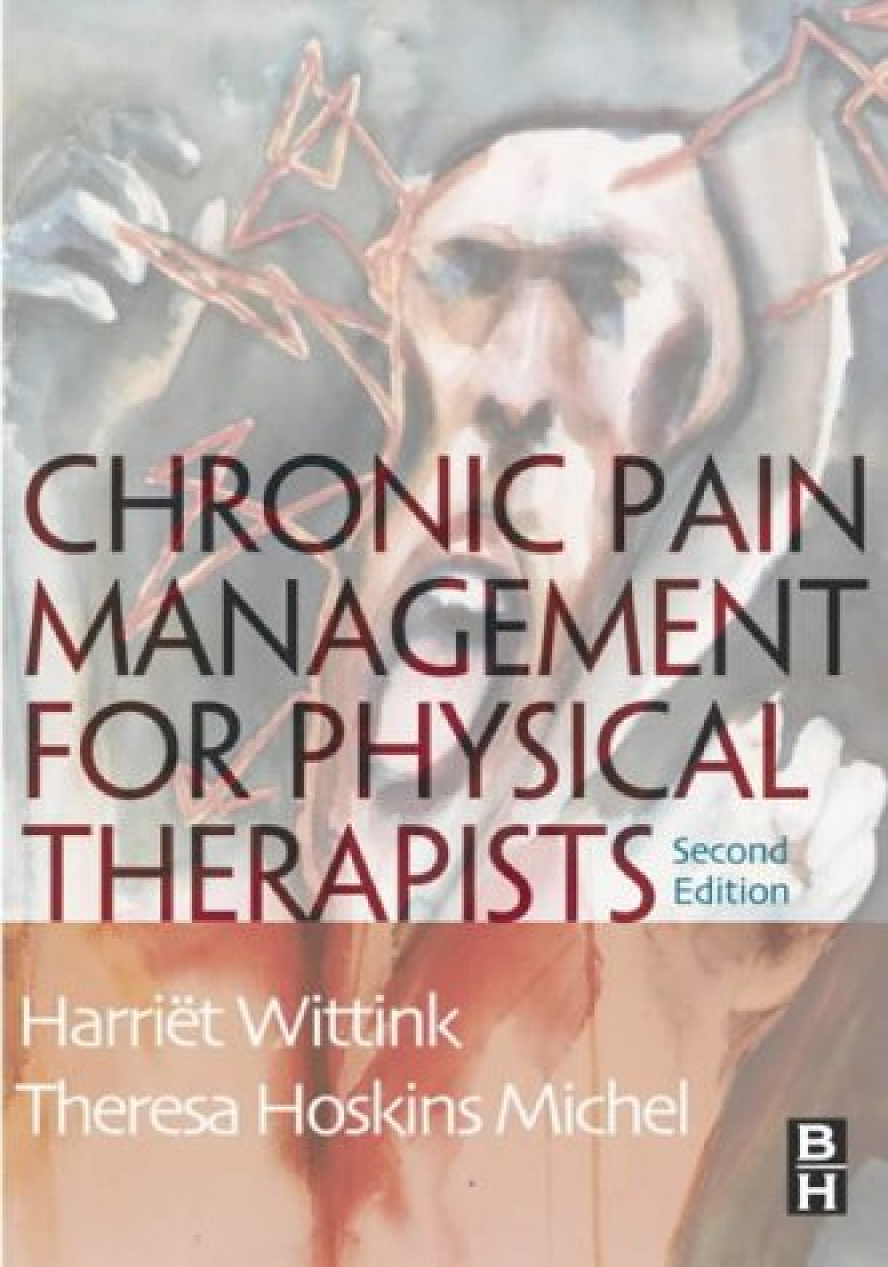

CHRONIC PAIN MANAGEMENT FOR PHYSICAL THERAPISTS

Second Edition

Harriët Wittink
Theresa Hoskins Michel

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To my parents
For giving me roots to grow from and wings to fly with,
And to Dick and Marian Wittink

HW

To all my students, former, present, and future, who help me evolve, challenge me, stimulate me, question me, and amaze me as they surpass my levels of expectation

THM

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Foreword

Chronic pain exacts an economic toll of tens of billions of dollars per year in the United States alone, and a human toll of suffering that cannot be calculated. Specialists who practice pain management see on a daily basis that nearly all patients with chronic pain have secondary problems due to disuse, asymmetries, and muscle imbalances. Most commonly, chronic pain patients become deconditioned while enduring their chronic pain problem, regardless of its specific pathology. This deconditioning can take the form not simply of loss of muscle mass and strength but also of reduced flexibility, range of motion, and functional capacity. The psyche also deteriorates: depression and withdrawal are common in patients with chronic pain. These losses may lead to new patterns of pain in a maladaptive pattern recognized since the origins of recorded medical practice. The ancient Greeks placed great emphasis on physical means to restore patients to full health and had highly developed methods to achieve this end. Even earlier, a variety of medicinals were used and supplemented by nondrug therapies, such as immobilization, counterstimulation, and acupuncture or its primitive equivalent, therapeutic tattooing. Today, the International Association for the Study of Pain has endorsed a multidisciplinary approach to chronic pain. This approach, by definition, involves not only medical therapy or injections but also the use of behavioral and physical modalities. No facility may term itself a comprehensive, multidisciplinary pain management center in the absence of on-site expertise in physical therapy or rehabilitation. The International Association for the Study of Pain, which recommends worldwide standards for pain management facilities, reached this position based on current international consensus among a select group of experts in pain management.

The International Association for the Study of Pain Task Force on Professional Education disseminates a core curriculum for professional education in pain, the product of a multidisciplinary group of clinicians, scientists, and educators. The recommendations made by this erudite collection of pain professionals have been followed by the editors of this book, making it a unique resource for physical therapists who approach this comprehensive curriculum.

This second edition of *Chronic Pain Management for Physical Therapists* reflects state-of-the-art, current-day practice. It is a source of "family pride" that its multidisciplinary authorship is Bostonian in character, chiefly derived from the New England Medical Center and Massachusetts General Hospital; the MGH Institute of Health Professions, which seeks to educate leaders in the fields of physical therapy, nursing, clinical investigation, and communications disorders; and affiliated medical schools—the Tufts University School of Medicine and Harvard Medical School.

Daniel B. Carr, M.D., F.A.B.P.M., F.F.P.M.A.N.Z.C.A.

Preface

In this second edition of *Chronic Pain Management for Physical Therapists*, we have maintained the structure of the International Association for the Study of Pain's (IASP) proposed curriculum for students in occupational and physical therapy (see Appendix I), but have broadened the scope.

The field of pain management has continued to develop since we published the first edition of this book. Pain is now officially recognized as the "Fifth Vital Sign" in the United States and is considered as important to measure and treat as heart and respiratory rates, blood pressure, and temperature. In 2001, the Joint Commission on Accreditation of Healthcare Organizations mandated that everyone deserves appropriate pain management, not only dying patients. Measuring pain intensity is now considered as essential as measuring temperature, blood pressure, and heart and respiratory rates. The first lawsuit has been filed and won for not providing adequate pain control in a patient dying of cancer, emphasizing growing public awareness of the importance of pain management.

Measuring outcomes of treatment has become increasingly important, as third-party payers demand more accountability and providers seek to deliver the best possible care. Health care as a whole is moving toward evidence-based medicine as exemplified by the Cochrane collaboration. Practice guidelines on a host of diagnoses have been developed based on the current available best evidence for evaluation and treatment and are being implemented.

The Internet age has made information more accessible to patients and health care providers alike. Due to the importance of the Web as a source of information, we have included Web sites that we think are helpful and could potentially be shared with patients. The Web is a fluid medium, with Web site addresses constantly changing and new addresses being added. We tried to provide Web sites that will endure, but realize things change quickly. We apologize beforehand if you find that a Web site we recommended is no longer available.

More physical and occupational therapists have joined professional pain organizations, and a special interest group within the IASP addressing "Pain and Movement" was formed in 2000. Worldwide, therapists are using performance-based testing as a part of outcomes measurement in a variety of pain conditions. The available research on physical and occupational therapy intervention in chronic pain conditions is growing, albeit slowly as compared to the plethora of information coming from other health professions. We tried to provide readers with the current available evidence for treatment. It is no longer acceptable to practice based on belief systems; we must know what the scientific evidence is for our interventions and practice accordingly. For this reason, we chose not to discuss various (hands-on) treatment approaches common in and outside the United States, because there simply is no research to substantiate their effectiveness or even biological plausibility.

Writing and editing this book has been an experience of friendship, dedication, and collaboration between dedicated workers with a shared passion. In an increasingly money-depleted and insurance-regulated health care environment in which everyone is stretched to the limit, the authors of this book found time to share with us their knowledge, expertise, and love for the field of pain management. We sincerely thank all of our contributors for their sacrifice, knowledge, and generosity.

