 percent non-Hispanic white, 16.4 percent Hispanic, 12.2 percent black, 6.5 percent Asian and Pacific Islander, and 0.6 percent American Indian, Eskimo, Aleut.

What does the future hold—is demography destiny?

There are two important global trends ahead in population aging. Most noteworthy and most widely discussed is the graying of Europe, East Asia, and, to a lesser extent, North America. As of the year 2000, many countries in Europe, along with Japan and South Korea, were on the

verge of depopulation, as a consequence of birth rates that have been persistently below the replacement level, and life expectancy that keeps increasing, even (or perhaps, especially) at the older ages. There is a concern about the social and economic impact of an ever-growing proportion of the population that is retired from the labor force and facing potentially debilitating health conditions associated with aging. In essence, the question is, Who will keep the economy going and support these individuals in their old age? There are several solutions. The birth rate could increase, but there are few signs that this will happen. The death rate could go up, but there is little likelihood of that. Workers could stay in the labor force longer and thus delay the economic impact of aging, but in fact the age at retirement has been going down, rather than up, over the past few decades in most rich countries. The other solution, and probably the most likely one, is for the populations of these countries to be rejuvenated by migrants from other—typically less developed—countries. The United Nations has termed this "replacement migration" (United Nations, 2000).

Migration is already serving to prop up the numbers of younger people in several European counties (especially France, Germany, and the United Kingdom), but in eastern Europe, in particular, migration would have to increase substantially to prevent depopulation and rapid aging. Japan has traditionally closed its doors to international migration, but demography could be destiny in pushing Japan to decide to allow more immigrants, such as those from the Philippines, to enter the country and become permanent residents, rather than just allowing a small number of short-term guest workers, as has been the policy for a long time. The United States and Canada, of course, are already experiencing replacement migration and for this reason neither country is on the verge of depopulation, and both have relatively low percentages of the population in the older ages, at least compared to Europe and Japan.

The other important issue for the future is the aging of the older population itself. Health technology has made significant gains in allowing people to survive stroke, heart attacks, cancer, and to live more comfortably with a variety of chronic ailments that would have incapacitated a person only a few decades ago. Although we continue to think of age sixty-five as somehow the beginning of old age, medical technology—combined with improvements in lifestyle such as less smoking and more exercise—have pushed back the age at which the average person's health noticeably slows down the pace of living and leads into eventual dependency on a caregiver. It is likely that age eighty or even beyond is closer now in the twenty-first century to what age sixty-five was in the late nineteenth and early twentieth centuries in terms of becoming decrepit and dependent—the things about aging that most younger people fear the most. This suggests that the process of population aging will push us to rethink our view about when old age actually begins.

JOHN R. WEEKS

See also LONGEVITY: REPRODUCTION; LONGEVITY: SELECTION; LONGEVITY: SOCIAL ASPECTS; MIGRATION, GEOGRAPHIC; MOBILITY AND DISTRIBUTION.

BIBLIOGRAPHY

ANDERSON, R. N. "United States Life Tables, 1997." *National Vital Statistics Reports* 47 (1999): 28.

COALE, A., and DEMENY, P. *Regional Model Life Tables and Stable Populations*. New York: Academic Press, 1983.

National Center for Health Statistics. *Older Americans 2000: Key Indicators of Well-Being; Federal Interagency Forum on Aging Related Statistics*. Washington, D.C.: Centers for Disease Control, National Center for Health Statistics, 2000.

ROGERS, A. "Introduction." *Elderly Migration and Population Redistribution: A Comparative Study*. Edited by Andrei Rogers. London: Bellhaven Press, 1992.

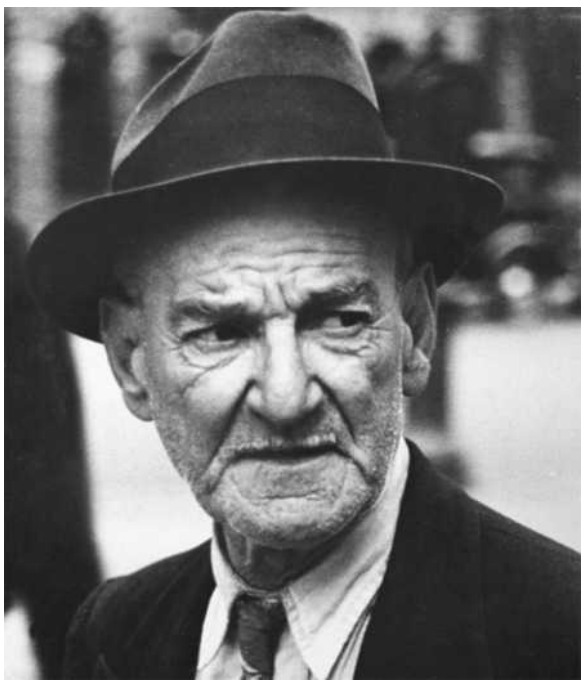
United Nations. *World Population Projections to 2150*. New York: Population Division of the United Nations, 1998.

United Nations. *Replacement Migration: Is it a Solution to Declining and Ageing Populations?* New York: Population Division of the United Nations, 2000.

U.S. Census Bureau. *Population Projections of the United States by Age, Sex, Race, Hispanic Origin, and Nativity: 1999 to 2100*. Washington, D.C.: U.S. Census Bureau, 2000. Available on the World Wide Web at www.census.gov

POVERTY

In 1999, in the United States, 3.2 million people age sixty-five and over, representing 9.7



The suit and tie might hide the fact that this elderly man is homeless and lives in poverty. (Library of Congress)

percent of the older population, were officially classified as *poor,* that is, their income (or that of their families) fell below the income threshold defined by the Census Bureau as the poverty line for their family size. This percentage represented an all-time low for the poverty rate among older persons, which has declined fairly steadily since U.S. poverty statistics first became available in 1959. This decline was dramatic during the 1960s, during which time the rate dropped from about 35 percent to about 25 percent, and there were further sharp declines in the early 1970s (to about 15 percent) in the wake of significant Social Security increases that took place in that period. Plateauing during the "stagflation" of the late 1970s, the elderly poverty rate has since undergone further gradual improvement.

This evolution was accompanied by an equally dramatic shift in the age distribution of poverty. In 1959, older persons were experiencing rates of poverty substantially higher than those of any other age group. Their disadvantage, relative to children, did not diminish during the late 1960s as the War on Poverty was initiated; it actually appears to have widened somewhat during this period, when antipoverty initiatives focused heavily on families with children. By 1969, the child poverty rate had declined to below 15 percent (a rate it has not achieved since), compared to about 25 percent for older persons. However, beginning in the early 1970s, these age groups experienced a sharp reversal of relative fortune. By 1974, the 65+ poverty rate had improved to the point that it had overtaken the child poverty rate, and the two rates have continued to diverge. During the Reagan era of the 1980s, child poverty rates worsened while those for older people improved, and the gap has remained since. In the mid-1990s, the 65+ poverty rate began to dip below the rate for those aged eighteen to sixty-four, and was slightly below that rate in 1999 (U.S. Bureau of the Census, 2000, p. ix).

Half-Full or half-empty?

These developments might be, and often have been, viewed as an unalloyed "good-news" story for older people. Indeed, particularly in conjunction with findings suggesting that the highest-income portion of the older population is becoming increasingly affluent (Crystal, 1982; Crystal and Waehrer, 1996), some have suggested that the major remaining social policy question is why these gains have not been shared by members of other age groups, especially children.

Other data, however, provide reason for concern. Of particular significance is the high proportion of *near-poor* older people. In 1999, 13.2 percent of older people had incomes between 100 percent and 150 percent of the poverty line, a higher proportion than was the case either for children or for those of working age. Altogether, a total of 22.9 percent of older people lived below 150 percent of the poverty line (U.S. Bureau of the Census, 2000, p. 2).

Taking a longitudinal, rather than a "snapshot," perspective on late-life poverty also suggests that impoverishment is a very real possibility in older life, despite relatively low cross-sectional poverty rates. Rank and Hirschl (1999) used life table analyses of Panel Study of Income Dynamics data to examine the probability that individuals with various characteristics will experience a year below the poverty line at some point after age sixty. Overall, they estimated that this will occur for 40 percent of America's elderly population and that 48 percent will experience a year below 125 percent of the poverty line. These rates were much higher for those

with less than 12 years of education and for African Americans. For example, 88 percent of unmarried, African-American women with less than twelve years of education were projected to fall into poverty at some point in old age, as compared with 13 percent of married white females with twelve or more years of education. In addition to increasing the risk for transitions into poverty, these same factors have also been shown to inhibit escape from poverty among elders (Jensen and McLaughlin, 1997), leading to more persistent old-age poverty among these subgroups.

In addition to highlighting the important role of racial differences and marital status, these results also confirm the importance of educational attainment in determining the risk of late-life impoverishment. This is consistent with other evidence that early advantages, such as those gained by formal education (typically completed by one's mid-twenties) shape individuals' economic destinies in a continued, and even increased, fashion many decades later in the life course, through a process of cumulative advantage and disadvantage (Crystal and Shea, 1990). For example, Crystal, Shea, and Krishnaswami (1992) found that years of education explain more of the variance in income after age sixty-five than at earlier ages, despite the many vicissitudes of life in the intervening decades. It is likely that among baby boomers, individuals with limited formal education will be at even greater risk of late-life impoverishment when they reach old age, since income gaps by education have been considerably higher for baby boomers than for earlier cohorts (Crystal and Johnson, 1998).

Comparing poverty rates across life stages

Perhaps of even greater concern is the question of whether the official poverty line sufficiently reflects the needs of older people, particularly in a society in which so many aspects of health care, long-term care, and other needs related to disabilities of aging depend on older people's own resources rather than public provision. Further, the poverty line for elderly individuals and for two-person, elderly-headed households is somewhat lower than the line for the nonelderly, although it is not clear that their economic needs are really less. For example, in 1999, for an older person living alone, the poverty line was $7,990, compared to $8,667 for a nonelderly person; for a two-person, elderly-headed family the poverty line was $10,075, compared to $11,214 for a nonelderly family. On the other hand, some have argued that the situation is even better for older people than the poverty figures show because the value of Medicare is not included in the poverty-line calculation.

The conventional poverty line has been widely acknowledged to be rather arbitrary in its construction. It dates from the 1960s, when it became important to planners of the War on Poverty to have a measure of a minimally adequate living level with which to define poverty and monitor progress toward the ambitious goal of eliminating it—an objective toward which there has only been real progress, ironically, with the older population, despite the War on Poverty's emphasis on children.

The basic idea underlying the original construction of the poverty definition, which was undertaken in the 1960s for the federal government by Mollie Orshansky, was straightforward to the point of being simplistic. Essentially, based on some studies that suggested that lower-income people spent about one-third of their income on food, Orshansky constructed food budgets for a minimally adequate diet, and multiplied these budget amounts by three. These original poverty line figures have been updated subsequently, based on Consumer Price Survey inflation adjusters. They have been criticized since their creation, both from the left (largely on the basis that a static measure of this kind does not incorporate increasing expectations for minimal adequacy in a society of increasing prosperity) and from the right (largely on the basis that they overestimate deprivation and have underrepresented progress, since they do not incorporate the value of in-kind benefits such as Food Stamps, Medicaid, Medicare, and housing subsidies).

Those who believe that trends in the existing poverty measure present a more positive picture than they should have often argued that a relative income measure, such as a specified percentage of the median income, would be a more appropriate measure of trends in poverty than the existing poverty lines, because it would take account of the increasing cost of social participation at a basic level (automobiles, flush toilets, or air conditioning in Southern climates might be considered more of a necessity in 1999 than in 1965). Those who believe that the trends present an overly negative picture have often argued for

valuing in-kind benefits in the poverty calculation. The argument here may be strongest for benefits like Food Stamps, which are near equivalents of cash. The argument for including health benefits seems more tenuous, as it does not appropriately address the greater health care needs of older persons, who even with Medicare spend more out-of-pocket on health care than do the non-elderly. Crediting each older individual with the average value of his or her Medicare benefit, as measured by average spending on behalf of all older people, attributes a large sum of "income" to each older person, though most are not receiving anything like that amount of services, since the distribution of Medicaid spending is highly skewed and a significant share of it takes place near the time of death. Such a calculation would distort cross-age comparisons by crediting the older age group with greater income because of their higher use of medical services. It would also distort time-trend analyses, making older people seem increasingly well-off as the cost of medical care services increases, thus reducing their income available for other purposes. If one attempted to attribute varying amounts of in-kind income to older individuals based on their actual or predicted Medicare expenditures, one would have the even more illogical result that older individuals get richer as they get sicker.

There have been a number of attempts to construct alternative poverty measures. A National Academy of Sciences (NAS) panel reviewed these issues and issued a report that recommended new ways to measure poverty. This report (see Citro and Michael, 1995) was critical both of the current measure's noninclusion of in-kind benefits and its failure to take account of the ways in which the cost of various goods, such as food, housing, and medical care, has changed relative to other goods since the early 1960s. Most recently, in response to such concerns, the Census Bureau has calculated poverty rates based on four alternative measures of poverty, one of which generally follows the NAS recommendations (Short, Garner, Johnson, and Doyle, 1999). This alternative measure adjusts poverty thresholds by geographical differences in the cost of living, counts noncash benefits as income, and subtracts from income some work-related, housing, and childcare expenses. The other three alternative measures include: the Different Child Care Method (DCM) assigns fixed amounts of childcare expenses to working families with children, based on the number and age of the children; the Difference Equivalence Scale (DES) uses a new method for adjusting for changes in expenses as family size increases; and the No Geographic Adjustment (NGA) measure, that, unlike the NAS measure, does not adjust thresholds for geographic differences in the cost of living. The alternative measures were standardized to the 1997 official poverty lines in such a fashion that each produced the same overall (all-ages) U.S. poverty rate as the official rate, and the measures were applied to income data for 1999. Interestingly, the 65+ poverty rate was considerably higher for each of the alternative measures than for the current official measure, while the child poverty rate was lower (there was little change for working-age persons). For example, while the 1999 poverty rate for persons 65 and over was 9.7 percent by the official measure, it was 13.3 percent (NAS), 13.0 percent (DCM), 13.7 percent (DES), and 13.6 percent (NGA) for the four alternative measures. By contrast, the poverty rate for persons under eighteen years of age was 16.9 percent under the official measure, but was 14.8 percent (NAS), 15.5 percent (DCM), 14.3 percent (DES), and 14.6 percent (NGA) for the four alternative measures. These results tend to support the argument that the official poverty lines underestimate the real prevalence of poverty among older people.

It is also important to note that the relatively low elderly poverty rate is not an indication that older people do not need Social Security; the rate is low only as a result of the presence of Social Security and would be far higher without it. For example, the Census Bureau found that without government transfers (mainly from Social Security) the 1999 poverty rate for persons over age sixty-five would have been 47 percent. Social Security has an important equalizing effect on income distribution—while there is evidence that inequality is higher among older people than at any younger age (Crystal and Shea, 1990), inequality would be far worse without Social Security. Social Security's tremendous success in reducing poverty in old age results in large part from its progressive income replacement design. It replaces a higher proportion of low incomes than of higher ones, while collecting the same contributions as a percentage of income (up to a ceiling)—a redistribution strategy that would be difficult to maintain to the same extent if part of Social Security benefits were replaced with individual private retirement accounts.

Differential needs and out-of-pocket health care costs

Of particular relevance in evaluating efforts to calculate needs-to-income for older people, as the official poverty lines do, is the burden of out-of-pocket health care costs. Clearly, the health care needs of older people are greater than those of younger people, a factor not taken into account in the official poverty lines. While it is sometimes assumed that a needs-tested safety net exists for the poorest elderly, most older people living at near-poverty or worse are not reached by that safety net. For example, Medicaid (which covers Medicare's co-payments and deductibles as well as services such as prescription drugs and long-term health care that are not covered by Medicare) is received by less than half of older people in the lowest income quintile (Crystal et al., 2000).

The two major types of out-of-pocket expenditures that are significant for older people are payments to health care providers and insurance premiums, including Medicare Part B premiums. About one-third of Medicare beneficiaries receive help in filling Medicare's gaps through retiree group health benefits from a former employer or a spouse's former employer, typically at no cost or at a highly-subsidized price; these benefits tend to be unavailable to individuals who held lower-paying jobs and those with less education. More than one-third of Medicare beneficiaries purchase individual supplemental policies (Medigap) in the marketplace. Prices of these products are unsubsidized and their coverage is limited.

Out-of-pocket costs for prescription drugs, a major category of health care not covered by Medicare, have received considerable attention. There has been less attention to the costs of dental services, also uncovered by Medicare, and of home health and assistive care. Analyses using the 1995 Medicare Current Beneficiary Survey (MCBS) indicate that despite Medicaid coverage for some, older people in the lowest income quintile (roughly equivalent to those living below about 140 percent of poverty) were spending 32 percent of their incomes on health care expenditures (in 1995). Prescription drugs accounted for 40 percent of their payments for health care goods and services (as opposed to 26 percent for those in the highest-income bracket), and dental care accounted for 12 percent (Crystal et al., 2000). With these high levels of financial need for health care, it seems illogical that the poverty line for elderly-headed households is lower than that for non-elderly-headed households, suggesting that the official poverty lines underestimate true poverty among older people.

Late-life poverty in the United States and abroad

Social Security, as noted above, does incorporate a redistributive element and plays an equalizing role that reduces old-age inequality. However, it lacks, even in combination with related programs such as Supplemental Security Income (SSI), a high minimum benefit and provides less protection for lower-income individuals than do systems in a number of other developed countries. Smeeding, Rainwater, and Torrey (1993) compared levels of late-life inequality and minimum benefits in public pension systems (as a percentage of median income) across a number of countries. The United States provided the lowest minimum benefit (defined by the means-tested SSI level) at 34 percent of median income, and experienced the highest level of late-life inequality. Countries such as France, Canada, and Australia guaranteed benefits close to 50 percent of median income and experienced intermediate levels of late-life inequality, while the Netherlands and Sweden, with their well-developed social welfare systems, provided guarantees of 72 percent and 66 percent of median income, respectively, and experienced the lowest rates of late-life inequality. Countries such as the Netherlands and Sweden with high minimum retirement income guarantees have largely eliminated late-life economic poverty. Of course, these and their other social welfare protections typically have come at the cost of a higher payroll tax and other taxation rates on working-age citizens than have been found politically acceptable in the United States.