We owe a large debt of gratitude to Professor Joanne Phillips of the classics department at Tufts University, who unhesitatingly shared with us a host of information on the history of pain treatment and her own copy of the Hippocratic texts. We hope we got it right. We also owe a large debt to Robert Kerns, Ph.D., Debra Lerner, Ph.D., and Michael Sullivan, Ph.D., who generously shared their work with us to enrich this edition.

Without the help, support, and teaching of—and many discussions with—our mentors, colleagues, friends, and coworkers in pain management, we would not continue to grow, question, and learn. Andy Sukiennik, Alan Witkower, Joe Audette, Celeste Gascon, Lisa Cohen, Maureen Simmonds, Anne Marie Barrett, Judith Spross, Annabel Edwards, Heinrich Wurm, Carolyn MacKenzie, and Marilyn Means: *thank you* does not begin to express our gratitude. A very special thanks to Bill Rogers and Dan Carr, mentors and friends without whose knowledge and patience no papers or grants would ever get written.

On a personal note, Harriët wishes to thank Brian Ott, Alan, Joe, and Andy for keeping her sane and the McNallies and her family in the United Kingdom, Netherlands, and United States for their love and support. She would further like to remember Betsy Kay, friend and colleague, who is missed by all who knew her. Terry will be eternally grateful to her husband, Tony, for being her best friend through thick and thin, and to the two urchins, Joel and Sarah, who somehow grew up while she was busy working!

And finally, a grand thank you to our patients who question, challenge, teach, terrify, amaze, exasperate, and delight us every day. They are, in fact, heroes. They are people who face what most of us fear: pain 24/7, that which is chronic pain.

Harriët Wittink, Ph.D., M.S., P.T.
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Chapter 1

Chronic Pain Concepts and Definitions

Harriët Wittink, Theresa Hoskins Michel, and
Melissa Wolff-Burke

A person with chronic pain is referred to you. You cringe. You have the sinking feeling that the patient will challenge, drain, frustrate, and perhaps anger you. You wish the patient would go somewhere else. Perhaps you could refer him or her to the pain clinic down the street. You wonder how therapists there can work with patients with chronic pain, and you wish for the hundredth time that chronic pain patients would not come to you. Does this sound familiar? We all have treated patients with chronic pain, and we know that the usual approaches probably will be unsuccessful. This book is written with the understanding that information about pain increases and changes on a daily basis, and it aims to ease tension, decrease anxiety, and give the reader information and techniques to provide effective care for patients with chronic pain.

Think about different pain experiences you may have had—a toothache, headache, fracture, or surgery. How would you describe the pain to an empathetic listener? Is your throat scratchy, burning, or tight? Is your fracture site throbbing, aching, or torturously painful? How do you know your listener really understands what it means to you to have this pain? Does your mlistener know you missed your child's performance at school because of the surgery? Is your listener aware that this is the fourth time you have had a debilitating headache in 4 months and that you are worried about keeping your job?

Consider other types of pain. You argue with your parents. You slam down the phone and are angry and hurt. Your stomach is in knots, and you have a headache. Are you in pain? You certainly are. You attend the funeral of a friend. You feel empty and sad. Would you describe the experience as painful? You probably would.

Pain involves both sensation and emotion. Physical pains are linked with emotional responses, and emotional pains are linked with physical responses. Chronic pain involves a complex interconnection of multiple factors that we explore in this chapter and book. It is important to recognize that tissue damage is not the only source of pain and that it is impossible to separate the functions of the mind and the body when treating pain. No two people will describe pain in the same way or have exactly the same pain experience.

(BRIEF) HISTORY OF PAIN TREATMENT

Pain has been an ailment of humans throughout existence. In English the word *pain* derives from the Latin *poena* or *punishment*, the underlying idea being that disease is caused by divine vengeance. Prescriptions for stopping pain, written on clay biscuit-shaped pads, were found in the Sumerian grave of Queen Shubad of Ur (3500 B.C.). A clay pot, likely used for distillation of plant essences into medication, was found in another grave site dating back to 5500 B.C. In the land of Sumer, prescriptions for healing both the visible and invisible aspects of disease were regarded with equal importance and were often found on the same clay biscuit. Treatment combined "medication" with incantations. On the other side of the world, in Denmark, medicine bags, amulets, surgical instruments, and objects used for healing were found in graves dated 500 B.C., suggesting that there, too, healing included incantations.

Hippocrates (born approximately 460 B.C.) is considered the father of medicine. Physicians who followed the Hippocratic method attributed chronic disease to the imbalance of one of four humors in the body (blood, yellow bile, black bile, and phlegm), or to an imbalance of the four primary opposites (hot, cold, dry, and wet) and the four primary bodies or elements (earth, water, air, and fire), or both of these. The doctor's role was to combat the disease or to help nature to do so. Treatment was directed to voiding the body of an imbalance by providing advice on food, drink, and the amount of sleep and exercise needed; the application of heat (baths and compresses) or cold—depending on whether the client was "cold" or "hot"; prescription of hellebore (a hallucinogenic herb) and other narcotic plants such as mandrake, henbane, nightshade, and poppy; bloodletting; and cauterization. Opium was an important ingredient in many ancient remedies.

Art depicting massage, traction, and spinal manipulation (early forms of physical therapy) traces back to around the time of Hippocrates. In ancient medical tradition, words were very important; practitioners were expected to present their theories and explanations fluently, either in a public debate with a rival or at the bedside with the client, or the potential client needed to be persuaded of the healer's skill. Ancient doctors were aware of the importance of trust and tried to gain it by their appearance as well by their bedside manner. The Hippocratic treatises continue to hold wisdom still applicable today:

> Life is short, science is long; opportunity is elusive, experiment is dangerous, judgment is difficult. It is not enough for the physician to do what is necessary, but the patient and the attendants must do their part as well, and circumstances must be favorable. (Chadwick et al. 1983).

The study of anatomy traces back to Aristotle (born around 384 B.C.), who believed the brain to be a cooling organ designed to regulate the heat generated by the heart's action and to induce sleep. Although the Hippocratic treatises make little or no mention of dissection, Aristotle used this method extensively on animals. Herophilus and Erasistratus, Hellenistic biologists in Alexandria, were able to conduct postmortem (and sometimes premortem) dissections. Herophilus (approximately 320–250 B.C.) was interested in the anatomy of the brain and was the first to regard the brain and the nerves as a unit. He and his successor Erasistratus distinguished between sensory and motor nerves. Pain had no special significance and was treated as a disorder in itself with heat, cold, massage, diet, rest, sexual abstinence, topical applications, and bloodletting.

The Roman Galen of Pergamum (second century A.D.) placed considerable importance on pain in his writings and attributed pain to the tactile sense. He divided pain into a sign of internal changes in organs or as a sign of changes coming from the external world; pain served to warn and protect every human being. Galen was responsible for classifying the different forms of pain—pulsific, tensive, and pungitive (lancinating)—to help analyze the diagnostic value of pain. Treatment of pain might include cold ambient air or application of cold, as a moderate numbness eliminates pain. Opium served as a cold substance.

Galenism introduced the writing of Hippocrates to the generations of physicians to come, and its humoral foundations retained a firm foothold until the seventeenth century, when Mechanism was triumphing in the natural sciences.

Descartes (1596–1650) is held responsible, perhaps unfairly, for *dualism*, the notion of a complete separation of mind and body. He dismissed the idea of sensory and motor nerves and instead proposed that nerves were tubes that connected the brain to "pores" (nerve endings) in the skin and other tissues. According to his proposal, external motions affect the peripheral ends of the nerve fibrils, which in turn displace the central ends. As the central ends are displaced, the pattern of interfibrillar space is rearranged, and the flow of animal spirits is thereby directed into the appropriate nerves (much like pulling a cord that rings a bell). It was Descartes' articulation of this mechanism for automatic, differentiated reaction that led to his generally being credited with the founding of reflex theory (Figure 1.1).

In the *specificity theory*, pain was considered a reflex response to a physical stimulus (Descartes 1644). If the stimulus was known, the pain was predictable and explainable. Using this paradigm, cutting the pathway for pain should eliminate the

Figure 1.1. The mechanism for automatic reaction in response to painful events. A = fire, B = peripheral end of nerve fibers.) (Reprinted with permission from R. Descartes, L'Homme. In M Foster (ed) (transl), Lectures on the History of Physiology During the 16th, 17th, and 18th Centuries. Cambridge, UK: Cambridge University Press, 1901.)

pain. Also, the bigger the injury, the bigger the pain. Many of our patients believe this today, because it makes intuitive sense.

This traditional biomedical model assumed that all pain was a symptom of an underlying cause. Once the cause was found and fixed, the patient should be relieved of pain. If the cause of pain was not found, the patient was thought to be lying or crazy.

Multicomponent views of pain are a recent development, but the belief of separation of mind and body persists today to some extent. Before the 1960s, the mind and body were seen as distinctly separate by most. In the understanding of pain, however, several important observations were made. Henry Beecher's ideas were greatly influenced by his famous observations of wounded soldiers on the Anzio beachhead who rarely complained of pain (Beecher 1946). He theorized that the perception of pain integrated physical sensation with the "reaction component," which depended on a number of variables, including age, gender, ethnicity, experience, fatigue, anxiety, distraction, suggestion, the external environment, and the time of day. Because of this reaction component, the pain experience was "complex, subjective, and different for each individual" (Beecher 1957, 165).

The fortunate collaboration between Patrick Wall, a neuroscientist, and Ronald Melzack, a psychologist, yielded a new theory on pain mechanisms called the *gate-control theory* (Melzack and Wall 1965). They proposed that noxious stimuli reaching the spinal cord could be suppressed by non-noxious information converging on the same level. These non-noxious stimuli could come from the periphery or descend from the brain and close the gate to the noxious stimuli. This theory meant that pain would no longer be regarded as merely a physical sensation from a noxious stimulus. The experience of pain could be modulated consciously by mental, emotional, and sensory mechanisms. Physical therapists rely heavily on this theory when trying to decrease pain. Applying modalities such as transcutaneous electrical nerve stimulation, performing a massage, engaging the patient in conversation as a distraction, and educating the patient about his or her condition are ways that the gate-control theory is used.

In the 1970s, the first multidisciplinary pain center was formed at the University of Washington, under the inspired leadership of John Bonica, M.D., who in 1953 had authored *The Management of Pain*, the first textbook devoted to pain treatment. In 1973, the first international symposium on pain was held in Seattle. From this meeting came the International Association for the Study of Pain (IASP), the journal *Pain*, and the formation of national IASP chapters throughout the world. Pain management and treatment had become a specialty area for clinicians in many different professions, including physical therapy.

Great advances have been made in the past decade in understanding pain on both a clinical and a molecular level. New medications (although the poppy remains popular), pain measurement tools, and interventional and behavioral techniques have been developed to address pain.

In the twenty-first century, pain management has finally reached national attention. In 2001, the Joint Commission on Accreditation of Healthcare Organizations mandated the following: Effective pain management is appropriate for all patients, not just for dying patients. The intent of the new standard is the following: Pain can be a common part of the patient experience; unrelieved pain has adverse physical and psychological effects. The patient's right to pain management is respected and supported. The organization plans, supports, and coordinates activities and resources to assure that the pain of all individuals is recognized and addressed appropriately. This includes

- initial assessment and regular reassessment of pain,
- education of relevant providers in pain assessment and management,
- education of patients (and families when appropriate) regarding their roles in managing pain, as well as the potential limitations and side effects of pain treatments, and
- after taking into account personal, cultural, spiritual, and ethnic beliefs, communicating to patients and families that pain management is an important part of care.

Health care facilities must

- recognize the right of patients to appropriate assessment and management of pain,
- identify pain in patients during their initial assessment and, when required, during ongoing periodic reassessments, and
- educate patients and their families about pain management (http://www.jcaho.org).

Pain has become the fifth vital sign, along with measurement of blood pressure, temperature, heart rate, and respiratory rate. Yet we do not really fully understand the complexity of pain—why some patients respond to treatment and others do not, or how to choose the best treatment for the individual with pain who is suffering and comes to us for help. The decade 2001–2010 has officially been proclaimed the *Decade of Pain Control and Research* by the U.S. Congress in the hope that this will bring a much-needed focus on pain and will help to stimulate further progress in research, training, and clinical care.

Conceptual models, definitions, and classifications have been developed to understand and explain the intricacy of the pain experience and are described in the section Definitions and Classifications of Pain.

DEFINITIONS AND CLASSIFICATIONS OF PAIN

McCaffery and Beebe (1989) defined *pain* as "whatever the experiencing person says it is, existing whenever he says it does." The consensus definition of *pain* developed by the IASP is "an unpleasant sensory *and* emotional experience associated with actual *or* potential tissue damage, *or* described in terms of such damage" (Merskey and Bogduk 1994). Both of these definitions emphasize that pain does not have to be seen on an x-ray, by magnetic resonance imaging (MRI), or in lab tests to be considered a true experience of pain.

Other terms that are useful in understanding chronic pain are the following:

Allodynia Condition in which a normally non-painful stimulus is perceived as painful

Hyperalgesia Increased perceived intensity of a "normally" painful stimulus

Hyperesthesia Increased sensitivity to stimulation

Hypoalgesia Decreased response to a normally painful stimulus

Dysesthesia An unpleasant abnormal sensation, whether spontaneous or evoked

Anesthesia dolorosa Pain in an area or region that is anesthetic

Causalgia A syndrome of sustained burning pain, allodynia, and hyperpathia after a traumatic nerve lesion, often combined with vasomotor and sudomotor dysfunction and later trophic changes

Central pain (pain located in the central nervous system [CNS]) and *neuropathic pain* (pain due to disease or injury to the nerve) are types of pain initiated or caused by a lesion or dysfunction in the nervous system. An example of central pain is pain from a thalamic infarct; patients experience hemi-body pain. *Neuralgia* describes pain in the distribution of a nerve, whereas *neuropathy* describes a disturbance of function or pathologic change in a nerve. Possible causes of neuropathic pain can be viral (postherpetic neuralgia), traction injury of a nerve, or ischemia. Summation, or progressive aggregation of perceived pain with repeated application of an identical stimulus, is typical in patients with neuropathic pain (Fields 1991). The physiologic basis of peripheral and central pain is described in detail in Chapter 3.

Two terms that are key in understanding the experience of chronic pain patients are *pain threshold* and *pain tolerance*. *Pain threshold* refers to the lowest level at which a stimulus is recognized as painful by the person experiencing the stimulus (Merskey and Bogduk 1994). The pain threshold seems to be more dependent on physiologic factors than pain tolerance (Merskey and Spear 1967). Pain tolerance, however, has a wider variation and is influenced by the individual's personality, belief system, and past painful experiences. It is the greatest level of pain a person is prepared to endure (Merskey and Bogduk 1994). Pain tolerance varies greatly among individuals and within a person. On days that are already frustrating, an irritation that may seem minor on other days can become a major disturbance. Pain threshold may vary only slightly in an individual, whereas pain tolerance can change significantly within one person from situation to situation.

Pain is also divided into the categories of chronic and acute pain (Table 1.1). Some individuals experience pain that does not fit into either of these categories perfectly, however. Further distinctions between the various pain states include acute, subacute, recurrent acute, ongoing acute, chronic, and intractable chronic pain (adapted from Crue and Pinsky 1984). The distinguishing characteristics of these pain states are summarized in Table 1.2.

The following discussion on patients with chronic pain reinforces that pain is a complex, subjective, perceptual phenomenon with uniquely personal dimensions.

Table 1.1. Major Differences between Acute and Chronic Pain

Acute Pain	Chronic Pain
Pain is a symptom.	Pain is a disease.
Well-defined time of onset.	Time of onset sometimes well defined.
Pathology is often identifiable.	Pathology may not be identifiable.
Objective signs of autonomic nervous system activity.	Dysregulation of autonomic nervous system activity.
Response to tissue injury.	Response to peripheral and/or central changes in somatosensory pathways.
Has a biological function.	Unknown biological function.
Often relieved by treatment directed at pain.	Does not respond to treatment directed at pain.
Usually responsive to medication.	Less responsive to medication.
Associated with anxiety.	Associated with anxiety, depression, helplessness, hopelessness, weight changes, loss of libido.
Primarily involves the individual.	Involves the individual, family, social network, lifestyle.
Responds to biomedical approach.	May respond to biopsychosocial approach.
Impairment/functional limitation.	Functional limitation/disability.

Source: Data from MS Wolff. Chronic Pain—Assessment of Physical Therapists' Knowledge and Attitudes [thesis]. Boston: Massachusetts General Hospital Institute of Health Professions, 1989.