While the existing U.S. poverty measure has significant limitations in comparing poverty rates across years or age groups, it is nevertheless a useful indicator of a group among the older population that is clearly experiencing economic privation. Similarly, near-poverty (e.g., those living below 150 percent of the poverty line) is a useful way to define a group that, while not in quite as dire straits, also experiences considerable privation and is an appropriate target for efforts to address unmet needs in the older population. It is therefore helpful to examine the characteristics

of the older population living in poverty. Not surprisingly, they are disproportionately female, and living alone, have chronic health conditions, and are over seventy-five years of age. In 1999, 69.7 percent were women. The poverty rate (in 1999) was 26.4 percent among African American women and 5.7 percent among white men. Similarly, among the 7.5 million elderly Americans living below 150 percent of the poverty line, 68.4 percent were women (47.1 percent of African American women fell into this category, and 14.7 percent of men). These differentials reflect lagged effects of differences in early advantages and disadvantages, differences in economic opportunities during the working years, the economic impact of differential rates of disability and ill health across socioeconomic groups in later life, and similar factors. This process of cumulative advantage and disadvantage reflects the fact that despite some redistributional features, retirement income systems in the United States are based heavily on pre-retirement earnings. The circumstances of the substantial population living below 150 percent of poverty (almost one-quarter of the older population) contrast sharply with those of more affluent older adults, representing a continuation of a long-standing "two worlds of aging" pattern in the United States (see Crystal, 1981).

STEPHEN CRYSTAL

See also CONSUMER PRICE INDEX AND COLAS; ECONOMIC WELL-BEING; INCOME SUPPORT FOR NONWORKERS, NATIONAL APPROACHES; INEQUALITY; LIFE CYCLE THEORIES OF SAVINGS AND CONSUMPTION; SAVINGS.

BIBLIOGRAPHY

CHULIS, G.; EPPIG, F.; HOGAN, M. O.; WALDO, D.; and ARNETT, R. "Data Watch: Health Insurance and the Elderly." *Health Affairs* Spring 1993: 111–118.

CITRO, C. F., and MICHAEL, R. T. *Measuring Poverty: A New Approach*. Washington, D.C.: National Academy Press, 1995.

CRYSTAL, S. *America's Old Age Crisis: Public Policy and the Two Worlds of Aging*. New York: Basic Books, 1982.

CRYSTAL, S.; HARMAN, J.; SAMBAMOORTHI, U.; JOHNSON, R.; and KUMAR, R. "Out of Pocket Health Care Costs Among Older Americans." *Journal of Gerontology: Social Sciences* 55B, no. 1 (2000): S51–S62.

CRYSTAL, S., and JOHNSON, R. *The Changing Retirement Prospects of American Families: Impact of Labor Market Shifts on Economic Outcomes*. Public Policy Institute Publication #98-01. Washington, D.C.: AARP, 1998.

CRYSTAL, S., and SHEA, D. "Cumulative Advantage, Cumulative Disadvantage, and Inequality Among Elderly People." *The Gerontologist* 30, no. 4 (1990): 437–443.

CRYSTAL, S.; SHEA, D.; and KRISHNASWAMI, S. "Educational Attainment, Occupational History, and Stratification: Determinants of Later-Life Economic Resources." *Journal of Gerontology: Social Sciences* 47, no. 5 (1992): S213–S221.

CRYSTAL, S., and WAEHRER, K. "Later-Life Economic Inequality in Longitudinal Perspective." *Journal of Gerontology: Social Sciences* 51B, no. 6 (1996): S307–S318.

JENSEN, L., and MCLAUGHLIN, D. "The Escape from Poverty Among Rural and Urban Elders." *The Gerontologist* 37 (1997): 462–468.

KAROLY, L., and ROGOWSKI, J. "The Effect of Access to Post-Retirement Health Insurance on the Decision to Retire Early." *Industrial and Labor Relations Review* 48 (1994): 103–123.

LILLARD, L.; ROGOWSKI, J.; and KINGTON, R. "Long-Term Determinants of Patterns of Health Insurance Coverage in the Medicare Population." *The Gerontologist* 37 (1997): 314–323.

RANK, M., and HIRSCHL, T. "Estimating the Proportion of Elderly Americans Ever Experiencing Poverty During Their Elderly Years." *Journal of Gerontology: Social Sciences* 54B, no. 4 (1999): S184–S193.

SHORT, K.; GARNER, T.; JOHNSON, D.; and DOYLE, P. *Experimental Poverty Measures: 1990 to 1997*. U.S. Census Bureau, Current Population Reports, Consumer Income, P60-205. Washington, D.C.: U.S. Government Printing Office, 1999.

SMEEDING, T.; TORREY, B. B.; and RAINWATER, L. *Going to Extremes: An International Perspective on the Economic Status of the U.S. Aged*. Working Paper No. 87. Luxembourg: Luxembourg Income Study, 1993.

U.S. Bureau of the Census, Current Population Reports; Series P-60, No. 210, *Poverty in the United States: 1999*. Washington, D.C.: Bureau of the Census, 2000.

POWER OF ATTORNEY

See ADVANCE DIRECTIVES FOR HEALTH CARE

PRESCRIPTION DRUGS

See MEDICATION COSTS AND REIMBURSEMENT

PRESSURE ULCERS

Skin ulcerations caused by pressure and/or shearing stress are known under a variety of names, including *decubitus ulcers, pressure ulcers, pressure sores,* and *bedsores*. They are caused by impaired blood flow (perfusion) through the affected area, which reduces tissue oxygenation. This process is termed *ischemia* and results in partial or total tissue death. It occurs when there is concentrated external pressure on part of the body for a period of time. This commonly occurs in an area with a bony prominence, such as the knees, hips, or elbows, but it can also occur in a number of other areas if the underlying tissue of fat and muscle is thinned. The effect is enhanced if the skin vessels have been previously damaged by intermittent pressure.

Shearing occurs when there is a sliding movement on the skin surface, producing partial or complete disruption of the underlying tissues. Minor shearing forces, short of actual disruption, occur quite frequently and produce ischemia due to impairment of the blood flow. Any factor (e.g., bedsheets, moist skin) that increases frictional resistance of the skin surface will increase the tendency to shear.

Maceration results when the skin surface is moist and occluded for a prolonged time. The outer part of the skin becomes whitish and soggy, and bacteria and other organisms can then proliferate. Such organisms invade when a slight abrasion occurs, and the resulting infection can lead to skin breakdown. Even minute foreign materials on the skin surface, such as dried bread crumbs or other debris, can cause local ischemia and thus promote breakdown.

Care must be taken to distinguish harmless colonization of bacteria from the pathological state of infection. The presence of inflammation (redness, heat, pain, and swelling) characterizes infection.

General factors that can increase the risk of pressure ulcers include poor nutrition, debilitating illness, clouding of consciousness causing immobility, and impending death. Conditions that predispose a person to bedsores include urinary or fecal incontinence, insensitive skin, peripheral vascular disease through arteriosclerosis or diabetes, and being underweight or overweight. The incidence of this condition in hospitals provides clues as to standards of care. It has been recorded variously as being between 2.7 percent and 29.5 percent, with a prevalence of 3 to 5 percent. When a pressure sore occurs in the elderly or immobile in a nursing home, there is a fourfold increase in the risk of death.

A number of classifications of ulceration have been used, but that of the National Pressure Ulcer Advisory Panel (NPUAP) is now generally favored (see Table 1).

The economics of bedsores is also important. It is difficult to estimate the cost of ulcer management, as settings vary from acute-care institutions to chronic-care nursing homes. For acute care, one estimate put the cost at between $5,000 and $40,000 per patient per year. The cost is significantly less in chronic care institutions.

To prevent bedsores, an optimal nutritional state must be achieved. In particular, a positive protein balance and adequate Vitamin C, iron, and zinc levels are required. Debilitated elderly persons, the mentally disabled, and those with dietary deficiency due to social circumstance are all at risk. For those at risk, the daily nursing routine must include inspection at least once daily. The bedridden should be turned at least every two hours, with good nursing techniques used to avoid friction and shear. Skin moisture and soiling must be minimized.

There are a number of ways in which pressure can be redistributed from bony prominences and other predisposed sites. Pillows or foam wedges are used to separate limbs. *Doughnuts* are not used, as they can increase pressure. Wheelchair cushions should be made of foam, viscoelastic foam, gel, or fluid flotation. Similarly, mattresses of the air pressure, water, air-fluidized, or air-support types are recommended. Team consultation, combining doctors, attending nurses, physiotherapists, occupational therapists, and equipment suppliers can be most helpful in planning the various stages of management (see Table 2).

The affected areas should be dressed using surgical gauze in combination with certain other materials. Films are thin, transparent, semipermeable, and nonabsorbent. They can be left in place for one or two days. Hydrocolloids are adherent, impermeable to gas, and are absorbent. They conform to the area on which they are used and can be left for a few days on deeper wounds. Foams are moist and absorbent, and they require a dressing to hold them in place. Alginates are used for deep cavities and sinuses. They are very

Table 1
Classification of Pressure Ulcers (according to the National Pressure Ulcer Advisory Panel)

Definition	Clinical Characteristic	Significance
Stage I: Nonblanchable erythema (redness) of the intact skin.	The area matches the area of pressure. In general, it is present for longer than 30 minutes but less than 24 hours.	This heralds impending ulceration and is a sign that immediate action should be taken.
Stage II: Partial thickness skin loss involving the epidermis with or without dermis.	The ulceration is superficial and may start as an erosion through abrasion and appear as a blister or shallow crater.	Indicates that structural damage has taken place; allows entry of infective organisims; and it can be a very short time to deeper extension.
Stage III: Full thickness skin loss, with damage or necrosis (tissue death) of subcutaneous tissue as far as underlying fascia.	Ulcer is a deep crater with or without undermining of surrounding tissue.	Serious surgical damage has occurred, which can extend rapidly at any time to underlying tissue.
Stage IV: Full thickness skin loss, with extensive destruction and possible damage to muscle, bone, and joints.	Major surgical damage. Very deep sinus extensions may be present, which may only be revealed by probing or radiographic techniques.	Life-threatening situation. Needs immediate surgical or orthopedic intervention.

SOURCE: National Pressure Ulcer Advisory Panel (NPUAP)

absorptive and need a secondary dressing. Other agents used to treat pressure ulcers include growth factors, hyperbaric oxygen, skin grafts, and skin substitutes. In general, healing times are one to two weeks for Stage II and six weeks to three months for Stages III and IV.

J. BARRIE ROSS

See also GERONTOLOGICAL NURSING; SKIN; SURGERY IN OLDER PEOPLE.

BIBLIOGRAPHY

BAR, C. A., and PATHY, M. S. J. "Pressure Sores." In *Principles and Practice of Geriatric Medicine,* 3d ed. Edited by M. S. J. Pathy. Chichester: John Wiley & Sons, 1998. Pages 1375–1394.

BENNETT, G. C. J. "Pressure Sores—Aetiology and Prevalence." In *Textbook of Geriatric Medicine and Gerontology,* 4th ed. Edited by J. C. Brocklehurst, R. C. Tallis, and H. M. Fillit. Edinburgh: Churchill, 1992. Pages 922–938.

KANJ, L. F.; WILKING, S.; VAN, B.; and PHILLIPS, T. J. "Pressure Ulcers." *Journal of the American Academy of Dermatology* 38 (1998): 517–536.

PREVENTIVE MEDICINE

See PERIODIC HEALTH EXAMINATION

PRIMATES

Nonhuman primates provide valuable experimental models for many aspects of aging research. These include diseases of aging (such as diabetes, cardiovascular dysfunction, and osteoporosis), reproductive senescence, neurobiological aging and related cognitive decline, and interventions to alleviate age-related deterioration. The choice of species is dependent on the purpose of the investigation and degree of similarity between the primate model and humans. Many types of nonhuman primates have been employed in gerontological studies, and these include various macaques (cynomologous, pigtails, and rhesus), lemurs, squirrel monkeys, baboons, chimpanzees, and others. By far, the most frequently employed nonhuman primate in gerontological and biomedical studies in general is the rhesus monkey, known by some as the "E. coli (the best characterized and most popular research bacteria) of primates." Mark Lane, at the National Institute on Aging, observed that the number of research articles on the aging of nonhuman primates has increased dramatically, from a total of less than 150 in the period between 1940 and 1978, to over 400 between 1995 and 1999.

Diseases of aging and "normal" aging

Since the major causes of death in humans are cardiovascular, it is not surprising that pri-

Table 2
Ulcer Management

Stage	Action
I	Observe every 2-4 hours. Protect surface in nonirritating way.
II	Trace ulcers weekly. Avoid infection. Cleanse with normal saline and dress with saline compresses. Topical antibiotics if significant infection.
III	Surgical removal of necrotic (dead) tissue. Moist saline dressing. Saline irrigation. Enzyme creams for low grade necrosis.
IV	Extensive surgical procedures, with or without skin or full tissue grafts.

SOURCE: Author

mate models have been used extensively to study cardiovascular disease and related problems such as obesity and diabetes. Some primates develop atherosclerosis spontaneously, while others must be fed special diets to induce this disease. The latter are usually high in cholesterol and fat. William Cefalu and his colleagues at Bowman Gray School of Medicine have examined various aspects of diet and atherosclerosis in monkeys and compared the manifestations of this disease with those in humans. Dietary lipid is important for both species, and similarities also exist with respect to plasma lipoprotein contributions (i.e., "good" cholesterol or high density lipoprotein, termed HDL, is protective, while "bad" cholesterol, or low density lipoprotein/LDL, contributes to cardiovascular disease), genetic and gender specific susceptibility, and pathology.

Obesity is a risk factor for both cardiovascular problems and diabetes in human and nonhuman primates. Although both obesity and diabetes occur without feeding special diets to nonhuman primates, neither are as prevalent as in humans, at least in the populations of most developed countries. As in humans, diabetes in monkeys is characterized by fasting hypoglycemia (low blood sugar), glucose intolerance, and reduced sensitivity to insulin (the hormone responsible for regulating sugar entry into cells).

Also as in humans, monkeys lose bone mass during aging. In its most extreme form, this constitutes the disease osteoporosis. Females of both species suffer more from this malady than their male counterparts. Part of the problem may stem from the senescence of the reproductive system, and a critical factor in this process is loss of estrogen in females. Rhesus monkeys exhibit regular menstrual cycles of approximately monthly duration until very late in life. Menopause, which is similar to that in humans, occurs with reduced concentrations of blood estrogen and increased concentrations of follicle stimulating hormone (necessary for maturation of ova, but increased in most primates when estrogen levels decline). Loss of estrogen has been linked to both bone loss and cardiovascular disease in humans and monkeys.

Estrogens may also protect, to some extent, against memory (cognitive) loss in many primate species. Menopausal monkeys have more difficulty remembering than pre-menopausal counterparts (Roberts et al.). For this and other reasons, nonhuman primates are used to examine both cognitive changes and overall aging of the brain and nervous system. Various memory tests have been devised to measure different aspects of monkey learning and memory, with the general conclusion being that, like older humans, aged nonhuman primates can still learn new tasks but have difficulty in proportion to the complexity of the challenge. Also like older humans, senescent rhesus monkeys exhibit either neuronal (nerve cell) loss or structural deterioration in certain brain regions. One aspect of the latter, the appearance of so-called senile plaques, parallels a similar phenomenon in humans with Alzheimer's disease.

Finally, it should be mentioned that nonhuman primates also provide important models for evaluating the effects of various interventions on aging and the above age-associated diseases. The most robust such manipulation, reduced dietary caloric intake, has been employed in both rhesus and squirrel monkeys since 1987 (Ingram et al.). It should also be noted that, in addition to information about the diseases of aging, monkeys provide much valuable insight into "healthy" aging as well (Ingram et. al.; Short, Williams, and Bowden). This includes normal age changes in hormones, blood chemistry, and blood cells as well as physiological and behavioral processes.

Advantages and disadvantages of nonhuman primates as aging models

As with essentially all experimental models, monkeys offer a variety of advantages and disadvantages. Clearly, the most pronounced of the former is their biological similarity to humans. It

is estimated that the DNA of rhesus monkeys possesses approximately 90 percent similarity with that of man. Chimpanzees are almost 99 percent identical to humans. Consequently, it is not very surprising that so many aspects of aging are similar across the phylogenetic range of primates. Thanks to their relatively shorter life spans, monkey aging can be observed faster than that of humans. Other advantages include an ability to control experimental conditions (e.g., long-term diet, environment, etc.) more rigorously than would be possible in studies employing humans. In addition, interventions (such as evaluation of new drugs) that are not ethically acceptable in man can be applied to nonhuman primates.

Unfortunately, the length of the monkey life span can also be a disadvantage. Although considerably shorter than for humans, the twenty-five to forty-year longevity of a rhesus monkey is still too long to conduct many experiments. Moreover, the cost of such monkey studies, both in terms of labor and initial animal procurement, may also be prohibitive in many cases. Even the availability of many nonhuman primate species may preclude their experimental use, as increasing numbers of investigators recognize the unique value of well-controlled data in species so similar to humans. Furthermore, despite the widespread use of monkeys such as the rhesus, their genetic heterogeneity is far greater than in many shorter-lived, cheaper animal models (e.g., rats and mice). Lastly, the ever-increasing level of restrictions and regulations concerning the use of nonhuman primates in research constitutes a major burden for scientists desiring such models.

GEORGE S. ROTH

See also ACCELERATED AGING: ANIMAL MODELS; DIABETES MELLITUS; GENETICS; MEMORY; NUTRITION, CALORIC RESTRICTION; PHYSIOLOGICAL CHANGES, ORGAN SYSTEMS: BONE; PHYSIOLOGICAL CHANGES, ORGAN SYSTEMS: CARDIOVASCULAR.

BIBLIOGRAPHY

CEFALU, W. T., and WAGNER, J. D. "Aging and Atherosclerosis in Human and Nonhuman Primates." *Age* 20 (1997): 15–28.

INGRAM, D. K.; CUTLER, R. G.; WEINDRUCH, R.; RENQUIST, D. M.; KNAPKA, J. J.; APRIL, M.; BELCHER, C. T.; CLARK, M. A.; HATCHERSON, C. H.; MARRIOTT, B. M.; and ROTH, G. S. "Dietary Restriction and Aging: The Initiation of a Primate Study." *Journal of Gerontology Biological Sciences* 48 (1990): B148–B163.