PATIENTS WITH CHRONIC INTRACTABLE PAIN

Turk (1996) refers to *chronic intractable pain* as "a heterogeneous group of pain problems in which neither diagnosis, nor site of pain, nor medical findings are an apparent major source of variance in any of the targets of treatment." Patients with chronic pain used to be grossly divided into two groups: the patients with chronic pain, and the patients with chronic pain syndrome. The first group are patients who are coping well with their pain and have relatively little disability; the latter group are the patients who are completely disabled by their pain and who are helpless and hopeless. Currently, the term *chronic intractable pain* is used for all patients

Table 1.2. Distinguishing Characteristics of Acute and Chronic Pain States

Pain State	Characteristic
Acute pain (e.g., pain resulting from fractures, ruptures, avulsions, blockages, burns)	Duration up to a few days, cause usually known. Presumed nociceptive input.
Subacute pain (e.g., postoperative pain, postfracture pain)	A few days' to a few months' duration (depending on tissue healing time).
Recurrent acute pain (e.g., sickle cell crises, migraine, rheumatoid arthritis)	Recurrent nociceptive input from underlying chronic pathologic process.
Ongoing acute pain (e.g., pain from uncontrolled malignant neoplastic disease)	Ongoing nociceptive input.
Intractable chronic nonmalignant pain (e.g., causalgia, myelopathy, neuropathy)	Duration more than 6 mos. Nociceptive input may be known and may not be curable. Seemingly adequate adaptation to functioning in life process by the patient.
Intractable chronic nonmaligant pain (e.g., intractable low back pain)	Duration more than 6 mos. No known nociceptive input. Poor adaptation by the patient to life process. Significant disability, with pain as the primary focus of the patient's existence.

Source: Data adapted from BL Crue, JJ Pinsky. An approach to chronic pain of non-malignant origin. Postgrad Med J 1984;60:858.

with chronic pain to avoid labeling. The term *intractable* is apt, as indeed, chronic pain is difficult to manage for health care providers *and* for patients. At a basic level, chronic pain is a phenomenon of the CNS. Whether it is an increase in sympathetic receptor activity (Perl 1993), pain caused by a primary lesion or dysfunction in the central or peripheral nervous system (Merskey and Bogduk 1994), or distortion of non-noxious peripheral input (Crue and Pinsky 1984), chronic pain often is not amenable to standard therapeutic modalities and rehabilitation efforts. This is why physical therapists find successful treatment for chronic pain to be so elusive. Pain that persists beyond presumed nociceptive input associated with normal tissue healing time can be considered chronic. In chronic pain, sensory processing and pain regulatory systems become altered (Bruehl et al. 1999), and central sensitization may occur. It is almost as if the CNS develops a memory for pain, much like the skill of learning to ride a bicycle is never unlearned. The same may be true of chronic pain. A pattern is established in the CNS of a person with chronic pain that is difficult, if not impossible, to erase.

In chronic intractable pain, it may not be clear what the underlying physical disorder is. There may be very little objective evidence of any remaining nociceptive stimulus. Even if the cause of the pain is known, as is the case in patients with painful peripheral neuropathy who have diabetes, acquired immunodeficiency syndrome (AIDS), or multiple sclerosis, to date no treatment is available to cure the pain. Instead of focusing on the elimination of pain, we need to think in terms of functional impairment when deciding how to approach treatment of patients with chronic intractable pain.

A large category of patients with chronic intractable pain tends to function despite their pain. They often work and fulfill their social roles. Their quality of life may be impaired owing to their pain, and they may not function at the level they wish to; however, they do not regard their pain as disabling. In these patients, the relationship between pain, tissue damage, and the degree of functional impairment is proportional. Abnormal illness behavior is usually not present.

Case Example

The patient is a 35-year-old woman complaining of chronic headaches that have been ongoing for a year. Her headaches are present in the morning and increase in intensity through the day. She works fulltime as a secretary, which involves much work at a computer, and has a part-time job as a security guard at night. She is married and has two children, ages 10 and 8 years. Household duties are shared with her husband. She believes that her headaches interfere with her concentration at work. She also feels more tired and has had difficulty with her second job. At night, she has trouble falling asleep owing to the pain in her head and neck.

On examination, she presents with forward head and poor posture. She has normal cervical range of motion (ROM) and normal upper extremity strength, reflexes, and sensation. Her pectoralis, sternocleidomastoid, and suboccipital muscles are short, and her cervical extensors, neck flexors, serratus, and middle and lower trapezius are weak. Palpation of her suboccipital muscles reproduced her headache, as did testing of C0–C1 and C1–C2 joint mobility, which was limited. In this case, the patient had chronic pain, but a relationship could be established between her pain and objective findings.

Impairments: fatigue, headache pain, forward head posture, shortened muscle length of the pectorales, sternocleidomastoids, and suboccipitals, and weakness of the neck flexors and extensors, serratus anterior, and middle and lower trapezius, and decreased joint mobility at C1–C2

Functional limitation: decreased sleep and concentration due to pain

Disability: decreased work performance

Assessment, diagnosis, and prognosis: Patient is a 35-year-old woman who presents with headaches coincidental with impaired cervical joint mobility, and neck and shoulder muscle tight- and weakness. Patient will experience gradual reduction in headache with improved sleep and job performance, with restoration of muscle balance, cervical joint mobility, and improved posture over a period of 4 weeks or eight sessions of physical therapy.

Case Example

The patient is a 62-year-old woman with nonpulmonary sarcoidosis. She complains of constant severe bilateral lower leg pain. She is retired and performs all her household duties, but at a slower rate than she previously did. She cooks and shops independently and maintains a productive social life with her husband, children, and grandchildren. On examination, she presents with 0/5 strength of her foot dorsiflexors and a slight plantar flexion contracture of both ankles. Hamstrings and gastrocnemius length are significantly decreased. Her gait is abnormal, with short step length and absent knee flexion.

A light touch to her lower legs provokes an unpleasant tingling sensation. Knee and ankle jerks are absent bilaterally. She is diagnosed with painful peripheral neuropathy due to her sarcoidosis. She has an abnormal gait due to bilateral foot drop, causing myofascial pain in addition to her painful peripheral neuropathy.

In this case, the patient has a progressive disease for which there is no cure. Medications are marginally helpful. Physical therapy assessment and intervention are as follows:

Impairments: bilateral lower leg pain, decreased hamstring and gastrocnemius length, abnormal gait due to bilateral foot drop, and sensory disturbance below the knees

Functional limitation: decreased ability to perform household tasks, decreased ability to walk

Disability: decreased performance of activities of daily living (ADLs) and instrumental ADLs

Assessment, diagnosis, and prognosis: Patient is a 62-year-old woman who presents with pain in both lower legs, sensory disturbance, altered muscle length of bilateral lower extremities, and abnormal gait due to sarcoid peripheral neuropathy and mechanical pain. She will benefit from bilateral ankle foot orthotics, gait training, and a home program that includes muscle lengthening to improve safety and independence in gait, reduce mechanical sources of pain, and increase performance in ADLs and instrumental ADLs. She should be seen three times over a course of 6 weeks.

Case Example

The patient is a 50-year-old man who injured his wrist while skiing. Four months later, he had a surgical lunotriquetral arthrodesis and immediately developed unrelenting pain in his hand. His fingers were swollen, discolored, and painful when touched. He rigorously performed his ROM exercises, and though he regained use of his fingers and wrist, pain persisted with use and light touch.

Impairments: pain, sensory disturbance, and swelling in hand

Functional limitation: decreased tolerance to touch

Disability: decreased performance of ADLs and job activities

Assessment, diagnosis, and prognosis: Patient is a 50-year-old man who presents with sensory and vascular changes after surgical intervention consistent with chronic regional pain syndrome. Patient will benefit from referral to the Pain Management Program anesthesiologist for evaluation of appropriateness of a stellate ganglion block to decrease or eliminate symptoms consistent with chronic regional pain syndrome and regain full functional use of hand. The patient will further benefit from ongoing ROM exercises and strength and dexterity training of his hand to prevent deterioration in function. The patient should be seen two times in the course of 2 months to be instructed in a home program and to follow up to assure patient is independent in correct execution of exercises and is making appropriate progress.

Eight weeks after surgery, the patient was seen by an anesthesiologist for a course of stellate ganglion blocks (see Chapter 3). This was combined with ongoing ROM and strengthening exercises. The blocks were successful in reducing tactile pain and vascular symptoms. The patient pursued his exercise program and resumed his premorbid activity level.

Other patients with chronic intractable pain do not fare that well, however. Although the term *chronic pain syndrome* is no longer used by pain specialists, the Office of Disabilities of the Social Security Administration uses the following criteria to establish a diagnosis of chronic pain syndrome: (1) intractable pain of more than 6 months' duration; (2) marked alteration in behavior with depression or anxiety; (3) marked restriction in daily activities; (4) excessive use of medication and frequent use of medical services; (5) no clear relationship to organic disorder; and (6) history of multiple, nonproductive tests, treatment, and surgeries.