LANE, M. A. "Nonhuman Primate Models in Biogerontology." *Experimental Gerontology*. Forthcoming.

ROBERTS, J. A.; GILARDI, K. V.; LASLEY, B.; and RAPP, P. R. "Reproductive Senescence Predicts Cognitive Decline in Aged Female Monkeys." *Neuroreport* 27 (1997): 2047–2051.

SHORT, R. A.; WILLIAMS, D. D.; and BOWDEN, D. M. "Cross-sectional Evaluation of Potential Biological Markers of Aging in Pigtailed Macaques: Effects of Age, Sex and Diet." *Journal of Gerontology* 42 (1987): 644–654.

PROBLEM SOLVING, EVERYDAY

Adult performance in intellectually demanding real-life situations has received increasing attention in the cognitive and psychological research literatures since the 1970s. The ability of adults to solve cognitive problems encountered in daily life has frequently been referred to by several terms, including everyday problem solving, practical problem solving, everyday cognition, pragmatics of intelligence, and practical intelligence.

The study and measurement of practical intelligence or everyday problem solving arose out of concern with traditional academic paper-and-pencil measures of intelligence for two reasons. First, the validity of traditional intelligence tests as measures of everyday problem solving came into question. Specifically, question arose as to whether these tests actually assessed real-life functional competence, that is, whether intelligence-test scores were predictive of actual performance in a natural setting. Second, most traditional measures of intelligence were not originally developed for assessment of cognitive functioning in middle and later adulthood, and some questioned whether these tests represented salient mental abilities, particularly in later adulthood.

Everyday cognitive competence has been defined as the capacity to perform cognitively demanding tasks of daily living, and it is viewed as one component of functional ability. Measures of everyday or practical intelligence focus on tasks encountered by adults in their "real" life rather than more artificial or abstract tasks encountered only in academic or clinical settings. Domains of

complex everyday tasks, evident particularly in technologically advanced and affluent cultures, include the Instrumental Activities of Daily Living (IADLs), such as telephone use, financial management, and medication regulation.

Life-span approach to everyday problem solving

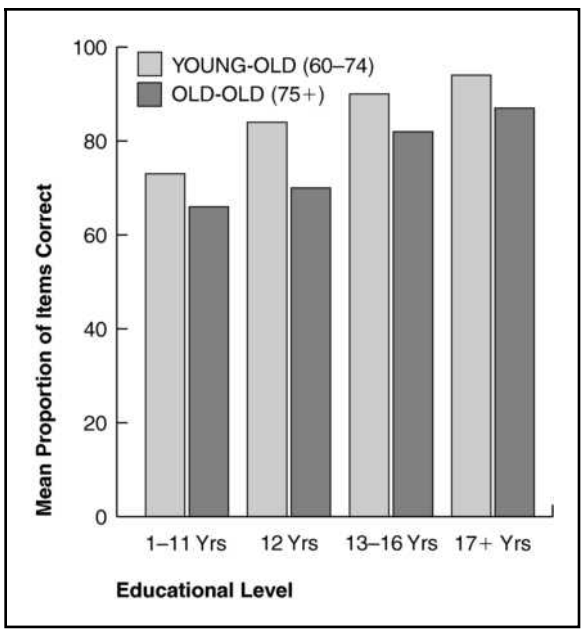
A life-span approach to the study of everyday problem solving encompasses four tenets: (1) examination of age-related change in everyday problem-solving performance from young to later adulthood; (2) consideration of the importance of individual differences in everyday cognition; (3) adoption of a multidimensional approach both to basic mental abilities and practical intelligence; and (4) examination of the association between traditional academic models of intelligence and everyday cognition.

Individual difference and age-related change in everyday cognition. A major concern in a life-span approach is the trajectory of change in everyday cognition as individuals age. That is, does the level of everyday problem-solving performance vary between individuals of different age cohorts, and does an individual's performance change as he or she becomes older? Cross-sectional and longitudinal research suggest that older adults perform more poorly on everyday cognitive tasks than young adults and middle-aged adults. Longitudinal research indicates that declines in everyday cognition are relatively modest from the sixties to the seventies, but a much steeper decline is shown in the late seventies to eighties.

Level of performance on everyday cognitive tasks is related to individual variables such as education, gender, and, in particular, a person's experience and expertise in a particular domain of daily living. For example, adults have shown greater expertise in everyday cognitive tasks related to their work lives or leisure pursuits.

In addition to age and task type, education also appears to play a role in everyday cognitive competence. Older adults suffer in comparison with younger cohorts in both the level of education attained and the quality of education. Possessing sufficient education may be particularly influential in the maintenance of everyday competence, as elders with less education tend to perform more poorly on everyday cognitive tasks throughout later adulthood. Figure 1 shows the proportion of everyday cognitive problems answered correctly by older adults, stratified by age and educational level. Note that the old-old (adults age seventy-five and older) and those with less than twelve years of education are particularly disadvantaged on everyday cognitive tasks. As normative cognitive changes occur with age, elders, especially those who are cognitively challenged and possess less formal education, may be at increased risk for declining competence on everyday tasks requiring cognitive complexity.

Figure 1
Proportion of everyday problem items answered correctly; nondemented elderly by education level



SOURCE: Author

Multidimensionality and relationship to cognitive ability. A life-span approach also stresses the importance of examining multiple dimensions or facets of everyday cognitive competence, as well as of traditional intelligence. Multidimensionality is of concern in two respects. First, there are likely to be multiple domains of everyday cognition that are only minimally related to each other and may exhibit different trajectories of age-related decline. Marsiske and Willis (1995) found, for example, that adults' performance on three measures of everyday problem solving was relatively unrelated, suggesting that distinct dimensions of practical intelligence exist. For ex-

ample, practical problem solving in this study involved tasks in which (1) respondents were required to generate as many efficacious solutions as possible to problems encountered in everyday life (e.g., getting the lawn mowed while having a heart condition); (2) document literacy was assessed by ability to generate a single correct solution in response to questions about presented stimuli from everyday life, such as a train schedule or rebate form; and (3) respondents' chosen solutions to social dilemma vignettes were compared to those of experienced raters.

Second, since everyday tasks are cognitively complex, multiple basic mental abilities underlie, or predict, performance on an everyday task such as reading a medicine label or interpreting a transportation schedule. The specific basic abilities that underlie a task will vary across tasks. A hierarchical relationship between traditional conceptions of intellectual abilities and everyday cognition has been suggested in which performance of cognitively complex everyday activities depends upon several basic cognitive abilities, such as the ability to reason and solve novel and abstract problems (fluid intellectual abilities) as well as knowledge acquired through education and culture (crystallized abilities). Indeed, evidence indicates basic abilities such as reasoning, vocabulary, numerical skills, and spatial orientation underlie the performance of older adults' everyday activities. It has been proposed that basic cognitive abilities (i.e., fluid and crystallized intelligence) are genotypically invariant across cultures and, although their phenotypic manifestation may vary by culture, they are a requisite, but not sufficient, component of competence on tasks of everyday life.

Social context of everyday problem solving

A recent focus in the area of everyday cognitive competence research is the consideration of the social context of everyday cognitive performance. Cognitive collaboration research is built on the premise that, in addition to assessing adults' performance on "real-world" tasks, it is important to take into account the everyday context of problem solving—that is, with social partners such as one's spouse. Older adults have demonstrated enhanced performance when working with a social partner on several types of everyday problem-solving tasks, such as prose recall and social problem solving. This line of research holds much promise, as cognitive collaboration with social partners may enhance older adults' everyday cognitive performance, possibly compensating for normative age-related decline.

Interventions into everyday cognition

An emerging area in the field of cognition and aging is the investigation of training techniques designed to enhance adults' cognitive performance or to remediate age-related loss in demented and nondemented elderly. Cognitive-training intervention programs have focused primarily on basic cognitive abilities, such as memory, and fluid abilities, and they have demonstrated improvement on these abilities. Extension of training effectiveness to adults' performance on more complex forms of cognition, such as everyday cognition, are now beginning to be examined. One study addressing this issue is a multisite clinical trial study being conducted by the National Institute on Aging and the National Institute of Nursing Research. This study is examining the feasibility of obtaining transfer effects of three cognitive interventions (inductive reasoning, speed of processing, and memory) to older adults' everyday functioning (e.g., everyday problem solving ability, health care utilization, IADL performance).

JENNIFER MARGRETT
SHERRY L. WILLIS

See also FUNCTIONAL ABILITY; HUMAN FACTORS, INTELLIGENCE; MEMORY; MEMORY, EVERYDAY.

BIBLIOGRAPHY

BALTES, M. M.; MAAS, I.; WILMS, H. U.; BORCHELT, M.; and LITTLE, T. D. "Everyday Competence in Old and Very Old Age: Theoretical Considerations and Empirical Findings." In *The Berlin Aging Study: Aging from 70 to 100.* Edited by P. B. Baltes and K. U. Mayer. Cambridge, U.K.: Cambridge University Press, 1999. Pages 384–402.

CAMP, C. "Memory Interventions for Normal and Pathological Older Adults." In *Annual Review of Gerontology and Geriatrics,* vol. 18. Edited by R. Schulz, G. Maddox. and M. P. Lawton. New York: Springer, 1998. Pages 155–189.

DENNEY, N. W. "Everyday Problem Solving: Methodological Issues, Research Findings, and a Model." In *Everyday Cognition in Adulthood and Late Life.* Edited by L. Poon, D. C.

Rubin, and B. A. Wilson. Cambridge, U.K.: Cambridge University Press, 1989. Pages 330–351.

DIXON, R. A., and GOULD, O. N. "Adults Telling and Retelling Stories Collaboratively." In *Interactive Minds: Life-Span Perspective on the Social Foundation of Cognition*. Edited by P. B. Baltes and U. M. Staudinger. New York: New York University Press, 1996.

JOBE, J. B.; SMITH, D. M.; BALL, K.; TENNSTEDT, S. L.; MARSISKE, M.; REBOK, G. W.; MORRIS, J. N.; WILLIS, S. L.; HELMERS, K.; LEVECK, M. D.; and KLEINMAN, K. *ACTIVE: A Cognitive Intervention Trial to Promote Independence in Older Adults*. Controlled Clinical Trials. In press.

LAWTON, M. P., and BRODY, E. "Assessment of Older People: Self-Maintaining and Instrumental Activities of Daily Living." *The Gerontologist* 9 (1969): 179–186.

MARSISKE, M., and WILLIS, S. L. "Dimensionality of Everyday Problem Solving in Older Adults." *Psychology and Aging* 10 (1995): 269–283.

MCCLELLAND, D. C. "Testing for Competence Rather than for 'Intelligence.'" *American Psychologist* 28, no. 1 (1973): 1–14.

POON, L.; RUBIN, D.; and WILSON, B. *Everyday Cognition in Adulthood and Late Life*. Cambridge, U.K.: Cambridge University Press, 1989.

PUCKETT, J. M., and REESE, H. W., eds. *Mechanisms of Everyday Cognition*. Mahwah, N.J.: Lawrence Erlbaum, 1993.

SALTHOUSE, T. A. "Cognitive Competence and Expertise in the Aging." In *Handbook of the Psychology of Aging*, 3d ed. Edited by J. E. Birren and K. W. Schaie. New York: Academic Press, 1990. Pages 310–319.

SCHAIE, K. W. "The Hazards of Cognitive Aging." *Gerontologist* 29, no. 4 (1989): 484–493.

STAUDINGER, U. M., and BALTES, P. B. "Interactive Minds: A Facilitative Setting for Wisdom-Related Performance?" *Journal of Personality and Social Psychology* 71, no. 4 (1996): 746–762.

STERNBERG, R. J., and WAGNER, R. K. *Practical Intelligence: Nature and Origins of Competence in the Everyday World*. Cambridge, U.K.: Cambridge University Press, 1986.

WILLIS, S. "Everyday Cognitive Competence in Elderly Persons: Conceptual Issues and Empirical Findings." *The Gerontologist* 36, no. 5 (1996): 595–601.

WILLIS, S. L. "Assessing Everyday Cognitive Competence in the Cognitively Challenged Elderly." In *Older Adults' Decision-Making and the Law*. Edited by M. Smyer, K. W. Schaie, and M. B. Kapp. New York: Springer, 1996. Pages 87–127.

WILLIS, S. L. "Current Issues in Cognitive Training Research." In *Aging and Cognition: Mental Processes, Self-Awareness and Interventions*. Edited by E. A. Lovelace. Amsterdam: Elsevier, 1990. Pages 263–280.

WILLIS, S. L. "Cognition and Everyday Competence." In *Annual Review of Gerontology and Geriatrics,* vol. 11. Edited by K. W. Scaie and M. P. Lawton. New York: Springer, 1991. Pages 80–109.

WILLIS, S. L., and MARSISKE, M. "Life-Span Perspective on Practical Intelligence." In *The Neuropsychology of Everyday Life: Issues in Development and Rehabilitation*. Edited by D. E. Tupper and K. D. Cicerone. Boston; Kluwer, 1991. Pages 183–198.

WILLIS, S. L., and SCHAIE, K. W. "Cognitive Training in the Normal Elderly." In *Plasticité cérébrale et stimulation cognitiv*. Edited by F. Forette, Y. Christen, and F. Boller. Paris: Foundation National de Gérontologie, 1994. Pages 91–113.

PROBLEM-SOLVING THERAPY

Social problem-solving therapy (PST) is a cognitive-behavioral intervention that is an efficacious treatment for depression. According to this model, depression is multifaceted, the result of an interaction between daily stress, major life events, weak coping skills, and depressive affect (Nezu: see Figure 1). People most vulnerable to depression either have inadequate problem-solving skills or problem-solving skills that are not being used because they feel unable to change their situation. According to PST, the ideal way to intervene in this depression-producing cycle is to teach patients how to mobilize their coping resources and begin tackling the problems in their lives. Once they begin to solve problems, depression lifts and the motivation to face other problems increases.

Application to older adults

Older people are often at risk for developing depression because of the number of life changes, such as disability, loss, daily stresses, and managing chronic illnesses and living on a fixed income. However, very few older people develop clinical levels of depression (Kessler et al.). According to the problem-solving model, the

deciding factor in who becomes depressed and who does not is whether or not the person facing so many life changes has the ability to solve problems effectively and believes that problems are solvable. Some studies have shown that older people with active problem-solving skills (seeking information, asserting oneself) are less inclined to become depressed than older people who engage in passive problem-solving (praying, waiting for someone to offer help). These data support the notion that Nezu et al. propose: if you teach someone how to actively solve problems, that person will become more able to negotiate his or her environment and hence will be less likely to become depressed.

Social problem-solving therapy

According to D'Zurilla and Nezu, problem solving consists of five skills. The first is problem orientation, which is concerned with how one views his or her ability to cope with a problem. The second is problem definition, which is concerned with the specific and concrete definition of the problem, and setting achievable and definable goals. The third skill, generation of alternative solutions, involves creating various methods for solving problems and meeting one's goals while withholding judgment on their effectiveness. The fourth skill, decision making, involves a systematic process to select the best solution for a problem from the list generated. The fifth and final skill, solution implementation and evaluation, involves planning and initiation of solutions, and subsequently evaluating the success of the solution. The intervention is delivered over ten to twelve sessions. The first session covers education about depression and explication of the model. It is important to educate older people about what depression is and how this therapy works because so many older adults hold inaccurate ideas about depression and are afraid of psychotherapy. After this introduction, the next five sessions focus on teaching each of the skills. It is important that these skills be taught sequentially, rather than all at once. Older people generally need a longer period to process new information, and allowing more time for discussion of each step facilitates learning. After each skill is taught and practiced, the remaining sessions are spent using the model to solve the patient's problems. Guided practice is particularly important in teaching new psychosocial skills. The more opportunities older people have to practice new behavior, the more likely they are to retain the skills and use them in the future.

Support for PST in older adults

Thus far only three empirical studies have evaluated the efficacy of PST in older, depressed adults. The first study was conducted by Hussain and Lawrence on older nursing home patients. In this study patients received either PST or supportive therapy. Patients who received PST showed fewer symptoms of depression after treatment than those who received the supportive care. The second study, conducted by Areán et al., compared PST to reminiscence therapy (RT), a treatment that at the time of the study was a common geriatric intervention. Although both interventions were superior to no treatment, PST resulted in far fewer symptoms and more remission of depression than RT. A study by Barrett et al. compared PST to Paxil and placebo in older medical patients with mild depression. This study found that PST was equivalent to placebo. It should be noted that the version of PST used in this study was one developed by Mynors-Wallis. This version of PST presents the problem-solving skills in one session, rather than allowing older patients an opportunity to practice each skill individually. It is likely that this mode of presentation is ineffective with older patients, and thus the more traditional presentation of PST is necessary for there to be any benefit for older people. More research into the process of delivery is needed to fully answer this question.

PATRICIA AREÁN

See also DEPRESSION; INTERPERSONAL THERAPY; STRESS AND COPING.

BIBLIOGRAPHY

AREÁN, P. A; PERRI, M. G.; NEZU, A. M.; SCHEIN, R. L.; CHRISPTOPHER, F.; and JOSEPH, T. "Comparative Effectiveness of Social Problem-Solving Therapy and Reminiscence Therapy as Treatment for Depression in Older Adults." *Journal of Consulting and Clinical Psychology* 61, no. 6 (1993): 1003–1010.

BARRETT, J. E.; WILLIAMS, J. W., JR.; OXMAN, T. E.; KATON, W.; FRANK, E.; HEGEL, M. T.; SULLIVAN, M.; and SCHULBERG, H. C. "The Treatment Effectiveness Project. A Comparison of the Effectiveness of Paroxetine, Problem-

Solving Therapy, and Placebo in the Treatment of Minor Depression and Dysthymia in Primary Care Patients: Background and Research Plan." *General Hospital Psychiatry* 21, no. 4 (1999): 260–273.

D'ZURILLA, T. J., and NEZU, A. M. *Problem-Solving Therapy: A Social Competence Approach to Clinical Intervention*. New York: Springer, 1999.

HUSSAIN, R. A., and LAWRENCE, P. S. "Social Reinforcement of Activity and Problem Solving Training in the Treatment of Depressed Institutionalized Elderly Patients." *Cognitive Therapy and Research* 5, no. 1 (1981): 57–69.

KESSLER R. C.; MCGONAGLE, K. A.; ZHAO, S.; NELSON, C. B.; HUGHES, M.; ESHELMAN, S.; WITTCHEN, H. U.; and KENDLER, K. S. "Lifetime and 12-Month Prevalence of DSM-III-R Psychiatric Disorders in the United States: Results from the National Comorbidity Survey." *Archives of General Psychiatry* 51 (1994): 8–19.

LERNER, M. S., and CLUM, G. A. "Treatment of Suicide Ideators: A Problem-Solving Approach." *Behavior Therapy* 21, no. 4 (1990): 403–411.

MYNORS-WALLIS, L. "Problem-Solving Treatment: Evidence for Effectiveness and Feasibility in Primary Care." *International Journal of Psychiatry in Medicine* 26, no. 3 (1996): 249–262.

MYNORS-WALLIS, L.; DAVIES, I.; GRAY, A.; and BARBOUR, F. "A Randomized Controlled Trial and Cost Analysis of Problem-Solving Treatment for Emotional Disorders Given by Community Nurses in Primary Care." *British Journal of Psychiatry* 170, no. 2 (1997): 113–119.

MYNORS-WALLIS, L. M.; GATH, D. H.; DAY, A.; and BAKER, F. "Randomized Controlled Trial of Problem-Solving Treatment, Antidepressant Medication and Combined Treatment for Major Depression in Primary Care." *British Medical Journal* 320, no. 7226 (2000): 26–30.

NEZU, A. M. "Efficacy of Social Problem-Solving Therapy Approach for Unipolar Depression." *Journal of Consulting and Clinical Psychology* 54, no. 2 (1986): 196–202.

NEZU, A. M., and PERRI, M. G. "Social Problem-Solving Therapy for Unipolar Depression: An Initial Dismantling Investigation." *Journal of Consulting and Clinical Psychology* 57, no. 3 (1989): 408–413.

NEZU, A. M.; NEZU, C. M.; and PERRI, M. *Social Problem Solving Therapy: Theory, Research, and Practice*. New York: John Wiley and Sons, 1989.

PRODUCTIVE AGING

In the formative years of gerontology as a field of study, considerable attention was paid to the frailties and limitations associated with the advancing years of older people. This attention to both the physical and psychosocial aspects of aging provided the essential foundation for an understanding of the challenges facing an aging society. Older adults were often viewed as a "deserving poor," worthy of public intervention after a lifetime of contributions. In the decade that followed the 1971 White House Conference on Aging, programs and services for older people experienced substantial expansion in their array of services and levels of funding. Perhaps no other single volume stirred the passion of the public in this regard more than the 1975 Pulitzer Prize-winning book by Robert N. Butler, *Why Survive?* which chronicled the "tragedy" of growing old in America.

By 1980, the early years of growth in social programs for elderly Americans had slowed, and considerable effort went into maintaining those that had been developed during the previous two decades. While this was generally a time of social program retrenchment, many of the programs designed for elderly persons were left intact.

Perhaps as a reaction to the prevailing public perception that aging was synonymous with decline and disease, Robert Butler became concerned by the perception and misrepresentation that older people were less able to participate fully in society than their younger counterparts, and that they were a costly burden on a vital nation. Butler introduced the term *productive aging* at the 1983 Salzberg Seminar in an attempt to reflect a more balanced view of the capabilities and potential of older people. According to Butler, "Many people express concern about the costs and dependency of old age. . .I wanted to stress the mobilization of the productive potential of the elders of society" (Butler and Gleason, 1985, p. xii).

While the contemporary aging network remains composed primarily of professionals focused on the problems associated with growing old, the field has made strides to examine the normative aspects of aging and the positive contributions of older adults in modern society. Better balance has been given to the significant contributions of older people in terms of volunteering, helping with children and grandchil-

dren, assisting friends and family who are sick, and professional achievements through work and hobbies. Begun as a broad concept to counter the negative images associated with being old, the term *productive aging* came into wider use in the 1990s, and along with its wider use came efforts to better define the term.

Definition

In 1993, Caro, Bass, and Chen defined productive aging to be "any activity by an older individual that contributes to producing goods or services, or develops the capacity to produce them (whether or not the individual is paid for this activity)." Research by Caro and Bass (1995), conducted under the auspices of The Commonwealth Fund's Americans Over 55 at Work Program, sought to measure the extent of participation by Americans age fifty-five and older who were engaged in work, caregiving of grandchildren or great-grandchildren, caring for sick friends or relatives, and educational training associated with career preparation. Kevin A. Coleman (1995) developed a conservative economic estimate of the cost to replace the value of these specific contributions of older people—it was well over $121 billion dollars.

Alternatives to the above definition have also been proposed. For the most part, the literature reveals consistent agreement among authors that the term include activities that can be measured and that have some direct or indirect economic value. However, there is some disagreement regarding the breadth of activities to be included in the definition. For example, Herzog et al. (1989) includes doing housework as part of the definition. Housework is also included under the rubric of productive aging in John W. Rowe and Robert L. Kahn's study on successful aging (1998).

Some controversy

Using an econometric word such as *productive* in association with aging has also raised some controversy in the gerontology scholarly community. Critics have asked whether this means that a person who is not contributing in an economically measurable manner is "unproductive?" (Holstein, 1992). In the activities cited as part of productive aging, for example, personal enrichment is not included. Meditation, religious reflection, personal growth, reminiscence, physical exercise and sports, entertainment, and education for expressive purposes are all outside the definition of productive aging, though these are important activities undertaken by many older individuals.

The response by proponents of productive aging has been that there are many activities undertaken by older people that are of great value to older people, as well as to society. Aging productively does not negate these valuable and important activities. Personal enrichment and growth is part of an individual's struggle to find meaning in life. Further, productive aging, while valuable, does not, nor does it intend to, represent the ultimate aspiration of the aging experience. Productive aging is not intended to be an idealized form of aging.

Of concern to many advocates for older adults, however, is that for those elders who choose to engage in productive aging, there is an uneven playing field where older people encounter specific prejudices, cultural traditions, and genuine barriers. They argue that this is unfair, counterintuitive, and discriminatory, and that it needs to be remedied. A society in which older individuals may contribute without facing ageism is indeed a goal worth struggling for.

Variables that influence productive aging

There are at least four distinct categories of variables that influence the productive engagement of older people: environmental variables, situational variables, individual variables, and social policy (Bass and Czso, 2001). The environmental variables that influence individual productive participation include the general state of the economy, the norms within a distinct culture or subculture, larger world events (such as war), political developments, demographic changes, and cohort membership. These variables are largely outside the control of the individual, but, in some respects, they can be influenced by social policy. It is less likely, for example, for an older person to find employment in an economic recession than in a time of low unemployment.

Situational variables include prescribed roles, obligations and responsibilities, socioeconomic status, educational attainment, organizational circumstances, traditions, community context, and health. For the most part, an individual has little choice over situational variables;

they are part of the individual's milieu. The way in which these circumstances are configured, however, can create either constraints or opportunities for productive aging.

Individual variables are those that are most frequently discussed when examining productive outcomes. These variables include motivation, drive, creativity, attitude, aptitude, habits, gender, race, ethnicity, physical features, and genetic profile. While there is often room for adjustment of individual variables, some variables are inherited and cannot be changed. Individualized variables can influence one's interest in productive participation.

Finally, and perhaps least considered in its influence, is social policy. Social policy determines government and employer policies, pension policy, organizational rules, taxation regulations, priorities, and public and private programs.

Impingement from any one of these four categories can limit the extent to which a person chooses to participate in a productive aging activity. Alternatively, an incentive or encouragement from any of these variables, particularly from social policy, can encourage greater participation. It is here where economists, policymakers, and planners have begun to consider ways in which policies can remove barriers and provide incentives to encourage those who choose to participate in some form of productive activity.

Policy considerations

Through the efforts of The Commonwealth Fund and other allied research efforts, it is possible to quantify the scope of the daily contributions that older adults provide to their employers, families, and communities. But, as many elders point out, they face constant barriers in their desire to remain in the mainstream of activity. Age discrimination in employment continues to be a part of everyday life. Colleges and universities remain focused on developing programs to attract young people and are less interested in attracting older adults interested in retraining; vestiges of depression-era policies designed to encourage the retirement of older people to make room for younger workers remain in practice; incentives exist to encourage older people to remove themselves from significant roles; and social and economic disincentives frequently confront those who want to remain economic contributors. These are the policies and practices that proponents of productive aging seek to change.

Economists point out that the economic challenges of the early twenty-first century are quite different than that of the previous century. Contrary to having vast supplies of young skilled labor, the nation has been faced with modest economic growth, a limited supply of skilled labor, and an aging population. The United States will need to develop strategies to respond to these changing economic and demographic conditions. According the Hudson Institute, in their report *Workforce 2020,* should America continue to experience even limited economic growth, sustained skilled-labor shortages loom on the horizon. Economists argue that rather than encouraging early retirement of older workers, public policy needs to be directed toward retraining and engaging the available talent.

Productive aging calls into question the lost opportunities to both society and the individual through policies or practices of articulated withdrawal of older people from productive activity. Policies, from Social Security to private pension policies, need to be considered in light of the changing economic landscape and the overall benefits to the individual, the tax base, and the economy, should older people choose to be engaged in productive activity well into their later years. While productive aging is not the holy grail of aging, it does raise questions about the enhanced roles some older people may choose to play in a modern and mature society.

SCOTT A. BASS

See also AGING; EDUCATION, DISENGAGEMENT; VOLUNTEER ACTIVITIES AND PROGRAMS.

BIBLIOGRAPHY

BASS, S. A. *Older and Active: How Americans over 55 Are Contributing to Society*. New Haven: Yale University Press, 1995.

BASS, S. A., and CARO, F. G. "Productive Aging: A Conceptual Framework." In *Productive Aging: Concepts, Cautions, and Challenges*. Edited by N. Morrow-Howell, J. E. Hinterlong, and M. W. Herraden. Baltimore, Md.: Johns Hopkins University Press, 2001.

BASS, S. A.; KUTZA, E. A.; and TORRES-GIL, F. M. "Diversity in Aging: The Challenges Facing the White House Conference on Aging." In

Diversity in Aging: Challenges Facing Planners & Policymakers in the 1990s. Edited by S. A. Bass, E. A. Kutza, and F. M. Torres-Gil. Glenview, Ill.: Scott, Foresman and Company, 1990. Pages 175–183.

BUTLER, R. N. *Why Survive?* New York: Harper & Row, 1975.

BUTLER, R. N., and GLEASON, H. P. *Productive Aging: Enhancing Vitality in Later Life*. New York: Springer, 1985.

CARO, F. G.; BASS, S. A.; and CHEN, Y.-P. "Introduction: Achieving a Productive Aging Society." In *Achieving a Productive Aging Society*. Edited by S. A. Bass, F. G. Caro, and Y.-P. Chen. Westport, Conn.: Auburn House, 1993. Pages 3–25.

CARO, F. G., and BASS, S. A. "Dimensions of Productive Engagement." In *Older and Active: How Americans Over 55 Are Contributing to Society*. Edited by S. A. Bass. New Haven: Yale University Press, 1995. Pages 204–216.

COLEMAN, K. "The Value of Productive Activities of Older Americans." In *Older and Active: How Americans Over 55 Are Contributing to Society*. Edited by S. A. Bass. New Haven: Yale University Press, 1995. Pages 169–203.

ESTES, C. L. *The Aging Enterprise*. San Francisco: Jossey-Bass Publishers, 1983.

HERZOG, A.; KAHN, R.; MORGAN, R.; JACKSON, J.; and ANTONUCCI, T. "Age Differences in Productive Activities." *Journal of Gerontology: Social Sciences* 44 (1989): 129–138.

HOLSTEIN, M. "Productive Aging: A Feminist Critique." *Journal of Aging and Social Policy* 4, no. 3/4 (1992): 17–33.

JUDY, R. W., and D'AMICO, C. D. *Workforce 2020*. Indianapolis, Ind.: Hudson Institute, 1997.

QUINN, J., and BURKHAUSER, R. "Retirement and the Labor Force Behavior of the Elderly." In *The Demography of Aging*. Edited by L. G. Martin and S. H. Martin. Washington, D.C.: National Academy Press, 1994. Pages 50–101.

ROWE, J. W., and KAHN, R. L. *Successful Aging*. New York: Pantheon Books, 1998.

PROFESSIONAL ORGANIZATIONS

More than a thousand age-based organizations exist in the United States at the national, state, and local levels. A number of such groups have emerged in other countries, such as Canada, as well as at the international level. These organizations are nonprofit collective entities with the betterment of persons age sixty and older as their objective (Liebig). However, not all have a professional orientation; many are consumer-based or consumer-focused advocacy groups. While most have "aging," "gerontology," or "geriatrics" in their name, others are not as easily identifiable, such as Generations United.

Organizations in aging can be classified as mass membership (such as AARP); special subgroups of older adults (the Older Women's League comes to mind); occupation-based or trade associations (the National Association of Retired Federal Employees and the American Association of Homes and Services for the Aging are examples); and professional groups of researchers and service providers (Day; Jaszczak; Krol; Van Tassel and Meyer; Wallace and Williamson). These organizations, associations, providers, professionals, and industries that serve elderly persons constitute "the aging enterprise" (Estes, 1979, 1993). They have been dubbed the "gray lobby" when they seek benefits from policymakers (Pratt).

Professional organizations

This entry centers on associations of academics and practitioners in gerontology and geriatrics, primarily mainstream age-based organizations. However, other organizations, such as the National Association of Social Workers, American Bar Association, and American Psychological Association, also address issues related to older adults. They have special sections that explore the responses of their respective professions to the needs of elders.

The major organizations representing academic researchers and practicing professionals are the American Geriatrics Society (AGS), the American Society on Aging (ASA), the Gerontological Society of America (GSA), and the National Council on Aging (NCoA) in the United States, and the Canadian Association of Gerontology (CAG) and the Canadian Geriatric Research Society (CGRS) in Canada. Some (GSA and CAG) primarily have a research constituency, while others (AGS and CGRS) are oriented toward medical school researchers and physicians. The ASA and NCoA, by contrast, draw members primarily from a wide range of practitioners and volunteers engaged in service delivery (Maddox).

These groups reflect the usual characteristics of professional organizations, including a post-baccalaureate educational requirement. They

hold annual conferences for members and others, such as the lay public; conduct research, faculty development, or continuing education workshops; produce and disseminate peer-reviewed publications (e.g., journals of basic and applied research); and give awards for meritorious service to the organization and to the field of aging. They also have a special membership category and activities for students (professionals-in-training). They are concerned with enhancing the dialogue between researchers and practitioners so that research results can lead to better practice, and also with promoting communication among practitioners to strengthen "best practices." They engage in advocacy and the shaping of public policy to benefit their members and the older adults whom they serve. The ASA, GSA, and NCoA accomplish this goal through their own efforts and also through an umbrella association comprising both professional and consumer groups, the Leadership Council on Aging, located in Washington, D.C.

Most professional organizations in aging were created during the 1940s and 1950s, in comparison with consumer groups, which proliferated during the 1970s and 1980s (Liebig). As shown in Table 1, the U.S. groups were established earlier than their Canadian counterparts; the geriatric societies were created first in both nations.

U.S. professional associations

American Geriatrics Society. The AGS was established in 1942 to promote effective, high-quality research that addresses the health care problems of older adults; to create and expand geriatric training centers; to expand and implement geriatric education and training for physicians, nurses, other health professionals, and the general public; to ensure access to geriatric medical care for older persons; and to pursue a vigorous public policy effort. Since 1952 the formation of state affiliates has been encouraged. Since the 1980s, the AGS focus on education has been reflected in the Teachers of Geriatric Medicine section, the Fellows in Training program, and a Board Review course. The AGS holds an annual meeting for its sixty-five hundred members that is accredited for continuing medical education and makes available audiocassettes of annual meeting presentations. Since 1983 the AGS has published the monthly *Journal of the American Geriatric Society*. It also produces the bimonthly *AGS News,* the biennial *Geriatric Review Syllabus,* and *The Directory of Fellowship Programs in Geriatric Medicine,* covering U.S. and Canadian programs. Other publications include position papers on topics of interest to the membership, such as Medicare subsidies for medical school education, and a membership directory.

American Society on Aging. Nearly ten thousand public- and private-sector professionals in aging belong to ASA, which got its start as the Western Gerontological Society in 1954. It seeks to foster a sense of community among those working with and on behalf of the elderly; to provide quality training; to promote research and disseminate knowledge; to facilitate innovative approaches to service delivery; to promote a positive image of aging; to influence social and public policies by sponsoring debates on emerging issues; to enhance and strengthen the involvement of ethnic and racial minorities; and to collaborate with other organizations to enhance the well-being of older persons and their families.

The ASA is organized around several affinity groups, such as business, religion, and lesbians and gays. Its annual meeting is held every other year in California in March and takes place in California every other year. In addition, ASA sponsors a summer series of workshops, regional seminars, a fall conference, and public forums in various parts of the country. Publications include a quarterly, practice-oriented journal, *Generations; Aging Today,* a bimonthly newspaper; *Inside ASA,* a semiannual newsletter for members; and specialized publications, such as *Critical Debates in an Aging Society*. The ASA annually recognizes individuals who have contributed to the organization and to the cause of aging in society, older ASA members who exemplify the contributions that persons over age sixty-five can make, student researchers, media leaders, exemplary practitioners, and businesses with programs and products benefiting older adults.