The American Medical Association continues to use the term *chronic pain syndrome* in its *Guide to the Evaluation of Permanent Impairment* (fourth edition) and defines it as follows:

1. *Duration*: In the past, the term *chronic pain* has been applied to pain of greater than 6 months' duration; however, current opinion is that the chronic pain syndrome can be diagnosed as early as 2 to 4 weeks after its onset. Prompt evaluation and treatment are essential.
2. *Dramatization*: Patients with chronic pain display unusual verbal and nonverbal pain behavior. Words used to describe the pain are emotionally charged, affective, and exaggerated. Patients may exhibit maladaptive, theatric behavior such as moaning, groaning, gasping, grimacing, posturing, or pantomiming.
3. *Diagnostic dilemma*: Patients tend to have extensive histories of evaluations by multiple physicians. The patient has undergone repeated diagnostic studies, despite which the clinical impressions tend to be vague, inconsistent, and inaccurate.
4. *Drugs*: Substance dependence and abuse involving drugs and alcohol are a frequent concomitant. Patients are willing recipients of multiple drugs, which may interact adversely. Often, they consume excessive amounts of prescribed drugs.
5. *Dependence*: These patients become dependent on their physicians and demand excessive medical care. They expect passive types of physical therapy over long periods of time, but these provide no lasting benefit. They become dependent on their spouses and families and relinquish all domestic and social responsibilities.
6. *Depression*: The condition is characterized by emotional upheaval. Patients tend to have psychological test results that suggest depression, hypochondriasis, and hysteria. Cognitive aberrations give way to unhappiness, depression, despair, apprehension, irritability, and hostility. Coping mechanisms are severely impaired. Low self-esteem results in impaired self-reliance and increased dependence on others.
7. *Disuse*: Prolonged, excessive immobilization results in secondary pain of musculoskeletal origin. Self-imposing splinting may be validated by misguided medical directives to be "cautious," and this can result in progressive muscular dysfunction and generalized deconditioning. The secondary pain further aggravates and perpetuates the reverberating pain cycle.
8. *Dysfunction*: Having lost adequate coping skills, patients with chronic pain begin to withdraw from the social milieu. They disengage from work, drop recreational endeavors, tend to alienate friends and family, and become increasingly isolated, eventually restricting their activities to the bare essentials of life. Bereft of social contacts, rebuffed by the medical system, and deprived of adequate financial means, the patient becomes an invalid in the broadest sense: physical, emotional, social, and economic.

In these patients, chronic pain, chronic disability, and chronic illness behavior become increasingly dissociated from the initial physical problem.

Instead, chronic pain and disability are associated more with emotional distress, depression, disease conviction, and adaptation to chronic invalidity (Waddell 1987). This process is discussed further in Chapter 7. There may be no clear relationship between pain and tissue damage and the degree of functional impairment (Vaseduvan 1992, Waddell et al. 1992, Waddell et al. 1993, Rainville et al. 1992). Waddell et al. (1992) showed that severity of pain accounted for only 10% of the variance of physical impairment and disability, and Main and Waddell (1991) showed that a larger proportion of the variance in disability in ADLs could be explained better by examining a combination of severity of pain, psychological distress, and illness behavior than by severity of pain alone. Disabled patients with chronic intractable pain report low activity levels compared with their prepain levels and those of normal controls. These low activity levels, however, are not always associated with significant physical limitations or with reduction in chronic pain. Patients have often tried to resume normal activity, only to experience an increase in their pain. Fear of pain plays a central role in their lives. They learn to anticipate the painful consequences of engaging in activity and avoid these activities, as they are afraid they will harm themselves by becoming more active. This gets reinforced by their health care providers, who tell them to "stop when it hurts" or to "let pain be your guide," even when the pain is no longer acute and the source of nociception is unclear. This fear-avoidance behavior (Fordyce et al. 1981), combined with fear of movement and (re)injury (Vlaeyen et al. 1995), results in a downward spiral of further limitation of activity and increased deconditioning. Pain behavior, such as limping, grimacing, restricting movement, and avoidance of physical activities contributes to impairments and functional limitations independent of the initial physical problem. These behaviors persist when they are rewarded in some manner by increased attention from friends or family, reinforcement from health care providers, or avoidance of disliked activities, such as work.

Case Example

The patient is a 54-year-old woman who injured her back 10 months ago while performing a heavy lift at work. X-rays and MRI of her back are negative for pathology. She reports that "everything" makes her back pain worse and that there is nothing she can do to ease her pain. She is unable to lift, carry, bend, walk more than 15 minutes, or sit longer than 10 minutes without significant increase in her pain. She is most comfortable lying down. Her total down time (time sleeping and lying down) is 21 hours per day. Her husband and children perform the housework and the grocery shopping. She occasionally cooks but finds it nearly impossible to stand for the length of time required. She frequently shifts position during the interview, occasionally standing up and rubbing her back. The interview is punctuated with tearful statements such as "I really try, but I can't do it. Nothing has meaning for me. I used to be so healthy, if I have to live like this, I'd rather die."

On physical examination, she is able to bend forward 10%. All other movements are reported to be painful and are restricted by 75%. Hip ROM is painful in all directions, and flexion is limited to 70 degrees owing to pain. Manual muscle test of the lower extremities is 4/5 throughout. Straight-leg–raising tests are negative, and sensation and reflexes are normal. She has no palpable spasm of the back muscles.

Impairments: back pain, decreased ROM of the lumbar spine and bilateral hips, decreased lower-extremity strength

Functional limitations: decreased ability to lift, carry, bend, or tolerate sitting or walking for more than 15 minutes

Disability: unable to perform household, spousal, and parental duties

Assessment, diagnosis, and prognosis: Patient is a 54-year-old woman with complaint of low back pain who presents with decreased ROM of her lumbar spine, both hips, and decreased strength in both lower extremities. Her functional limitations and disability are out of proportion with her objective findings. The patient will benefit from an interdisciplinary program, including a cognitive behavioral approach and physical therapy for functional restoration, including functional, strength, aerobic, and endurance training to overcome secondary impairments associated with severe deconditioning and fear of movement. She should be seen three times a week for 6 weeks with two follow-up sessions, for a total of 20 treatments in 6 months.

Obviously, this patient is overwhelmed by her pain and believes she has no control over it or her ability to function. Although she has many impairments, none of them indicates an identifiable physical problem or source of pain. She is more likely to be experiencing secondary conditions generated by her abnormal illness behavior. She is treated with a functional restoration program (see Chapter 7) with cognitive behavioral therapy (see Chapter 8) and eventually is able to return to work and resume her role within the family.

Some patients can function well in some parts of their lives, despite their pain, but not in others, as shown in the following case:

Case Example

The patient is a 35-year-old man who complains of neck, right shoulder, back, and bilateral hip pain. He also complains of numbness bilaterally in his legs when he lies down and occasional numbness in his entire right arm. Pain onset occurred 2 years ago, after a motor vehicle accident in which his vehicle was rear-ended. X-ray and MRI findings were normal. Electromyogram findings of both upper and lower extremities were normal. Computed tomography findings of his brain were normal. He had three separate courses of physical therapy in the past 2 years, including ice, ultrasound, stretching, and Nautilus exercise. He reports being mostly pain free after these treatments but is unable to continue exercising on his own. He has experienced increased pain in the past 2 weeks. He works full time, owns his own business, and spends most of his working hours driving his car. He is married and has seven children. He is able to do almost everything despite his pain, with the exception of house maintenance and yard work. He strongly desires to be pain free and is unsatisfied with the advice of the neurosurgeon, who told him to "live with the pain." He reports feelings of helplessness, hopelessness, and anxiety, and has difficulty sleeping. He is afraid he will become wheelchair bound because of his pain and will be unable to take care of his family.

Physical examination reveals normal ROM of his lumbar and cervical spine and normal strength, sensation, and reflexes in his upper and lower extremities. He has myofascial tenderness in his neck and shoulders. His intervertebral motion of the cervical and lumbar spine is normal. Nerve tension tests are negative.

Impairments: pain in neck, right shoulder and both hips, numbness in both legs when lying down, and occasional numbness in right arm

Functional limitations: unable to perform yard or house work

Disability: decreased performance level of leisure activities

Assessment, diagnosis, and prognosis: Patient is a 35-year-old man who presents with multiple site pain and numbness. He functions well despite these complaints but exhibits significant catastrophizing thoughts relating to his impairments and fear avoidance of exercise, even though it has reduced his pain complaints in the past. This patient would benefit from a referral to Behavioral Medicine. The patient would benefit from a formal, structured exercise program to decrease his fear of exercise and pain, but will be unable to attend owing to his work schedule. The patient will therefore be seen for three sessions of physical therapy, consisting of instructions in the use of independent pain management modalities and instruction in a health club exercise program (the patient belongs to a health club), including two follow-up sessions to ensure patient is progressing as expected, with decreased disability and somatic focus over a period of 3 months.

The pain behavior of some patients with chronic intractable pain is sometimes confused with malingering. *Malingering* is the conscious and purposeful faking of a symptom, such as pain, for some gain, usually financial (Turk et al. 1983). It is important to realize that true malingering is very rare, probably occurring in fewer than 5% of patients (Leavitt and Sweet 1986). When the physical therapist understands the concepts of CNS changes and the integration of emotional, cultural, social, and psychological factors in the production of pain, it is evident how difficult it is to willfully fake pain. When in doubt about malingering, the physical therapist should err in favor of the patient.