Gerontological Society of America. An outcome of a series of symposia funded by the Macy Foundation, the GSA began in 1945 as the American Gerontological Society. It was created to promote the scientific study of aging in public health, mental hygiene, the science and art of medicine, the cure of diseases, and the nature and problems of aging. A second objective was to encourage the exchange of knowledge about aging among scientists, practitioners, and decision makers working in the field. The GSA was

Table 1
Major characteristics of professional organizations in aging

Name	Date Established	Primary Membership	Major Purposes	Major Publications
American Geriatrics Society (AGS)	1942	physicians (academic, practitioners), other health professions, students	– promote geriatric research – expand geriatric training, education – ensure elder access to health care – pursue public policy	– *Geriatric Review Syllabus* – *Journal of American Geriatric Society* – *Directory of Fellowship Programs in Geriatric Medicine*
American Society on Aging (ASA)	1954	practitioners, academics, volunteers, business, older persons	–provide quality training – sponsor debates on emerging issues – enhance racial, ethnic minority involvement – promote research	– *Generations* – *Aging Today* – *Critical Debates in an Aging Society*
Gerontological Society of America (GSA)	1945	researcher, practitioners (clinical), students	– promote scientific study of aging and research training – encourage exchange of knowledge among scientists, practitioners and decision-makers	– *The Journals of Gerontology (4)* – *The Gerontologist* – *Public Policy and Aging Report*
Association for Gerontology in Higher Education (AGHE)	1974 (became part of GSA, 1999)	2- and 4-year colleges and universities: programs in gerontology and geriatrics	– provide network for educators in aging – improve quality of instruction in aging in higher education – sponsor national honor society	– *Core Principles and Outcomes of Gerontological, Geriatric and Aging Studies Instruction*
National Council on Aging (NCOA)	1950	practitioners, volunteers, older persons, researchers (applied)	– change negative societal attitudes – promote dignity, productivity and self-determination of older people; educate seniors – improve services for seniors – close gap between research and practice	– *Abstracts in Social Gerontology* – *Perspectives on Aging*
Canadian Association of Gerontology (CAG)	1971	researchers, practitioners, agency personnel, educators, business, older persons, students	– foster research, education and policy to improve life of older Canadians – improve service administration – encourage studies in aging – enhance cooperation between professions and disciplines – advocacy	– *Canadian Journal of Aging* – *Abuse and Neglect of Older Canadians: Strategies for Change* – *National Forum on Closing the Care Gap*
Canadian Geriatric Research Society (CGRS)	1955	academics, physicians (academic, practitioners), medical educators	– foster gerontological/ geriatric research, education and training – encourage funding of scientific and clinical research in geriatric medicine	*J. W. Crane Memorial Library Database*

(continued)

SOURCE: Author

Table 1 (cont.)
Continued from previous page

Name	Date Established	Primary Membership	Major Purposes	Major Publications
International Association of Gerontology (IAG)	1950	national societies of of gerontology	– promote gerontological research (biomedical, behavioral, social) – promote training of professionals – promote interests of gerontological societies	Conference abstracts
International Federation on Aging (IFA)	1973	researchers and professionals in affiliated societies	– advocacy on behalf of older persons	– *International Aging*
International Institute on Aging (IIA-Malta)	1988	professionals from different nations	– provide professional education and training in developing countries – facilitate implementation of 1982 Vienna International Plan of Action on Ageing	– *Bold*

instrumental in the creation of the National Institute on Aging and of federal support for graduate and postdoctoral training programs. More than sixty-five hundred members affiliate with four sections—Biological Sciences, Clinical Medicine, Behavioral and Social Sciences, and Social Research, Policy and Practice—as well as with numerous formal and informal interest groups, such as Humanities and Aging and Technology and Aging, that provide opportunities for members to discuss topics of mutual interest. The GSA also has a very active student program that sponsors scientific sessions and social events at the annual meeting held each November. With the creation of the National Academy on an Aging Society in 1995, the GSA has undertaken a proactive role as a national forum for policy analysis and debate through *The Public Policy and Aging Report*.

The GSA has an extensive publications program. *The Journal of Gerontology,* begun in 1946 as a single journal focused on basic research, became four separate journals in 1988. In 1961 *The Gerontologist* was created to feature articles on applied research and policy. A new series on chronic and disabling conditions, published by the National Academy on an Aging Society, was begun in 2000. A monthly newsletter, *Gerontology News,* and a membership directory are provided to members. In addition, the GSA bestows annual awards (e.g., the Donald Kent and Joseph Freeman awards) on members who have conducted quality research that impacts practice and education. The GSA also has a Fellows program for persons who have contributed to it and to the field, and Minority Fellowships for students.

In 1999 the GSA incorporated the Association for Gerontology in Higher Education. AGHE had been created in 1974 to provide a network for two- and four-year college and university instructional programs and to improve the quality of gerontology and geriatric programs in institutions of higher learning. Its more than three hundred members are institutionally based. Major publications include *Core Principles and Outcomes of Gerontological, Geriatric and Aging Studies Instruction,* the *AGHExchange* newsletter, subject bibliographies (e.g., public policy), and a national directory of instructional programs in aging. An annual meeting, faculty development workshops, and sponsorship of merit scholarships and a national honor society, Sigma Phi Omega, also are part of AGHE's activities. In the late 1990s AGHE developed a Fellows program and its Programs of Merit as a means of evaluating the quality of instructional programs.

The National Council on Aging. Originally funded by the Ford Foundation and established as the National Committee on Aging in 1950, the NCoA took its current name in 1960. Its mission has been to change attitudes that denigrate the contributions of older people. The NCoA is committed to improving services for elders and promoting the dignity, self-determination, well-

being, and productivity of older adults as individuals and within familial and community contexts. Its more than seven thousand members are drawn from professionals and volunteers who provide senior services.

The NCoA is composed of many constituent units, each with its own leadership, structure, and programs. The first was the National Institute of Senior Centers, which has promoted standards, guidelines, and accreditation for senior centers. Since 1971 eight other units have been added. Generally designated as institutes or centers, these units conduct applied research, training, and advocacy on issues such as aging in rural areas, adult day care, older worker employment services, and health promotion. The NCoA's David W. Meyer Institute for Applied Gerontology is designed to close the gap between research and practice. The NCoA also is one of ten national sponsors of the Senior Community Services Employment Program, which provides work opportunities for low-income persons aged over fifty-five. It also has played a major role in educating seniors about Medicare+Choice options and created several intergenerational programs (e.g., Family Friends) in which senior volunteers work with severely disabled children, and Foster Grandparents. With the Child Welfare League it created Generations United to strengthen intergenerational linkages.

The NCoA holds regional conferences and an annual meeting, usually in the spring in Washington, D.C. It publishes *Abstracts in Social Gerontology,* the quarterly *Perspectives on Aging,* and the bimonthly *NCoA Network.* It provides training materials, videos, and other instructional materials for its members and the public.

Other societies. Mention should be made of professional organizations at the state and regional levels and of special-focus groups. Among the former are statewide associations such as the California Council on Gerontology and Geriatrics and the Minnesota Society on Aging. Regional gerontological associations include the Midwest, Southern, and Southwest societies. New organizations, such as the Association of Private Geriatric Care Managers and the National Association of Service Coordinators, reflect growing professional specialization. A few publish journals (such as the *Southwest Journal on Aging*), but their primary outreach efforts are annual meetings, newsletters, and membership directories.

Canadian professional organizations

The development of professional organizations in Canada has paralleled that of similar associations in the United States, but the proliferation of such groups has been considerably less. This may be because the total population of Canada is less than the total numbers of U.S. seniors. The official languages of the three major associations are English and French.

Canadian Geriatric Research Society. The CGRS was established in 1955 as a national scientific medical association. Its primary objective has been to encourage the funding of basic scientific and clinical research in geriatric medicine. Its membership is drawn from biological and clinical researchers, medical educators, and physicians. Its concerns center on gerontological/geriatric research, education, and training, as is reflected in its information dissemination and educational activities, including an annual conference. The CGRS houses the J. W. Crane Memorial Library, a database of more than six thousand titles.

The Canadian Society of Geriatric Medicine. A complementary organization, the Canadian Society of Geriatric Medicine, was established in 1981. In contrast to the more academic focus of the CGRS, the CSGM serves practitioners. Its concerns center on patient health care and geriatric practice, long-term care, geriatric medical education and training, and specialized medical services for older persons. The CSGM holds an annual meeting in the early fall and publishes a quarterly newsletter for its members.

The Canadian Association on Gerontology. The CAG, established in 1971 by 185 founding members, was formally incorporated in 1973. It is a national, multidisciplinary association dedicated to fostering research, education, and policy aimed at improving the quality of life for older Canadians. This mission is accomplished by encouraging studies in gerontology, disseminating information, improving service administration, and enhancing communication and cooperation among the professions and disciplines serving older adults. The CAG espouses the philosophy that older persons are entitled to make informed decisions about their own lives and situations. It advocates for the development of a just government policy that fosters the freedom of older adults to conduct their lives in accordance with this principle. The creation of knowledge and its practical application are key to realizing these beliefs (www.cagagc.com).

CAG members include health care practitioners, government agency personnel, social and behavioral scientists, biological and clinical researchers, social service providers, educators, businesspeople, and older persons. Its priority concerns are health, nutrition, and long-term care; income security and employment of older workers; and housing and the environment.

CAG publications include a quarterly, *The Canadian Journal on Aging;* the quarterly *CAG Newsletter;* position papers on home care and seniors and prescription drugs; and two monographs, *Abuse and Neglect of Older Canadians: Strategies for Change* and *National Forum on Closing the Care Gap*. The CAG holds an annual meeting in the fall, with an emphasis on special student activities and the publication *The Student Connection*. It presents three annual awards for contributions to the organization and the field, and two student awards. CAG is a member of the International Association of Gerontology (*CPA World Directory of Old Age*).

Professional organizations in other nations

National professional organizations in gerontology and geriatrics have proliferated around the world, largely since the 1980s. The World Health Organization and the United Nations, as well as international associations (see below), have played important roles in promoting the development of these national organizations, especially in developing nations in Latin America and Asia. The establishment of professional societies in Australia, Hong Kong, India, Israel, Japan, and other nations attests to the growing interest in aging around the world.

International associations

Further evidence of the globalization of aging has been the increase of multinational organizations in aging, beginning with the creation of the International Association of Gerontology (IAG) in 1950. The IAG membership comprises national societies from four regions: Asia/Oceania, Europe, Latin America, and North America. The IAG holds a quadrennial meeting to promote gerontological research and cooperation by member organizations in the biomedical, behavioral, and social aspects of aging. It also promotes the training of highly qualified professionals in aging and seeks to protect the interests of gerontological societies and associations. The Sandoz Prize is its major award for research merit.

Other societies are the International Federation on Ageing (IFA), created in 1973, with numerous affiliates around the world composed of professionals advocating on behalf of the elderly in their respective nations, and the International Institute on Ageing (Malta), which conducts education and training for professionals in developing nations, under U.N. auspices. The publications of these two organizations, respectively, are *International Aging* and *Bold*. They have strong links with professional societies in the United States and Canada, such as the GSA and CAG, as well as with groups focused on developing programs for the elderly, such as the American Association for International Aging, the International Association of Homes and Services for the Aging, and HelpAge, headquartered in England with affiliates in several countries.

As all countries experience larger proportions of older people in the twenty-first century, professional organizations in aging will continue to be established, especially in the developing nations. These associations will maintain their support for programs of research and training to ensure that quality research is conducted and practitioners provide high-quality services to the world's elders.

PHOEBE S. LIEBIG

See also CONSUMER ORGANIZATIONS IN AGING; GERIATRIC MEDICINE; GERONTOLOGY.

BIBLIOGRAPHY

Canadian Association of Gerontology. www.cagacg.org

Center for Policy on Aging. *CPA World Directory of Old Age*. Essex, U.K.: Longman Group, 1989.

DAY, C. L. *What Older Americans Think: Interest Groups and Aging Policy*. Princeton, N.J.: Princeton University Press, 1990.

ESTES, C. L. *The Aging Enterprise*. San Francisco: Jossey-Bass, 1979.

ESTES, C. L. "The Aging Enterprise Revisited." *The Gerontologist* 33 (1993): 292–298.

JASZCZAK, S., ed. *Encyclopedia of Associations*, 31st ed. New York: Gale Research, 1997.

KROL, J., ed. *Older Americans Information Directory*. Detroit: Gale Research, 1994.

LIEBIG, P. "Organizations on Aging." In *Encyclopedia of Gerontology: Age, Aging and the Aged*.

Edited by J. Birren. San Diego: Academic Press, 1996.
MADDOX, G. L., ed. *Encyclopedia of Aging,* 2d ed. New York: Springer, 1992.
PRATT, H. J. *The Gray Lobby.* Chicago: University of Chicago Press, 1976.
VAN TASSEL, D. D., and MEYER, J. E. W., eds. *U.S. Aging Policy Interest Groups: Institutional Profiles.* New York: Greenwood Press, 1992.
WALLACE, S. R., and WILLIAMSON, J. B. *The Senior Movement: References and Resources.* New York: G. K. Hall, 1992.

PROGERIA

See ACCELERATED AGING: HUMAN PROGEROID SYNDROMES; CELLULAR AGING: TELOMERS

PROLONGEVITY

In the Western tradition, at least since the time of the ancient Greeks, physicians, philosophers, and lay practitioners have advocated diverse means to obtain a long and healthy life. Although they hardly formed a unified group, or advocated a single method or approach, the authors together voiced a recurring belief in the idea of *prolongevity:* that, following specific regimes and methods, individuals could live to extreme old age, well beyond the seemingly preordained limit of three score and ten. (The term *prolongevity* was first coined by Gerald Gruman, whose exposition of the idea appeared in 1966). By the seventeenth and eighteenth centuries, and often following the lead of Luigi Cornaro, such writers repeatedly challenged the notion that the body was inexorably destined to age and decay. In their eyes, the years beyond sixty or seventy were not necessarily a time of disease and suffering but could indeed be a period of activity and vitality. With the correct behavior and a strictly defined regimen, no tottering old man would exist only through the benevolence of relatives; no suffering aged woman would experience a loss of each of the senses. Instead an individual would live an extremely long life, "without loss of physical power and energy," as the leading prolongevity writer Christopher William Hufeland wrote in 1797, only to die when all organs ceased to function in a single painless instant.

Although often varying in remedies and medications, prolongevity literature can be organized generally along an important chronological divide, reflecting the impact of medical understanding. Until the nineteenth century, writers often harked backed to a primitive past, when ancient patriarchs supposedly counted their days in centuries rather than years. Pointing to a loss of vital energy as the cause of old age decay, they searched for the means to maintain the body in an active state, uncorrupted by a loss of vitality. By the nineteenth century, however, while this theory still existed among some authors, numerous prolongevity advocates voiced a new "scientific" optimism. The key to longevity, they argued, lay in the findings of science and medicine. Rather than seeing the past as a time of long-lived individuals, they looked to a future in which new medicines and theories would eliminate the many sources of early mortality and lead to unlimited life extension. And, rather than solely advocating hygienic prescriptions that might be given to preserve the middle aged, they eagerly promoted experimental procedures that would turn back the ravages of even advanced old age.

Early prolongevity writers

Although individuals had for centuries searched for magic potions and fountains of youth, without question the most influential early prolongevity advocate was Liugi Cornaro, an Italian nobleman who, in 1550 wrote *The Art of Living Long.* Translated into English, French, Dutch, and German, the work became the bible of many early prolongevity advocates. By the nineteenth century, the English version alone had gone through more than fifty editions. Received warmly by the popular press, it based its argument on two simple premises: First, men and women were not destined to die at sixty or seventy, but with care and a good constitution could live extremely long lives. Second, the key to longevity lay in simple reforms to an individual's lifestyle. Giving up excesses in all things, Cornaro preached the religion of extreme moderation.

Cornaro's own history became the basis for many of his prescriptions. Between the ages of thirty-five and forty, and after having lived a life of excess, Cornaro was warned by leading doctors that his death was imminent. Suffering from a variety of illnesses including gout, fever, and dehydration, he immediately decided to reform his lifestyle. "Since old age is exactly the opposite of youth," he wrote, "just as disorder is the re-

verse of order, it becomes imperative for [an individual] to change his habits of life with regard to eating and drinking, upon which a long and healthy life depends." (p.96) Swearing off heavy food and drink, Cornaro established a regime based on a limited amount of bread, soup, and eggs. Within a year, he found, he "grew most healthy." No longer did he regularly become ill, nor did he experience any type of mental distress; even accidents did not leave him bruised and suffering. "Any man," he wrote, "who leads the regular and temperate life, not swerving from it in the least degree where his nourishment is concerned, can be little affected by other disorders or incidental mishaps" (p. 53).

By the time Cornaro first wrote his manuscript, at age eighty-three, he sang the praises of his diet and the life he created. Having lost neither his senses nor his vitality, he declared "he had never known the world was beautiful until I reached old age." In his view, and under his regime, Cornaro argued that old age was a time of great wisdom and productivity during which he could pass important knowledge to the young and inexperienced. Aging, he declared, did not imply an inevitable loss of reason or activity. "Indeed," he wrote, old age. . .is the time to be most coveted, as it is then that prudence is best exercised, and the fruits of all the other virtues are enjoyed with the least opposition; because, by that time, the passions are subdued, and man gives himself up wholly to reason." With proper attention to diet and behavior, individuals with good constitutions could live healthy lives until their deaths at 120; even those who were less robust could look forward to one hundred years of active living.

For those who read Cornaro's work or followed him in advocating a defined regime, proof of these theories was not hard to find. Many pointed to the biblical stories of ancient patriarchs who lived numerous centuries. Adam, for example, had lived 930 years; Noah survived until 950. Blessed by God, and not subject to the debilitating routine of modern life, their long and active lives seemed ample evidence that the life cycle did not end with debilitating disease at sixty or seventy. Even in more modern times, many pointed to the long life of Thomas Parr as evidence of the reality of prolongevity. In 1635, Parr died, purportedly at the extreme age of 152. As his autopsy was performed by the eminent physician William Harvey, few doubted the legitimacy of the claim. Here was actual proof that an extremely long life was not simply the province of the patriarchs but could be achieved by modern men and women.

Following the work of Cornaro and the seemingly indisputable evidence of Parr's long-lived existence, many joined in advocating the benefits of a hygienic life. Individuals such as the James McKenzie, William Temple, and William Sweetser shared Cornaro's enthusiasm for the reality of extending the life cycle. At the end of the eighteenth century, the most famous advocate of prolongevity was undoubtedly the German physician Christopher William Hufeland. Where Cornaro set the limits to an individual's life at 120, Hufeland declared that, with proper care, individuals could live for two centuries. In his *Art of Prolonging Life,* written in 1797, he, like Cornaro, developed hygienic rules based on the notion of moderation in all things. The chief enemy of a long life, he declared was modern life; rural society provided the best likelihood for longevity. "The most extraordinary instances of longevity," Hufeland wrote, "are to be found, however, among those classes of mankind who, amidst bodily labor, and, in the open air, lead a simple life agreeable to nature, such as farmers, gardeners, hunters, soldiers, and sailors. In these situations man still attains to the age of 140, or even 150."

Hufeland, like many of the other prolongevity writers, based this assumption on a belief in the body's natural bank of vital energy. According to this widely accepted model, at birth an individual was endowed with a finite amount of vitality. During childhood, the body used this vital energy for growth and activity. By adulthood, it did well to maintain its supply. With old age, however, the amount of vital energy was clearly in decline. The obvious result was the elderly individual's tendency toward increasing illness and general debility. "Man," wrote Hufeland, "during the period of old age, has a much smaller provision of vital power, and much less capacity for restoration. If he lived with the same activity and vigor as before, this provision would soon be exhausted, and death would soon be the consequence."

Given this model, then, the seemingly obvious goal of early prolongevity writers was to preserve a person's store of vital energy. In advocating for less food, alcohol, or sexual activity, the writers shared their belief that such temperate behavior was essential for existence. "The

decrease in the intensity of the vital processes," wrote Hufeland, "as age increases, prolongs . . . vital duration." The aim, he argued, was to live life extensively rather than intensively. As vital energy could not be manufactured or restored, additional years of life were possible only with constant attention to maintaining the body's limited supply.

Yet prolongevity writers such as Hufeland were hardly arguing for the extension of a debilitated old age. Although Cornaro had sung the praises of the final stage of life, few shared his reverie of the qualities of the senescent. Their goal instead, as Hufeland wrote, was "to preserve oneself in a state of youth until an advanced period of life." They generally had little advice or sympathy for the aged individual who had already experienced debility and disease. Cornaro, as prolongevity writers repeatedly reminded their readers, had not waited until old age to reform his habits or retain his critical energy. Instead, by focusing upon the young and middle-aged, these authors advocated the creation of a new life cycle that greatly extended the length and qualities of middle age until a painless and instant natural death ended an individual's life.

Scientific prolongevity

By the end of the eighteenth century, this vision of an extended middle age was shared by a growing number of philosophers. Yet, instead of linking their hopes for prolongevity to the simplistic lifestyles of the past, they placed their faith in the future discoveries of sciences. For individuals such as Benjamin Franklin, William Godwin, and Antoine-Nicolas de Condorcet, it was not the careful herdsman or the earnest farmer who had the best hope for a long life but the modern-day scholar and scientist. Rather, only with progress did they hope to envision a century-long existence. "The rapid progress *true* science makes," wrote Benjamin Franklin in 1780, "occasions my regretting sometimes that I was born so soon.. . .All diseases may by sure means be prevented or cured, not excepting even that of old age, and our lives lengthened at pleasure even beyond the antediluvian standard." Condorcet shared a similar vision placing the extension of life as part of the advance of civilization. "[T]he day will come, he wrote, "when death will be due only to extraordinary accidents or the decay of the vital forces, and that ultimately, the average age span between birth and decay will have no assignable value.. . .Certainly man will not become immortal, but will not the interval between the first breath that he draws and the time when in the natural course of events, without disease or accident, he expires, increase indefinitely?"

Although the philosophers only envisioned this future, in the nineteenth and early twentieth century, new generations of prolongevity writers experimented with a variety of procedures for attaining a long life. Although some still discussed the importance of hygiene and diet, others advocated more extreme approaches to the eradication of old age. Their work generally reflected the medical community's rejection of the notion that old age was simply an inexorable decline in vital energy. Rather, by the middle of the century, elite physicians began to link old age to specific physiological changes, first in the tissues of the body, and then in the cell. If, as these medical authorities argued, old age was a disease caused by pathological changes in the body, the key to longevity lay in deterring this pathological process or restoring senile cells to their adolescent condition.

Clearly influenced by the discovery of the germ theory and the finding of cellular pathology, prolongevity advocates such as Arnold Lorand, Elie Metchnikoff, and Charles A. Stephens sought to find a way to stop the cell from aging, and, ultimately, to eliminate old age entirely. Although these writers shared the language of the new scientific age, the range of their prescriptions was wide. Stephens, for example, declared that aging was linked to the imperfections of aging cells. With proper cellular nutrition, he believed, the aging process could be eliminated. Elie Metchnikoff argued that the cause of aging, and the destruction of the aging body, were cells termed phagocytes that poisoned the body and led to its decline. Advocating a diet rich in lactic acid, he promised the elimination of intestinal putrefaction and the destruction of microbes that led to the body's decay. In contrast, Arnold Lorand found that "senility is a morbid process due to the degeneration of the thyroid gland and of other ductless glands which normally regulate the nutrition of the body." He established a system of hygienic and therapeutic measures that were designed to improve the functions of the glands.

Other prolongevity writers took a more experimental and invasive approach. For C. E.

Brown-Sequard, for example, the aging of the body was directly linked to a weakening of the sexual function. While previous generations of advocates had argued for celibacy in old age, in order to preserve vital energy, Brown-Sequard declared that these glands could be rejuvenated scientifically. In 1889, at the age of seventy-two, the neurologist announced that he had restored his own youthfulness with a mixture of animal sexual glands. Receiving widespread popular interest and acclaim, the lay press in both Europe and America reported the success of his program. One drug company in 1889 even began producing a toxin called Spermine, composed of semen, bull's testicles, calf's liver, and calf's heart.

Although patients lined up for injections, the initial popularity of the product and Brown-Sequard's approach failed to lead to long-term success. Nonetheless, throughout the early twentieth century, toxins and operations promising to remove the effects of old age continued to reach an eager market. In the 1920s, L. L. Stanley injected a mixture of crushed testicular substance into patients, and Eugene Steinach performed an operation that tied off the vas deferens and redirected sperm from the testicles back into the body. Although some in the scientific community greeting the supposed efficacy of these procedures with skepticism, by 1928 one researcher estimated that the Stanley procedure had been performed effectively with over fifty thousand patients.

Regardless of their prescriptions, these "scientific" prolongevity writers agreed that aging was a disease that caused specific decline. Although they tended to see the characteristics of old age in far less positive terms than had Cornaro, they did not feel that the process for delaying old age had to begin at an early age. Many actually intervened in the lives of even the extremely old, hoping to restore energy or renew the senile cells. They had little doubt that once the proper scientific research had been completed old age would disappear; people would live in a state of middle age until the end of life.

Anti-longevity literature

Not everyone, however, found these statements viable or the prescriptions likely to meet the desired results. Even in the eighteenth century, anti-prolongevity writers questioned the wisdom of increasing the proportion of aged individuals in a society. For Thomas Malthus, for example, such pronouncements only further intensified the question of overpopulation. Already concerned that available resources could not support a geometrically increasing population, he hardly endorsed the notion of additional generations of aged individuals.

Others found the data on which the prolongevity advocates based their claims to be highly suspect. Biblical life spans were discounted as metaphor; even the case of Thomas Parr, as well as that of Henry Jenkins who supposedly lived to 169, found numerous critics. "The theory based upon their supposed abnormal longevity," wrote critic William Thoms in 1873, "necessarily falls to the ground." He seemed amazed at the "simple child-like faith with which men of the highest eminence in medical science accept without doubt or verity statements of the abnormal prolongation of life." Moreover, as statistician Edward Jarvis noted in 1872, little evidence existed that progress meant a rise in the average life span. Instead, he argued that an increase in mortality, and a decline in longevity, actually accompanied the urbanization of England.

In addition, some critics believed that even if longevity were lengthened, they doubted that the ills of old age would ever disappear. Questioning whether the weakness and debilitation of old men and women could ever really be eradicated, they dismissed the notion that individuals could live in perpetual middle age. For them, the promise of longevity was simply the threat of scores of needy and diseased aged individuals making increasing demands on society.

Conclusion

In recent times, the hope of prolongevity advocates appears to have some factual support. In the twentieth century, for the first time, the increase in life expectancy has occurred at the end of the life cycle, rather than simply being the result of decreasing child mortality. In 1995, the average life expectancy for men was 72.5; for women, it was 79.3. As the number of centenarians continues to rise, the fastest growing segment of the American population has become those over the age of eighty-five. Moreover, large segments of the elderly population are believed to be in far better health than earlier generations. Such advances have led a new generation of prolongevity advocates to foresee a time when aging might be genetically deterred or obliterated. According to science writer Albert Rosenfeld,

"the science of genetic engineering would one day progress to the point where genes could be modified, transferred, or deleted so that a genetic 'clock of aging'. . .might thus be adjusted in any way we chose to define as beneficial" (p. xiii). Like Franklin or Condorcet two hundred years earlier, such advocates of prolongevity are sure that the findings of science will virtually restructure the life cycle. And, while they wait, advocates such as Rosenfeld continue to endorse dietary prescriptions that hark back to the dictates of Cornaro.

As in the past, however, this confidence has not been without its critics. Many question the desirability of increasing the proportion of society's aged population, or the benefits of extending the life of the extremely debilitated. Despite all the changes brought by science, and while life *expectancy* has risen, they argue that the maximum life *span* of the individual has not changed: it appears rather set at 110, or at most, 120. Yet, clearly the hope of extending the life span will not be deferred by such criticisms. From Cornaro through Rosenfeld, the prolongation of life continues to engage the popular imagination and challenge the limits of science.

CAROLE HABER

See also AGE; GERIATRIC MEDICINE; LIFE SPAN EXTENSION; LONGEVITY; OLDEST OLD; STATUS OF OLDER PEOPLE: MODERNIZATION; STATUS OF OLDER PEOPLE: PREINDUSTRIAL WEST; STATUS OF OLDER PEOPLE: TRIBAL SOCIETIES.

BIBLIOGRAPHY

BELL, J. *On Regimen and Longevity*. Philadelphia: Haswell & Johnson, 1842.

COLE, T. R. *The Journey of Life*. New York: Cambridge University Press, 1992.

CORNARO, L. *The Art of Living Long*. (1558). New York: Arno Press, 1979.

GRUMAN, G. A. "A History of Ideas about the Prolongation of Life." In *Transactions of the American Philosophical Society* 56, no. 9 (1966): 3–102.

HABER, C. *Beyond Sixty-Five*. New York: Cambridge University Press, 1983.

HAYES, J. R. *How to Live Longer and Why We Do Not Live Longer*. Philadelphia: J. B. Lippincott, 1897.

HUFELAND, C. W. *The Art of Prolonging Life (1797)*. Boston: Ticknor, Reed, and Fields, 1854.

JARVIS, E. *Increase of Human Life*. Boston: David Clapp and Sons, 1872.

LORAND, A. *Old Age Deferred*. Philadelphia: F. A. Davis, 1923.

MACKENSIE, J. *The History of Health and the Art of Preserving It*. (1760). New York: Arno Press, 1979.

METCHNIKOFF, E. *The Prolongation of Life*. (1908). New York: Arno Press, 1977.

MINOT, C. S. *The Problem of Age, Growth, and Death*. New York: G. P. Putnam's Sons, 1908.

PINNEY, J. *An Exposure of the Causes of the Present Deteriorated Condition of the Human Life*. London: Longman, Rees, Orme, Brown, and Green, 1830.

ROSENFELD, A. *Prolongevity II*. New York: Alfred A. Knopf, 1985.

SHYROCK, R. H. *Medicine and Society in America 1660–1860*. Ithaca, N.Y.: Cornell University Press, 1975.

SMITH, S. *The Philosophy of Health*. London: C. Cox, 1847.

STEPHENS, C. A. *Natural Salvation*. Norway Lake, Maine: The Laboratory, 1903.

SWEETSER, W. *Human Life*. (1867). New York: Arno Press, 1979.

TEMPLE, W. *The Works of Sir William Temple*. London: T. Woodward, 1750.

THOMS, W. *Human Longevity*. (1873). New York: Arno Press, 1979.

PROSTATE

The prostate gland, the seminal vesicles, and the bulbourethral gland constitute the male accessory sex tissues. These tissues are responsible for the production of the secretions that form the major component of the ejaculate (semen). This function, as well as their growth and development, requires continued function of the testes to supply testosterone. Though the ejaculate components may not contain factors essential for fertilization, it is thought that they optimize conditions through buffering, increasing sperm motility, or enhancing sperm survival in the male and female genital tracts. In addition they may play a role in preventing invasion by pathogens through production of potent biological substances and mechanical washing of the urethra with these secretions.

Structure

The shape of the prostate has been compared to an inverted, compressed cone. It lies imediately below the base of the bladder, in front of the rectum, and encircles a roughly one-inch

portion of the urethra as it leaves the bladder. The ejaculatory ducts, which are formed by the convergence of each seminal vesicle and its corresponding vas deferens, perforate the prostate posteriorly and empty into the prostatic urethra. Because the urethra has both excretory and reproductive functions, it can close the bladder neck temporarily at the time of ejaculation to separate urine and semen.

The prostate undergoes significant growth during fetal development and again during puberty. At age twenty the gland has reached normal adult size, approximately the size of a plum. It remains stable in size unless malignancy or benign prostatic hyperplasia causes further enlargement.

Benign Prostatic Hyperplasia

Aging is associated with a number of pathologic changes in the prostate. The most important of these are benign prostatic hyperplasia (BPH) and carcinoma of the prostate. The diagnosis of BPH is most often made on the basis of clinical assessment of prostate size (examination by means of a finger placed in the rectum) and symptoms such as reduced urinary flow rate and increased urinary frequency in the daytime or at night. Microscopic evidence of BPH is found in only 8 percent of forty year old men, in 50 percent of men aged fifty-one to sixty, and over 90 percent of men over the age of eighty, but only about one-third of these men have bothersome symptoms (Lepor; McConnell; Narayan; Weiss and Flair). Infrequently, BPH completely blocks urination and thereby causes kidney failure as the urine backs up through the bladder and uretes to damage the kidneys.

The major risk factors for BPH are age and normal male hormone (testosterone) status. The role of testosterone in BPH has been known since ancient times, when it was observed that boys castrated before puberty did not develop urinary retention and that castration provided relief for urinary obstruction in about one-third of cases.

Despite the observed association between prostate size and urinary symptoms, it is clear that factors other than the size of the gland are involved. Accordingly, obstruction can occur with relatively minor prostatic enlargement, presumably in men with weaker bladder contractility. Conversely, many men have large prostates but experience minimal symptoms.

Management of BPH

The management of BPH depends to some extent on the severity of the symptoms. The classic symptoms include increased frequency of urination, urinary hesitancy, incomplete emptying of the bladder, straining to void, nighttime voiding, and poor stream. Surgery has been the mainstay of treatment for BPH; however, since the mid-1980s, pharmacological and minimally invasive options have become available. Certain situations, however, are generally considered absolute indications for surgery. These include kidney failure, complete inability to void, chronic urinary tract infections, or bladder stones. Patients without these indications should consider lifestyle or pharmacological options. Many patients may be satisfied after appropriate reassurance and minor lifestyle changes, such as decreased fluid intake in the evening. Others find the symptoms too disruptive and should consider pharmacological therapy or surgery.

Two classes of drugs are commonly used for men with mild to moderate symptoms. The first are alpha-adrenergic blocking agents that act on receptors in prostatic smooth muscle to decrease resistance to urinary outflow. This class includes terazosin, doxazosin, and tamsulosin. Several well-controlled studies have demonstrated the efficacy of such drugs in improving symptoms (Lepor). The second class of drugs are androgen deprivation agents, which include finasteride. This drug inhibits the conversion of testosterone to dihydrotestosterone, thus blocking the action of testosterone on the prostate. This has been reported to reduce prostate size. A study in the late 1990s, however, has demonstrated no improvement in symptoms in men with prostates that were not enlarged (Lepor).

Patients with moderate to severe symptoms who fail or cannot tolerate medical therapy should consider surgery. Surgical removal of the prostate for BPH in most cases is performed by a transurethral resection of the prostate, in which the obstructing portion of the prostate is removed with a urethral telescope and electrical "knife." This procedure can also be performed using a laser, with similar effectiveness. In approximately 10 percent of patients who require surgery for BPH, the prostate is too large to be removed through a scope, and in these cases open surgery is used to remove the obstructing portion of the gland. Whether preformed through a scope or open, surgery success in

terms of patient satisfaction is approximately 90 percent (Mebust). It is not associated with incontinence and should not affect erections, though frequently the ejaculate may go back into the bladder because the bladder can no longer close during ejaculation (Mebust).

Prostate cancer

Prostate cancer is the most common cancer in North American males and the second leading cause of death among men who die from cancer (Carter and Partin; Narayan; Pienta; Weiss and Fair). Despite its high incidence of diagnosis, there is an even greater incidence of prostate cancers that go unrecognized. The biological behavior of the clinically recognized cancers is highly variable. For those with less aggressive tumors, prognosis is excellent with or without treatment, whereas for those with more aggressive tumors prognosis is poor regardless of treatment. For these reasons the most appropriate treatment for various stages of cancer creates confusion and controversy as physicians attempt to predict the behavior of individual tumors.

Like BPH, prostate cancer is strongly associated with aging. It is rarely diagnosed in men under forty, but, starting at that age, its incidence increases progressively, reaching a peak in the eighth decade. Autopsy studies have shown microscopic evidence of prostate cancer in 30 percent of 50-year-old males and up to 50 percent of men over seventy-five. However, it is estimated that only about 20 percent of cancers found at autopsy are clinically significant (Carter and Partin; Pienta; Walsh; Weiss and Fair). Prostate cancer, like BPH, is affected by male hormones. It does not develop in castrated men and grows in the presence of male hormones; removal of male hormones by castration induces dramatic regression of cancer growth.

Most prostate cancer is diagnosed by means of either an elevated prostate-specific antigen (PSA) or abnormal digital rectal exam of the prostate. Management decisions are based on whether the tumor is confined to the prostate; the grade (microscopic appearance) of the tumor; the presence of metastatic disease; and the general medical condition and life expectancy of the patient. For healthy patients with no medical contraindications and a life expectancy longer than ten years who have localized prostate cancer, most urologists would advocate surgical removal of the prostate and lymph nodes. External beam radiation therapy is also used as a primary treatment of localized prostate cancer. Implantation of radioactive sources into the prostate has gained renewed interest since the 1990s for the treatment of prostate cancer. For prostate cancer that has invaded through the prostate capsule (metastasized), surgery or local noninvasive treatments are not effective. Treatment at this point is aimed at removing the active stimulation of cancer cell growth by removal of hormone sources. Given that 95 percent of the body's testosterone is produced by the testes, the simplest way of accomplishing this is by removal of the testes, or bilateral orchidectomy. The same effect can be achieved pharmacologically by using analogues of luteinizing hormone-releasing hormone, which block the pathway leading to the production of testosterone by the testes in combination with anti-androgens that block the effects of the androgens at the target tissues.