The previous case examples show the variety of patients who have chronic pain seen in the clinic. Patients with chronic intractable pain represent a widely heterogeneous group. To better understand patients with chronic pain, conceptual frameworks in the form of biopsychosocial models have been developed.

BIOPSYCHOSOCIAL MODELS

The gate-control theory formed the physiologic basis of the biopsychosocial model of medicine. The biopsychosocial model views pain as an interaction of biological, psychological, and social phenomena. This model recognizes that the person who "reports pain and is observed to be suffering, or reports suffering is not imagining pain" (Fordyce 1995, 17).

Nolan's Model

Nolan (1990) describes five different and linked components in the experience of pain: physiologic, perceptual, affective, cognitive, and behavioral components. The *physiologic* component that is the tissue source of the pain experience is known as *nociception* and is a result of an abnormality in the tissue. Much of physical therapy is directed at correcting the physiologic damage associated with pain. Chronic pain patients may not benefit from these techniques because the physiologic component is often not the major source of the pain experience. The *perceptual* component of pain reflects the individual's perception of the quality, location, severity, and duration of the pain stimulus. This differs from the *affective* component, which is influenced by psychological factors. Positive and negative emotions, such as fear, grief, anxiety, hostility, joy, relief, and relaxation, will affect the overall pain experience and response to intervention. The *cognitive* component, which also can positively or negatively affect outcome, is based on what the patient knows and believes about his or her pain. These beliefs are influenced by culture, past personal experience, acquired knowledge, and the experiences of others with whom the individual is familiar. These influences all interact to complement rehabilitation efforts or obstruct them.

The *behavioral* component, which is the manner in which the patient expresses pain to others through communication and behavior, is a blend of the other components. It is expressed in the smiling face of a person recovering from successful cancer surgery or in the scowling face and slumped posture of a person who experiences headaches. The behavioral component is the part most immediately visible to the observer. It is influenced by a complex history unique to the individual.

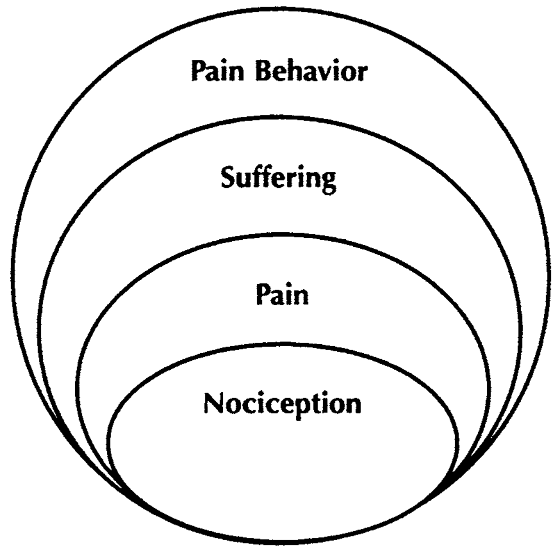

Figure 1.2. A schematic diagram for the components of pain. Only pain behavior is measurable and observable. (Redrawn with permission from JD Loeser. Chronic Low Back Pain. New York: Raven, 1982;145.)

Loeser's Model

A similar model of pain with four components was developed by Loeser (1982) and is outlined in Figure 1.2.

The first component, *nociception*, is the detection of tissue damage, which activates a specific set of receptors in the A-delta and C-fiber range, with *pain* (second component) being the subsequent cognitive recognition of the nociceptive stimulus carried by the peripheral and central nervous system. *Suffering*, the third component, is the negative affective response brought about by pain, depression, fear, or other events in the patient's emotional life. As with the Nolan model above, the outward and comprehensive manifestation of the pain event

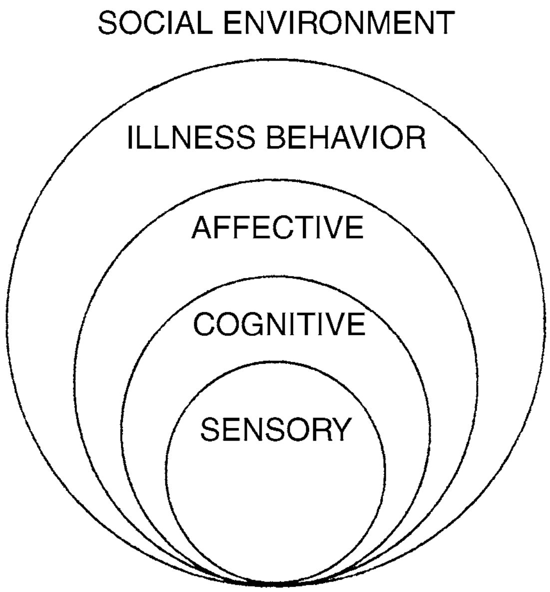

Figure 1.3. A biopsychosocial model of chronic pain and disability: a cross-sectional analysis of the clinical presentation and assessment of low back pain and disability at one point in time. (Reprinted with permission from G Waddell, M Newton, I Henderson, et al. A Fear-Avoidance Beliefs Questionnaire [FABQ] and the role of fear-avoidance beliefs in chronic low back pain and disability. Pain 1993; 52:164.)

is the *pain behavior* (fourth component) (Loeser and Egan 1989). Like other behaviors, it is influenced by cultural background and environmental consequences (Loeser and Fordyce 1983) and is a communication or action by the patient that the observer interprets as a suggestion that nociception has occurred. Verbal and nonverbal behaviors, such as taking medication, refusing to go to work, and going to doctors, are all included in this category. Another common pain behavior is fear avoidance, which is the avoidance of activities because of fear of reinjury and physical harm.

The relationship between components is not fixed and can vary among individuals and stages of the patient's life. Consider the example of a finger fracture. The suffering for a concert pianist with this injury may be extreme, whereas a high school football player with the same injury may not suffer at all. The nociception is the same for both, and the awareness of the pain may be similar, but the suffering and pain behaviors are likely to be extremely different.

Waddell's Model

Waddell expanded on Loeser's model to develop a model that emphasizes illness rather than disease (Figure 1.3).

The term *illness* refers to the internal, subjective experience of an individual who is aware that personal well-being has been jeopardized. Illness also refers to how that person perceives and responds to the experience of being ill. *Distress* is an emotional disturbance caused by stress and characterized by a variable combination of anxiety, increased bodily awareness, and depression (Waddell et al. 1984). Distress is largely secondary to the physical disorder (illness) and becomes better or worse, depending on the success or failure of treatment. Distress arising from unrelated causes may aggravate or perpetuate physical pain. *Illness behavior* can be assessed clinically as "observable and potentially measurable actions and conduct that express and communicate the individual's own perception of disturbed health," such as guarding, rubbing, sighing, and grimacing (Waddell et al. 1984). This is similar to the pain behavior described previously in Loeser's model. *Illness behavior* is defined as the lack of physical and social functioning, disrupting normal life.

Leventhal et al. (1980) developed a definition of illness behavior that focuses on the individual's perception and interpretation of his or her symptoms. They outlined the following four components: (1) the individual's awareness and labeling of sensations, (2) the individual's assumptions regarding the etiology of sensations, (3) the individual's anticipation of the consequences of the sensations, and (4) the individual's estimate of the duration of the symptoms.

The term *abnormal illness behavior* refers to inappropriate descriptions of symptoms and inappropriate responses to examination within the context of the clinical interview and examination. Symptoms and responses to examination may be inappropriate or nonorganic in the limited sense that they do not fit the usual clinical presentation of physical disease. These symptoms and responses have been shown to be statistically and clinically separable from the normally accepted symptoms and signs of physical disease and to be more closely related to affective and cognitive disturbances (Waddell et al. 1989).

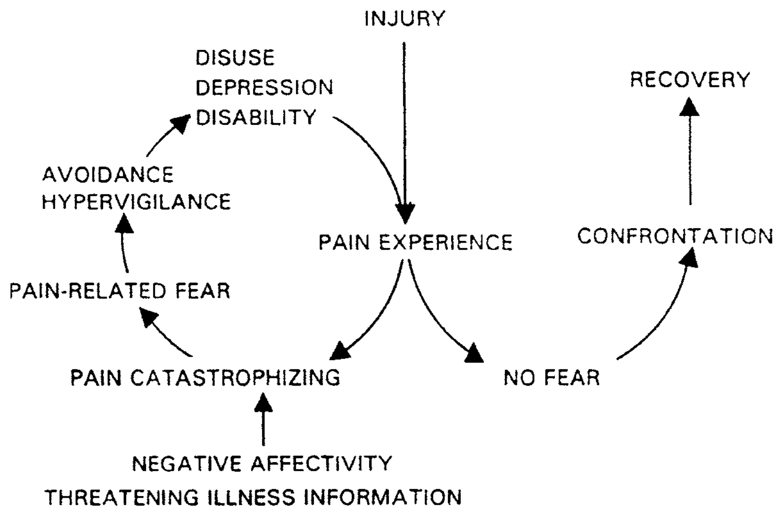

Figure 1.4. The fear-avoidance model. (From JWS Vlaeyen, SJ Linton. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. Pain 2000;85:317–332. Reprinted with permission from the International Association of the Study of Pain.)

The definition of *suffering* includes distress. Suffering is "distress brought about by the actual or perceived impending threat to the integrity or continued existence of the whole person" (Cassell 1991).

It is interesting to note that definitions of pain and suffering include mention of both actual and perceived events. Failure to attend to the suffering component may promote or prolong suffering itself (Cassell 1991).

Vlaeyen's Model

Vlaeyen et al. (1995) based their cognitive behavioral model of fear avoidance and (re)injury on the work of Lethem et al. (1983), Philips (1987), and Waddell et al. (1993) (Figure 1.4).

This model incorporates a biological component (physical injury), a psychological component (cognitive-perceptual processes), and a social component (disability). Lethem et al. (1983) were the first to use the term *fear avoidance* and described a model explaining how fear of pain and avoidance result in the perpetuation of pain behaviors and experiences, even in the absence of demonstrable organic pathology. "Confrontation" and "avoidance" are postulated as the two extreme responses to this fear, of which the former leads to reduction of fear over time. The latter, however, leads to the maintenance or exacerbation of fear. Catastrophizing thoughts (negative thinking about pain and its consequences) may be a precursor of pain-related fear. Vlaeyen and Linton (2000, 319) wrote: "Fear is characterized by escape and avoidance behaviors, of which the immediate consequence is that daily activities (expected to produce pain) are not accomplished anymore. The avoidance of physical activity leads to deconditioning, which may further worsen the pain syndrome. In addition, avoidance also means the withdrawal from essential reinforcers increasing mood disturbances such as irritability, frustration and depression."

DISABLEMENT MODELS

Disablement models were not developed specifically for pain, yet they are important to understand as they fit into the conceptual framework for physical therapy evaluation and treatment. In fact, the *Guide to Physical Therapist Practice* (American Physical Therapy Association 2001) is based in part on the process of disablement "as a framework for understanding and organizing practice and for optimizing function." *Disability*, as defined by Nagi (1991), is a pattern of behavior that emerges over a long period of time, during which the individual experiences functional limitations to such a degree that he or she cannot overcome the limitations to create some semblance of "normal" role and task performance. This is the description of the *sick role*. People with chronic pain often present themselves in these sick roles with chronic illness behavior and chronic disability that are increasingly dissociated from the physical problem. There may be scant evidence of a remaining nociceptive stimulus; however, the memory has been established, and emotional distress, depression, disease conviction, and adaptation to chronic pain and disability occur. Chronic pain becomes a self-sustaining condition that is resistant to traditional medical management. Physical treatment directed at a hypothetical but unidentified and possibly nonexistent nociceptive source is not only unsuccessful, but also potentially damaging (Waddell 1987).

Physical therapists are familiar with the concepts of disease, impairment, functional limitations, and disability. The assumption is made that pathologic states lead to impairments, and impairments lead to functional limitations, which in turn lead to disabilities. This basic scheme is consistent in three major, published disablement models: the Nagi Scheme (1965); the International Classification of Impairments, Disabilities, and Handicaps (Wood 1980), which adds the category of handicap after disability; and the National Advisory Board on Medical Rehabilitation Research (1992), which uses the term *societal limitation* instead of *handicap*.

These three major schemes are discussed and compared by Jette (1994). He emphasizes that the value to the clinician of describing restrictions in a patient's performance in terms of such schemes lies in the ability to identify the extent to which disabilities are a result of social and physical environmental factors, instead of factors within the individual. Jette provides the example of a rigid work environment, which can be a barrier that increases disablement in a patient. Working with employers to help patients may improve the productivity of certain patients with chronic pain. The basic definitions of these schemes, based on the International Classification of Impairments, Disabilities, and Handicaps model, are as follows (Cole and Edgerton 1990):

Disease or disorder "Something abnormal occurs within the individual; this may be present at birth or acquired later. A chain of causal circumstances, the 'etiology,' gives rise to changes in the structure or function of the body, the 'pathology.' Pathologic changes may or may not make themselves evident; when they do they are described as 'symptoms and signs.' These features are the components of the medical model of disease."

Impairment "An abnormality of structure, function, or both at the organ level. At this stage of the model, an affected individual becomes aware of the pathology or, in behavioral terms, becomes aware that he or she is unhealthy. Subclasses of impairment include disfigurement and intellectual, psychological, language, aural, visceral, skeletal, and sensory abnormalities."

Disability "Restriction or lack of ability to perform an activity in a manner considered normal, a disability is a disturbance manifested in the performance of daily tasks. Disabilities are the functional consequences of impairments. Principal subclasses of disabilities are concerned with behavior, communication, personal care, locomotion, body disposition, dexterity, and particular skills."

Handicap "A disadvantage resulting from an impairment or a disability, a handicap limits or prevents the fulfillment of a role that is normal (depending on age, sex, and social and cultural factors) for the affected individual. Handicaps largely reflect societal attitudes toward people with disabilities and impairments. Handicaps include physical dependency, lack of mobility, and economic dependency."

Nagi (1991) recognized a need for a concept that bridged the presence of an impairment and an individual's disability. He therefore proposed the concept of functional limitation, in which the process of disease leads to impairment, and constructed the following model:

$$\text{active pathology} \rightarrow \text{impairment} \rightarrow \text{functional limitation} \rightarrow \text{disability}$$

In Nagi's model, *impairment* is a loss or abnormality of an anatomic, physiologic, mental, or emotional nature. *Functional limitation* includes impairments set on the individual's ability to perform the task and obligations of his or her usual roles and normal daily activities. These include roles within the family, peer group, community, work, and other interaction settings, as well as activities involved in self-care. Whereas *impairment* refers to the tissues, organs, and systems, *functional limitation* refers to the whole person. Not all impairments lead to functional limitation or directly to disability (e.g., shoulder trauma [pathology] that leads to shoulder pain [impairment] can result in difficulty reaching overhead [functional limitation], which is disabling for a school teacher who needs to write on a blackboard, but not for a typist whose work does not include overhead reaching). *Disability* is defined as patterns of behavior that emerge over long periods of time during which an individual experiences functional limitations to such a degree that he or she cannot create some semblance of "normal" overall role performance or to such a degree that an individual's overall behavior is less than adequate to meet the expectations normal for one's age and gender as well as one's social and cultural environment. It refers to social rather than organismic functioning.

Nagi recognized that *disability* also includes the individual's definition of the situation and reactions and the definition of the situation by others and their reactions and expectations (family, friends, associates, employers, and organizations and professions that provide services and benefits). According to Nagi, this model is most appropriate for injuries and diseases that have identifiable onsets and for those that have stable residuals—this model may not be suitable for chronic illnesses. Although implied, the model does not account well for the behavioral response of patients to their impairments and for the consequences of their behavioral responses' having an impact on impairments, physical functioning, and disability. A person's response to an impairment may be more disabling than the impairment itself. Disability may be related more to patient beliefs and fears than to actual inability to perform socially accepted roles.

The model seemingly assumes a linear relationship between these domains. From the perspective of a disease model, chronic pain dysfunction appears to be a disparate set of signs and symptoms, many of them (e.g., sleep disturbance, depression, and psychosocial disability) not pathognomonic to a particular disease (Dworkin et al. 1992). Unfortunately, based on this model, many physical therapists continue to believe that treating pain will result in increased physical functioning and decreased disability. This may be true for some patient groups, but it does not fit the chronic pain population. A poor correlation exists between subjective pain ratings and the patient's ability to perform functional activities (Waddell 1987, Rainville et al. 1992). Waddell et al. (1984) showed, for instance, that the amount of treatment received by patients with back pain was more influenced by their distress and illness behavior than by the actual physical disease.

In chronic intractable pain, there is no linear relationship between impairment, functional limitation, and disability. Waddell reports a correlation of $r = 0.39$ between pain and disability and/or ADLs. Clearly, the relationships between the domains of pain, impairment, functional limitation, and disability are mediated by factors outside of the disablement model. We therefore attempted to integrate the disablement model proposed by Nagi with the biopsychosocial models previously described with the goals of maintaining a conceptual model (Nagi 1991) widely used within the physical therapy community and adapting it to models existing in pain management (see Figure 1.4).

In this pain-disablement model, disease (e.g., diabetes), trauma (e.g., work-related injuries), and unknown factors (e.g., fibromyalgia) can lead to pain, which becomes the primary impairment of the individual.

The pain-disablement model includes the following elements:

Primary impairment A loss or abnormality of an anatomic, physiologic, mental, or emotional nature as a *direct* result of disease, trauma, or unknown factors of which the dominant symptom is pain.