Conclusion

Aging in the male is intimately associated with both malignant and benign pathologic changes in the prostate. These diseases both increase in incidence with aging. It is estimated that almost 50 percent of men will develop symptoms of BPH in their lifetimes. Fortunately, current medical and surgical options offer good resolution of symptoms. Up to 11 percent of men will develop clinically significant prostate cancer during their lifetimes. However, current treatment options associated with early diagnosis, along with the slow growth of prostate cancers, mean that most men die of illnesses other than prostate cancer.

TROY SITLAND
JOHN GRANTMYRE

See also ANDROPAUSE; CANCER, DIAGNOSIS AND MANAGEENT; KIDNEY, AGING; URINARY INCONTINENCE; URINARY TRACT INFECTION.

BIBLIOGRAPHY

CARTER H. B., and PARTIN, A. W. "Diagnosis and Staging of Prostate Cancer." In *Campbell's Urology*. Vol. 3. Edited by P. C. Walsh, A. B. Retik, Jr., and A. J. Wein. London: W.B. Saunders, 1998. Pages 2519–2549.

LEPOR H. "Natural History, Evaluation, and Nonsurgical Management of Benign Prostatic Hypertrophy." In *Campbell's Urology*. Vol. 3.

Edited by P. C. Walsh, A. B. Retik, Jr., and A. J. Wein. London: W.B. Saunders, 1998. Pages 1453–1478.

McConnell J.D. "Epidemiology, Etiology, Pathophysiology and Diagnosis of Benign Prostatic Hypertrophy." In *Campbell's Urology*. Vol. 3. Edited by P. C. Walsh, A. B. Retik, Jr., and A. J. Wein. London: W.B. Saunders, 1998. Pages 1429–1449.

Mebust, W.K. "Transurethral Surgery." In *Campbell's Urology*. Vol. 3. Edited by P. C. Walsh, A. B. Retik, Jr., and A. J. Wein. London: W.B. Saunders, 1998. Pages 1511–1528.

Narayan, P. "Neoplasms of the Prostate Gland." In *Smith's General Urology*. Edited by E. A. Tanagho and J. W. McAninch. East Norwalk: Appleton and Lange, 1995. Pages 392–433.

Pienta K. J. "Etiology, Epidemiology and Prevention of Carcinoma of the Prostate." In *Campbell's Urology*. Vol. 3. Edited by P. C. Walsh, A. B. Retik, Jr., and A. J. Wein. London: W.B. Saunders, 1998. Pages 2489–2496.

Walsh P. C. "The Natural History of Prostate Cancer: A Guide to Therapy." In *Campbell's Urology*. Vol. 3. Edited by P. C. Walsh, A. B. Retik, Jr., and A. J. Wein. London: W.B. Saunders, 1998. Pages 2539–2545.

Weiss R. E., and Fair, W. R. *Management of Prostate Diseases*. Praddo, Okla.: Professional Communications Inc., 1997.

PSYCHIATRIC DISEASE IN RELATION TO PHYSICAL ILLNESS

Formerly, psychiatrists were termed alienists, as though they dealt with strange, alien phenomena that had nothing to do with the rest of us. People with psychiatric disease were either ignored, sometimes tolerated, but more often dealt with by incarceration in large institutions away from cities. The kind of mental illnesses found in these hospitals were the severe variety. Today we call them the psychoses (madness) and the dementias (cognitive disorders). To the public these disorders were undoubtedly strange, but they were studied extensively by those in the mental health movement in the nineteenth and twentieth centuries in North America and Western Europe. The illnesses were roughly classified so that it was possible to make several advances. First, how common these diseases were in terms of type and severity by standard demographic variables; second, how common milder forms of mental illness were (those were not admitted to hospital); and third, how these psychiatric disorders related to the so-called physical illnesses.

Epidemiology

The science of epidemiology deals with the frequency of diseases in the community. The term *incidence* means "new cases" and *prevalence* means "all cases," new and old. So prevalence is incidence times duration. Psychiatric disorders have large prevalence rates mainly because they start in younger people, except for the so-called dementias like Alzheimer's disease. These psychiatric disorders are chronic or intermittent throughout life. A definitive study on these disorders was the Epidemiologic Catchment Area (E.C.A.) study, which was carried out in the United States around 1980 and published in detail in 1991 (Robins and Regier). This showed that 20 percent of all Americans had a mental illness at any one time and 32 percent at some point during their lifetimes. Depression and anxiety were common. Men had more mental illness than women, especially due to their having more substance abuse and antisocial personalities. Women tended to have more obsessive-compulsive disorder, major depressive disorder, and somatisation disorder (presenting psychological problems with physical symptoms). Perhaps the most interesting finding was that depressive illness declined with old age. The finding was counterintuitive since it is often thought that elderly persons have sad lives due to loss of status, income, marriage partners, and health. Other studies in different parts of the world have, however, confirmed the finding; yet it remains much argued. The arguments against the finding are that elderly persons tend to express psychiatric illnesses in physical terms, and so their true nature may be missed; and if all the different kinds of depression are added up the result is as high a rate for elderly persons as for the middle aged.

The E.C.A. study indicated that there was considerable comorbidity, that is, simultaneous occurrence of different psychiatric disorders and, separately, physical diseases. There was a tendency for those with psychiatric diseases to come from disadvantaged backgrounds. In other words, rates were higher among those who failed to complete high school, those on welfare, the unemployed, the unskilled, and the single. Thus, lower socioeconomic status is an important factor in mental illness. At the same time it should be remembered that the same applies to physical ill-

ness. So poverty, or relative poverty, plays a part in physical and mental illnesses, both helping to cause them and resulting from them. A more recent U.S. study, looking specifically at comorbidity, found even higher prevalence rates: almost half of the population studied (48 percent) had a psychiatric illness during their lifetimes and almost a third (29 percent) were ill at any one time.

The clinical conundrum

So on the psychiatry side we see that these disorders are exceedingly common. More common than diseases like arthritis, diabetes, and asthma, with which we are all familiar. What is the public health significance of these mental disorders? As noted earlier, depression is significantly associated with lower socioeconomic status. But there is also a very important correlation with physical disease. This is what is called *the clinical conundrum* (Eastwood). This says that while psychiatric disorders, usually depression or anxiety, often present with physical complaints there is, indeed, a true excess of physical ailments and premature death among psychiatric patients. In other words, patients who are depressed may go to the doctor and say that they have an upset stomach or headache, and the doctor may take this at face value. He will attempt to evaluate the patient, by taking a history and carrying out an examination, and put the symptoms into some physical disease context. If this fails he may tell the patient that there is nothing wrong with him so the patient continues to have his psychiatric disorder, which the doctor fails to recognize. This is a terrible state of affairs, although too common, and leaves the patient depressed and/or anxious and not knowing what to do.

So it is important that the presentation of psychiatric illness is recognized for what it is. A patient may have an affective illness, anxiety, or depression, and present with so-called somatic symptoms; or may be hypochondriacal; or may have psychiatric symptoms as an overlay to preexisting physical disease. Elderly patients may suffer from delirium. This is a condition where the patient is temporarily confused, due to such causes as too much medication or infection. It can be seen that there is a complex intertwining of physical and mental illnesses in their presentations. Beyond that there is outcome. The clinical conundrum says that not only are the psychiatrically ill misdiagnosed but they actually carry more risk for physical diseases. This can be understood in terms of risk for certain physical diseases and/or risk of premature death. At one time certain diseases were labelled as being "psychosomatic." This was intended to mean that such diseases were specifically caused by "stress." These were diseases like peptic ulcer, diabetes, hypertension, and rheumatoid arthritis. This kind of simplistic thinking is now viewed as naive. All diseases are a complex mixture of genetic risk and environmental hazards. Epidemiology, by means of cross-sectional and longitudinal studies, has successfully examined the mind-body relationship. Early studies from mental hospitals, in a variety of countries, showed that patients had more diseases, such as tuberculosis, than might be expected. These could lead to premature death from so-called natural causes. In addition, these patients had more "unnatural" deaths from suicide. Community studies, which were carried out later, and were much more sophisticated, however, came up with the same results. An example is the Stirling County study, in Nova Scotia, Canada, which has followed a community sample since 1952 (Murphy et al.) The patients with depression, particularly males, carried a significantly greater risk of premature death, especially from heart disease. So not only do the mentally ill contract more physical diseases in general, but more specific diseases. Depression and vascular disease, for example, appear to be intimately and reciprocally related. Thus 20 percent of patients who have had a heart attack develop depression, as do 50 percent of patients who have had a stroke. This is the case after controlling for vascular risk factors. So depression may be an independent risk factor for vascular disease and vice-versa. One explanation for less depression being found in elderly persons is that the depressed have died in middle age from vascular disease. Clearly, with advancing age, and especially in great (very old) age, the relationship between mental and physical illness becomes more complicated. Everybody succumbs to physical disease prior to death, but not every elderly person has a mental illness. Curiously, those with Alzheimer's disease are frequently and, ironically, physically well. We do need to know more about depression. Women carry twice the burden of risk for depression as men, yet men get more heart disease and more often commit suicide. Life events, early life experiences, and being separated or divorced are important factors associated with depression. The Cross National Collaborative group study found that the preva-

lence of depression varies from country to country; that mood disorders are becoming more common and starting earlier in life; and that only about 15 percent get treated, even in the most advanced countries.

The global burden of disease

Finally, Murray and Lopez, working with The World Health Organization and the World Bank, have described the "global burden of disease," as a reference to the death and disability for the six billion people on Earth. They found that heart disease, which is related to depression, was the most common cause of death; suicide was the twelfth (highest among elderly, white males); cirrhosis of the liver and lung disease were thirteenth and sixth, respectively (think of the role of drinking and smoking in mental illness). Major depression was found to be the most common disabling disease. The world's top three causes for DALYs (disability adjusted life year) were heart disease, major depression, and stroke. These findings show how important psychiatric disease is in relation to physical illness worldwide.

ROBIN EASTWOOD

See also BEREAVEMENT; DELIRIUM; DEMENTIA; DEPRESSION; DISEASE PREVENTION; GERIATRIC PSYCHIATRY.

BIBLIOGRAPHY

EASTWOOD, M. R. "Physical Illness and Depression: A Number of Conundrums." *Principles and Practice of Geriatric Psychiatry*. Edited by J. R. M. Copeland, M. T. Abou-Saleh, and D. G. Blazer. Chichester, U.K.: John Wiley & Sons, Ltd., 1994.

KESSLER, R. C.; MCGONAGLE, K. A.; ZHAO, S.; et al. "Lifetime and 12 Month Prevalence of DSM-III-R Psychiatric Disorders in the United States: Results from the National Comorbidity Survey." *Archives of General Psychiatry* 51 (1994): 8–19.

MURPHY, J. M.; MONSON, R. R.; OLIVIER, D. C.; SOBOL, A. M.; and LEIGHTON, A. H. "Affective Disorders and Mortality: A General Population Study." *Archives of General Psychiatry* 44 (1987): 473–480.

MURRAY, C. J. L., and LOPEZ, A. D., eds. *The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability from Diseases, Injuries and Risk Factors in 1990 and Projected to 2020*. Cambridge, Mass.: Harvard University Press, 1996.

ROBINS, L. N., and REGIER, D. A., eds. *Psychiatric Disorders in America: The Epidemiologic Catchment Area Study*. New York: The Free Press, 1991.

WEISSMAN, M. M.; BLAND, R. C.; CANINO, G. J.; et al. "Cross National Epidemiology of Major Depression and Bipolar Disorder." *Journal of the American Medical Association* 276 (1996): 293–299.

PSYCHOLOGICAL ASSESSMENT

Assessment pervades nearly every aspect of psychological or psychotherapeutic work with older adults. Thorough evaluation of the psychological status of an older person is an important but oftentimes complex and daunting process, even for experienced clinicians. In general, psychological assessment techniques are designed to evaluate a person's cognitive, emotional, social, and personality functioning. In clinical settings, the purposes of assessment are to find out what kinds of problems an older person is experiencing, to clarify personality features, to identify psychiatric disorders, to develop case conceptualization and intervention plans, and to evaluate effects of treatment. Traditional assessment strategies require some modification for older persons, given their often complex problems, unique socialization and life circumstances, and frequent comorbid health problems.

Overview of diagnosis and psychometric concepts in assessment

Diagnosis. The primary diagnostic guide for mental health professionals is the *Diagnostic and Statistical Manual of Mental Disorders,* fourth edition (DSM-IV; 1994), which includes specified criteria for several hundred mental disorders and encourages a full multiaxial diagnosis, including information on clinical disorders, personality disorders, medical conditions, psychosocial stressors, and a global assessment of functioning. However, whereas the DSM-IV has separate sections for childhood and adult disorders, there is no specific section on, or criteria for, mental disorders in later life.

Psychometric concepts. The primary psychometric concepts regarding psychological assessment of older adults include the topics of reliability, validity, standardization, and norms.

Reliability. Reliability refers to the degree to which measurement is consistent and stable

over time. For example, a reliable psychological test yields consistent scores when a person retakes the test after an interval, usually several days to weeks. *Internal consistency reliability* is a measure of the extent to which items in a test are interrelated with each other. *Test-retest reliability* refers to the extent to which test scores are consistent from one administration to the next. Tests used with older persons should show ample evidence of reliability, since this is the first requirement for good measurement.

Validity. Validity refers to the extent to which a test measures what it purports to measure and the extent to which the test can be used to make accurate predictions. For example, does an anxiety test for older persons truly measure anxiety? Reliability and validity are closely intertwined, as reliability is a necessary, but not sufficient, condition for validity. An unreliable test cannot possibly be valid, although it is possible for a test to have good reliability but poor validity if the test does not measure anything meaningful. The primary types of validity for psychological tests are content, construct, predictive, and concurrent validity. One should make sure that the tests one is using have been well validated in an elderly sample that is similar to the sample from which the respondent comes. Caution should be used in interpreting tests without proven validity among older persons.

Standardization and norms. Scores on most psychological tests rarely provide absolute measures of the construct being assessed (e.g., self-esteem). Rather, tests frequently indicate the relative performance of a respondent when compared to others. Thus, most popular psychological tests are standardized, which means that there are fixed procedures for administration and scoring and that the test has been given to many different people in order to establish statistical norms for age, sex, race, and so on. Norms provide standards for interpreting test scores, so that a person's responses can be compared to an appropriate reference group. Without standardization and norms, it would be impossible to determine if an older adult's score is typical, above average, or below average, making the assessment worthless.

Tests developed specifically for older adults (e.g., the Geriatric Depression Scale) have excellent norms. Likewise, standard intelligence tests have extensive age norms. Many other psychological tests did not initially furnish norms for older adults, but researchers have since provided good age-norms for some of them. Unfortunately, some tests still have missing or inadequate norms for older persons. Clinicians and researchers are encouraged to carefully review the technical manual of tests they use to determine if evidence for reliability, validity, and relevant norms for older persons are available. If not, they should be cautious in interpreting scores.

Assessment strategies and clinical conditions

Due to the complex nature of assessment with older persons, multiple strategies are often used in combination to elicit the most comprehensive and meaningful description of the older individual.

Clinical interview. The clinical interview is perhaps the most important and informative strategy during an evaluation of an older person. During the interview, the clinician gathers information about the person's current difficulties (the presenting problem), including a history of the problem. Other topics include an in-depth personal history, psychiatric treatment history, family history, mental status, and level of social functioning. It is important to develop rapport with the older person to allow him or her to disclose intensely personal information. Clinicians should explain clearly the purposes and procedures of the assessment and show respect for the older person. Any concerns the person may have about the evaluation should be addressed, since many older adults associate psychiatric services with tremendous shame and stigmatization.

It is imperative that clinicians fully assess concomitant medical conditions and medication use. This is important because many medical illnesses, and the medications used to treat them, can cause psychiatric conditions (e.g., delirium, depression, anxiety, psychosis). Diverse drug interactions can cause memory problems that mimic a dementing illness, such as Alzheimer's disease. Older adults are encouraged to bring a complete listing of medications to the testing session. Referral for a thorough medical work-up is always indicated if the person has not recently been medically evaluated.

Interviewers need to be flexible when engaging older persons. The environment should be adjusted to reduce the impact of any sensory or physical limitations (e.g., brightly lit and quiet

testing room; use of large-print versions of tests). Traditional time constraints should be adjusted to not fatigue the older person. A final tenet in geriatric assessment is to involve close family members and/or caregivers in the assessment to gather corroborative or additional information about the person.

Personality assessment. Personality tests strive to uncover the structure and features of one's personality, or one's characteristic way of thinking, feeling, and behaving. Objective personality tests are self-report pencil-and-paper tests based on standardized, specific items and questions. In contrast, projective tests present stimuli whose meanings are not immediately obvious and have an open-ended response format, such as a story from the respondent.

The most popular objective personality test is the Minnesota Multiphasic Personality Inventory-2 (MMPI-2). The MMPI-2 has ten standard clinical scales (e.g., depression, schizophrenia, social introversion) and three validity scales to detect unusual test-taking attitudes. The MMPI-2 is widely utilized with older adults, although separate norms for older adults are not readily available and there is concern that some older adults may receive inaccurately elevated depression scores due to the high number of somatic items on the scale.

The Rorschach Inkblot Test and the Thematic Apperception Test (TAT) are popular projective tests. During the Rorschach Test, the respondent provides associations to ten bilaterally symmetrical inkblots. The TAT consists of thirty-one black and white pictures that tend to induce particular themes, such as sexuality and achievement. Typically, ten to twenty cards are administered and the respondent is asked to create a story about each picture. Though not developed specifically for older persons, both tests are used with older adults. Two projective measures designed for older adults include the Geriatric Sentence Completion Form (which provides provocative age-appropriate sentence "stems" that are completed by the respondent) and the Senior Apperception Test (which has age-relevant pictures and themes).

Symptom checklists. Self-report checklists have been developed for hundreds of psychological constructs. Fortunately, several elder-specific checklists are available and they have excellent psychometric properties. Some stellar examples include the Geriatric Depression Scale (GDS), the Geriatric Hopelessness Scale (GHS), and the Michigan Alcoholism Screening Test—Geriatric Version (MAST-G).

The GDS is one of the best screening measures for depression in older adults. It consists of thirty items presented in a simple Yes/No format. Items focus on cognitive and behavioral aspects of depression, and somatic items are excluded. The scale is in the public domain, and is available, with the scoring key, on the GDS website at http://www.stanford.edu/~yesavage/GDS.html. The GHS is a thirty-item Yes/No self-report scale that assesses pessimism and hopelessness in older adults, both of which are related to suicide. The MAST-G is used for substance abuse assessment, which is a significant problem among older persons and is linked to depression and suicide. The MAST-G contains twenty-four Yes/No items unique to older problem drinkers. In all cases, "yes" is the pathological response, and a cutoff of five positive responses indicates an alcohol problem.

Cognitive functioning. Assessment of cognitive functioning is an important part of any thorough geriatric assessment, since cognitive impairment (e.g., dementia) is an age-related problem (e.g., rates of dementia increase with age). Notably, other test results may not be valid if the respondent has significant cognitive impairment. Early detection of cognitive problems is crucial because many symptoms are reversible, especially for delirium. The primary DSM-IV cognitive disorders are delirium and dementia. Delirium refers to a clouding of consciousness with impaired concentration, disorientation, and perceptual disturbances that develop over a short period of time (hours to days). Since delirium is often obvious and acute, there are no specific tests for it. If delirium is suspected in an older person, they should be quickly referred for medical treatment, since delirium is typically reversible but can be deadly if the underlying cause (e.g., infections, malnutrition) is not corrected.

Dementia is a syndrome of multiple cognitive deficits that include memory impairment, but without impairment in consciousness. The most common type of dementia is Alzheimer's disease, which accounts for 50 to 60 percent of demented persons. It is important for clinicians to screen for dementia in all older clients during a psychological assessment. Several brief, standardized, and easily administered screening tools are available. The Folstein Mini-Mental

State Examination takes five to ten minutes to administer and is well-validated. Items tap orientation, concentration, memory, language, and gross motor skills. Scores range from 0 to 30, with scores under 25 indicating a need for further testing and evaluation. The Dementia Rating Scale is a psychometrically sound, interviewer administered test designed for dementia evaluation. It consists of thirty-six tasks and takes about thirty minutes to complete.

Should concern about cognitive impairment result from a screening test, more thorough neuropsychological testing is warranted. Such testing assesses brain-behavior relationships in multiple domains and behavioral disturbances that are caused by brain dysfunction, and also helps to quantify and localize brain damage. One approach is for the examiner to use a standard and fixed battery (e.g., the Halstead-Reitan Battery), whereas another strategy is to carefully choose a variety of different tests to assess particular neuropsychological domains of interest. Finally, laboratory tests (e.g., electrolyte panel, urinalysis, electroencephalography) and high-tech brain-imaging procedures (e.g., CAT scan, MRI scan) are often used to complement neuropsychological assessment.

Assessment of intelligence is another important area. Intelligence tests are standardized tests designed to measure a person's mental ability. The two prominent tests are the Stanford-Binet Intelligence Test, fourth edition and the Wechsler Adult Intelligence Scale, third edition (WAIS-III). The WAIS-III consists of fourteen separate subtests: seven verbal and seven performance. Raw scores for each subtest are converted into scaled scores, and score sums are converted into a verbal intelligence quotient, a performance intelligence quotient, and a full-scale intelligence quotient. Both tests have extensive age-norms and are the leading measures of intelligence assessment across much of the life span.

DANIEL L. SEGAL

See also DELIRIUM; DEMENTIA; DIAGNOSTIC AND STATISTICAL MOVEMENT OF MENTAL DISORDERS—IV; EMOTION; IMTELLIGENCE; MEMORY; MENTAL STATUS EXAMINATION; NEUROPSYCHOLOGY; PERSONALITY.

BIBLIOGRAPHY

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders,* 4th ed. Washington, D.C.: APA, 1994.

BLOW, F. C.; BROWER, K. J.; SCHULENBERG, J. E.; DEMO-DANANBERG, L. M.; YOUNG, J. P.; and BERESFORD, T. P. "The Michigan Alcoholism Screening Test—Geriatric Version (MAST-G): A New Elderly-Specific Screening Instrument." *Alcoholism* 16 (1992): 372.

BUTCHER, J. N.; DAHLSTROM, W. G.; GRAHAM, J. R.; TELLEGEN, A.; and KAEMMER, B. *MMPI-2: Manual for Administration and Scoring*. Minneapolis: University of Minnesota Press, 1989.

FOLSTEIN, M. F.; FOLSTEIN, S. E.; and MCHUGH, P. R. "Mini Mental State: A Practical Method for Grading the Cognitive State of Patients for the Clinician." *Journal of Psychiatric Research* 12 (1975): 189–198.

FRY, P. S. "Assessment of Pessimism and Despair in the Elderly: A Geriatric Scale of Hopelessness." *Clinical Gerontologist* 5 (1986): 193–201.

MATTIS, S. *Dementia Rating Scale*. Odessa, Fla.: Psychological Assessment Resources, Inc., 1988.

MURRAY, H. A. *Thematic Apperception Test*. Cambridge, Mass.: Harvard University Press, 1943.

RORSCHACH, H. *Psychodiagnostik*. Bern: Hans Huber, 1921; 1946.

YESAVAGE, J. A.; BRINK, T. L.; ROSE, T. L.; LUM, O.; HUANG, V.; ADEY, M. B.; and LEIRER, V. O. "Development and Validation of a Geriatric Depression Screening Scale: A Preliminary Report." *Journal of Psychiatric Research* 17 (1983): 37–49.

PSYCHOTHERAPY

Psychotherapy involves individual or group meetings with a therapist trained to use various techniques to treat psychopathology. Psychiatrists, psychologists, nurses, social workers, and counselors can provide psychotherapy interventions to older adults with psychiatric disorders. Review of the literature suggests that psychotherapy is an effective treatment intervention, either alone or in conjunction with medication, for many psychological disorders in older adults.

Advanced age can be accompanied by bereavement, relationship conflicts (either marital or with adult children), or chronic or acute illness. Although such difficulties are more common among older adults than younger adults, the development of psychiatric symptoms as a response to life stress is never normal, and most older adults remain psychologically healthy in the face of difficult circumstances.

The normal aging process does provide challenges for therapists in adapting psychotherapy

to older patients. Some types of cognitive function decrease in elderly persons, although the distribution of function is widely varied. Therapists may need to proceed through material at a slower pace, or in smaller units with more repetition. Memory aids, such as tape recordings of sessions, written notes, and reminders, can help patients recall information. Clearly defined goals and strategies, plus an agenda and structure for each session, are beneficial. Also, elderly patients are more likely to have loss in visual or auditory acuity or have coexisting medical problems, requiring adaptation of standard techniques.

Many elderly persons with medical problems take multiple medications, making it difficult for a psychiatrist to prescribe and manage additional medications. This makes psychotherapy an appealing option for older adults. Though research suggests the most promising treatment for late-life psychological disorders is combined medication and psychotherapy, psychotherapy alone is also an effective treatment option. Just as there is a myriad of medications for treating psychological disorders, psychotherapy options are quite varied as well, and depend upon structure, goals, and suitability to the problem of depression, anxiety, or dementia.

Depression

Antidepressants have traditionally been regarded as a primary treatment, yet psychotherapy has been shown by several studies to be at least equally effective in treating depression in elderly persons. Psychodynamic psychotherapy, life review and reminiscence therapy, interpersonal therapy, cognitive-behavioral therapy, and group therapy are commonly used treatments of late-life depression.

Psychodynamic therapy. This therapy is rooted in psychoanalytic theory, viewing current interpersonal and emotional experience as influenced by childhood experience. According to this theory, early childhood molds a complex inner world forged by unconscious and conscious mental processes. Relationships, such as that with one's mother, are internalized and create a sense of self. A life event, such as a loss, may initiate conflict within that inner world, and unresolved conflict manifests as depressive symptoms. In therapy, these conflicts are explored and resolved.

Life review and life reminiscence therapy. These therapies are also psychodynamically oriented. Life review revisits and resolves past conflicts and reintegrates life events through a review of life experiences. Reminiscence differs from life review by focusing on social intimacy and self-esteem through past experiences, instead of directly resolving past conflicts. The process includes autobiographies, visits to childhood locations, photographs, reunions, and scrapbooks.

Interpersonal psychotherapy (IPT). This time-limited outpatient therapy focuses on four problem areas of current interpersonal issues: interpersonal disputes, role transitions, interpersonal deficits, and abnormal grief. The therapist and client decide in which direction to focus. The immediate therapeutic objective is to alleviate depressive symptoms; however, the future goal is to improve social functioning and interpersonal relationships. Role-playing, communication analysis, clarification of wants and needs, and links between affect and environmental events are some of the techniques used. Suggested adaptations of IPT to elderly patients by clinicians include flexibility of session length, focusing on long-standing role disputes, and the need to help patients with practical problems. IPT has been proven to be as effective in treating elderly patients as specific medications, with longer-lasting effects when combined with antidepressant medication.

Cognitive-behavioral therapy (CBT). The cognitive model of depression is based on the idea that, due to early learning, depressed individuals develop stable, albeit distorted, cognitive schemas that predispose them to negatively interpret life events. CBT usually consists of three components: First, the patient is pressed to increase reinforcing activities and pleasurable experiences through behavioral activation. Then, automatic dysfunctional thoughts are exposed, challenged, and substituted with more accurate cognition. Finally, the cognitive schemas driving these automatic thoughts are explored and changed to accurately fit the patient's experiences. Behavioral activation and automatic-thought modification have been shown to be effective either individually or in conjunction with each other.

Social problem-solving therapy (PST) falls within the realm of cognitive and behavioral interventions and is anchored in a model in which ineffective coping skills under stress leads to deterioration of problem-solving abilities and sub-

sequent depression. PST approaches involve recognizing and altering maladaptive attitudes linked to ineffective problem-solving while increasing motivation to generate alternative solutions, make decisions, and assess solution utility.

Group therapy. Group therapy consists of a group of patients meeting regularly with a therapist or therapist team that leads the discussion. Some group therapy emphasizes the teaching of coping skills or social skills, while other groups may focus on supportive and expressive resolution of individual difficulties in a group setting. Older patients may prefer group therapy because it can provide a social network of support, as well as decrease the cost of care.

Anxiety disorders

There are three central cognitive-behavioral techniques in the treatment of anxiety: relaxation training, cognitive restructuring, and exposure. *Relaxation training* consists of tension-relaxation exercises involving different muscle groups and adaptations of the progressive relaxation techniques of Bernstein and Berkovec. *Cognitive restructuring* involves identifying cognitions associated with fear and modifying them into alternative, less distressing cognitions, as well as teaching coping strategies. Patients are also required to monitor thoughts and practice strategies outside therapy sessions. *Exposure* helps to manage phobias and consists of gradual real-life exposure or imagined exposure to the phobic situation. For example, a person with a phobia of the dentist, will, gradually and with therapist support, look at pictures of dentists, be in an examination room with a dentist and patient, and then have dental work performed. The patient is thus safely exposed to her or his fear.

There is virtually no research on psychotherapeutic treatment effectiveness in elderly anxious patients. However, Sheikh and Cassidy recommend that treatment strategies can be based on the research with younger populations and modified for older patients. The literature has demonstrated effectiveness of CBT for different anxiety disorders in adults, including generalized anxiety disorder (GAD), panic disorder, phobias, and obsessive-compulsive disorder. CBT interventions have been found successful, either alone or with medication for all of these disorders. Also, research suggests that post-traumatic stress disorder (PTSD) can be chronic, continuing into old age from an earlier event. Snell and Padin-Rivera have reported that group psychotherapy is effective in treating elderly veterans with PTSD.

Dementia

Patients with dementia have worsening memory impairment in addition to compromised functioning in at least one other cognitive domain. Alzheimer's disease constitutes the most frequent cause of late-life dementia. Psychotherapy with clients with dementia is made difficult by the loss of language, which complicates communication between client and therapist. The relative success of psychotherapy correlates with the level of connection and communication achieved between the therapist and client. When that client suffers from dementia, the therapist's job becomes more challenging. Subtler subvocal and paralinguistic cues of communication must be utilized in an effort to avoid clinical detachment.

Considerable debate exists on the prospect of memory interventions and the proposed success for patients with Alzheimer's disease. However, techniques using environmental adaptations and external memory aids have been used to help patients with dementia. Reality orientation programs have implemented the use of signs, diaries, memory wallets, and recordings to help patients recall personal information. Cognitive stimulation programs have also been increasingly advocated. Validation therapy acknowledges the truth of feelings behind acting-out behaviors in an effort to decrease these behaviors.

Barriers to treatment

The present body of research in geropsychology supports psychotherapy as a treatment option for older persons with psychological disorders. However, several limitations curb its effectiveness. Older adults are less likely to report psychological problems and to seek help from mental health professionals or physicians than are younger adults. This may be due to social stigma associated with treatment for psychological problems. Psychological problems in elderly persons may also be underdiagnosed because they may pass off psychiatric symptoms as signs of physical illness. The responsibility for the diagnosis of psychiatric disorders in older adults is often left to primary care physicians, who have a limited amount of time with their patients. Also, mental health professionals with expertise in geriatric psychology are quite few, and therefore may not be available for referral.

Even when diagnosed, not all late-life psychological problems are treated adequately. Ageism still pervades American health policy and the minds of many health care providers. Research by Ford and Sbordone found that psychiatrists viewed elderly patients as less likely to respond to treatment than their younger counterparts. Only since 1989 has Medicare covered outpatient mental health care, and it still only covers 50 percent of the cost, compared with 80 percent coverage of physical health care costs.

Despite these barriers, there is convincing evidence that older adults respond as well to psychotherapy as do younger adults. It is important to begin to address the individual, physician, and policy barriers that prevent older adults with psychiatric disorders from receiving aggressive treatment.

CHRISTINE M. VITT
AUTUMN EDENFIELD
THOMAS R. LYNCH

See also ANXIETY; COGNITIVE-BEHAVIORAL THERAPY; DEMENTIA; DEPRESSION; GERIATRIC PSYCHIATRY; INTERPERSONAL THERAPY; LIFE REVIEW; PROBLEM SOLVING THERAPY; PSYCHOLOGICAL ASSESSMENT.

BIBLIOGRAPHY

ALLEN, R.; WALKER, Z.; SHERGILL, P.; DATH, P.; and KATONA C. "Attitudes to Depression in Hospital Inpatients: A Comparison Between Older and Younger Subjects." *Aging and Mental Health* 2 (1998): 36–39.

AREAN, P. A.; PERRI, M. G.; NEZU, A. M.; SCHEIN, R. L.; CHRISTOPHER, F., and JOSEPH, T. X. "Comparative Effectiveness of Social Problem-Solving Therapy and Reminiscence Therapy as Treatments for Depression in Older Adults." *Journal of Consulting and Clinical Psychology* 61 (1993): 1003–1010.

BECK, A. T. *Depression: Clinical, Experimental and Theoretical Aspects*. New York: Harper and Row, 1967.

BERNSTEIN, D. A., and BORKOVEC, T. D. *Progressive Relaxation: A Manual for the Helping Professions*. Champaign, Ill.: Research Press, 1973.

BEUTLER, L. E.; SCOGIN, F.; KIRKISH, P.; SCHRETLEN, D.; et al. "Group Cognitive Therapy and Alprazolam in the Treatment of Depression in Older Adults." *Journal of Consulting and Clinical Psychology* 55 (1987): 550–556.

BUTLER, R. N. "The Life Review: An Interpretation of Reminiscence in the Aged." *Psychiatry* 26 (1974): 65–76.

DUFFY, M., ed. *Handbook of Counseling and Psychotherapy with Older Adults*. New York: John Wiley & Sons, 1999.

FORD, C. V., and SBORDONE, R. J. "Attitudes of Psychiatrists toward Elderly Patients." *American Journal of Psychiatry* 137 (1980): 571–575.

FRANK, E.; FRANK, N.; CORNES, C.; IMBER, S. D.; MILLER, M. D.; MORRIS, S. M.; and REYNOLDS, C. F., III "Interpersonal Psychotherapy in the Treatment of Late-Life Depression." In *New Applications of Interpersonal Psychotherapy*. Edited by G. L. Klerman and M. M. Weissman. Washington D.C.: American Psychiatric Press, 1983. Pages 167–198.

HIRSCHFELD, R.; KELLER, M.; PANICO, S.; ARONS, B.; BARLOW, D.; DAVIDOFF, F.; et al. "The National Depressive and Manic Depressive Association Consensus Statement on the Undertreatment of Depression." *Journal of the American Medical Association* 277 (1997): 333–340.

REYNOLDS, C. F., III; FRANK, E.; PEREL, J. M.; IMBER, S. D.; CORNES C.; et al. "Nortriptyline and Interpersonal Therapy as Maintenance Therapies for Recurrent Major Depression: A Randomized Controlled Trial In Patients Older Than 59 Years." *Journal of the American Medical Association* 281 (1999): 39–45.

SCOGIN, F., and MCELREATH, L. "Efficacy of Psychosocial Treatments for Geriatric Depression: A Quantitative Review." *Journal of Consulting and Clinical Psychology* 62 (1994): 69–74.

SHEIKH, J. I., and CASSIDY, E. L. "Treatment of Anxiety Disorders in the Elderly: Issues and Strategies." *Journal of Anxiety Disorders* 14 (2000): 173–190.

SNELL, F. I., and PADIN-RIVERA, E. "Group Treatment for Older Veterans with Post-Traumatic Stress Disorder." *Journal of Psychosocial Nursing and Mental Health* 35 (1997): 10–16.

TERI, L., and MCCURRY, S. M. "Psychosocial Therapies." In *The American Psychiatric Press Textbook of Geriatric Neuropsychiatry*. Edited by C. D. Coffey, J. L. Cummings, et al. Washington, D.C.: American Psychiatric Press, 1994. Pages 662–682.

ZARIT, S. H., and KNIGHT, B. G., eds. *A Guide to Psychotherapy and Aging: Effective Clinical Interventions in a Life-Stage Context*. Washington, D.C.: American Psychological Association, 1976.

ZEISS, A. M., and BRECKENRIDGE, J. S. "Treatment of Late-Life Depression: A Response to the NIH Consensus Statement." *Behavior Therapy* 28 (1997): 3–21.