Individual response The patient's response to the primary impairment(s) that results from the patient's belief system (e.g., cultural background, religion, age, race, gender, childhood experiences) and influences subsequent behaviors. These beliefs include fear of pain (Vlaeyen et al. 1995), fear of movement and (re)injury (Vlaeyen et al. 1995), and catastrophizing (Sullivan 1998). These beliefs can lead to fear-avoidance behavior (Fordyce et al. 1981, Waddell et al. 1993) of functional activities that, in their turn, lead to functional limitations and secondary impairments.

Functional limitation See definition by Nagi (1991).

Secondary impairments Impairments caused by the patient's response to pain. Long-lasting avoidance of activities has detrimental consequences both physically (loss of ROM, aerobic

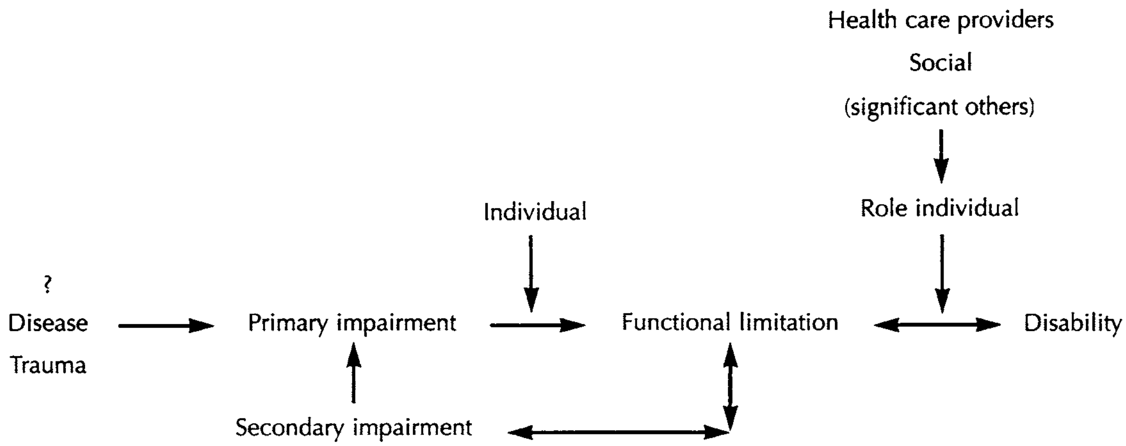

Figure 1.5. Proposed integration of Nagi's (1991) disablement model and biopsychological models of pain. (Wittink, 1996 [unpublished].)

fitness, muscle strength, and endurance) and psychologically (see Chapter 6). Secondary impairments may further limit the patient's ability to function and may contribute to the pain experience. An ongoing cycle may develop, increasing patient distress and suffering. Secondary impairments are common in patients with intractable chronic pain.

The individual The patient's thoughts and beliefs as they pertain to the meaning of pain—for instance catastrophizing (Sullivan et al. 1995, 1998) and fear-avoidance beliefs (Vlaeyen and Linton 2000), general and pain coping skills (Cole 1998, Unruh et al. 1999, Reid et al. 1998, Keefe et al. 1997, Snow-Turek et al. 1996). These beliefs result in behaviors (avoidance of physical activities, work, family duties) that are influenced by significant others, social factors, and health care providers, all of whom may reinforce or decrease illness behaviors, functional limitation, and disability by how they respond to the patient. One example is fear of work-related activities' (Waddell et al. 1993, Vlaeyen et al. 1995) preventing patients from returning to work. This may be reinforced by the social system (the workers' compensation system, the need for attorneys, and the need to apply for Social Security disability funds).

Significant others Partners, friends, and the patient's children, who do not respond to the pain the patient *feels*, but to how the patient *expresses* himself or herself. They respond to the patient's illness behavior and inability to "do things"—that is, to functional limitations and disability.

Social influences Outside factors over which the patient may not have control, such as environmental and occupational factors, employer attitudes, and litigation.

Health care providers All health care providers the patient comes in contact with (e.g., physicians, physical and occupational therapists, chiropractors, osteopaths). Recommendations by health care providers can have a powerful influence on patient functional limitation and disability. Catchlove and Cohen (1982) state that not insisting on a patient's return to work acknowledges the patient's view of him- or herself as "regressed, dependent, and incapable." Patients demonstrated a better return-to-work rate when they were instructed to do so either during or after treatment compared to a control group, for whom return to work was not a component of therapy.

Disability See definition by Nagi (1991) (Figure 1.5). This model is consistent with evaluation and treatment approaches used by physical therapists who specialize in pain management. Evaluation includes (aside from physical assessment) an assessment of the patient's illness behavior, fear of pain and movement, functional limitations, and disability. In cooperation with the psychologist, the physical therapist can formulate a good sense of the patient's belief systems, which helps direct treatment. Included in treatment are behavioral methods, such as decreasing fear of injury and physical activity by quota-based progressive exercise programs, education on hurt versus harm, performance-contingent rewards, as well as setting of functional goals.

EPIDEMIOLOGIC SCOPE OF THE PROBLEM OF PAIN

Pain is a major health problem in the United States and other Western countries. In a 1987 study, Bonica estimated that approximately 30% of the population of economically developed countries experienced chronic pain (Fordyce 1995). Fifty million Americans are partially or totally disabled for a few days or a few weeks by chronic pain (Fordyce 1995). Forty-five percent of all Americans seek care for persistent pain at some point in their lives (American Pain Society 1994). Back pain is the second leading symptomatic reason for visits to physicians' offices in the United States (Cypress 1983). Back pain affects 58–84% of all adults at some point in their lives (Dionne 1999). Back pain is the leading cause of disability in the United States and significantly affects all factors of the economy (Lawrence et al. 1998). Most studies have found that 70–90% of the total cost of lower back pain relates to those with either temporary or permanent disability (Frymoyer and Cats-Baril 1991, Webster and Snook 1994, Spitzer et al. 1987). The Quebec task force on Spinal Disorders (Spitzer et al. 1987) showed that the longer the worker with back pain is away from work, the less likely he or she is to return. After an absence of 3 months, the chances of a worker to return to work are less than 20%. The greater the duration of disabling lower back pain, the greater the probability of permanent disability (Waddell 1992). In the interval from the inception of the Social Security disability income program in 1957 through 1975, the average number of awards for the diagnostically questionable diagnosis of disk disease, using 3-year averages, increased 2,680% (Fordyce 1995). In 1990, the direct and indirect cost of back pain was estimated to be $75–100 billion (Frymoyer and Cats-Baril 1991). Waddell (1996) estimates the total cost of back pain to the United States society to be $\$100 \times 10^9$.

The prevalence of neck pain appears to be lower, around 9.5–35.0% (Ariens et al. 1999). Patients with neck pain are reported to take a mean of 25 sick days per year, and 13% experience recurrences (Ariens et al. 1999).

In 1992, migraine headaches accounted for substantial morbidity, resulting in an estimated 3 million days spent bedridden each month and lost labor costs ranging from $6.5 to $17.0 billion (Osterhaus et al. 1992). Estimated annual lost work days per 1,000 persons is 820 for tension-type headache, almost triple that in migraine (270) (Silberstein and Lipton 1996). Using customary therapy, the estimated cost for a person with migraine was estimated to be $1,949 (Canadian dollars in 1997), with medical expenditures adding an average of $280 to the cost of illness (Caro et al. 2000).

Temporomandibular (TMD) joint pain affects approximately 10% of women and 6% of men in any given year. This means that approximately 20 million adults will be affected by TMD joint pain (Drangsholt and LeResche 1999). Total annual cost was estimated to be $2 billion in 1998. Chronic TMD pain was shown to have a similar individual impact as back pain, severe headache, and chest and abdominal pain (von Korff et al. 1988).

Chronic widespread pain has an estimated prevalence of 10% in women younger than the age of 45, whereas at older ages the prevalence was higher than 20%. In men, the prevalence was between 5% and 10% up to age 55 years and older (15–20%) between 65 and 74 years (Macfarlane, 1999). The overall prevalence for fibromyalgia is estimated to be 2%, increasing as people get older. In a community survey in the United Kingdom, 75% of patients with chronic widespread pain had consulted their general practitioner with their symptoms, suggesting a large burden to the health care system (Macfarlane 1999). Simms et al. (1995) estimated the cost per year (1991 prices) of a fibromyalgia patient to be around $1,000, with most of the cost related to medication.

Magni et al. (1993) reported the frequency of chronic musculoskeletal pain in the National Health and Nutrition Epidemiologic follow-up study to be 32.8%. The group comprised significantly more women, older people, and those with lower incomes.

The above makes it clear that a large percentage of patients commonly seen by physical therapists is likely to be patients with pain, many of whom will have chronic intractable pain.

ATTITUDES AND BELIEFS OF PHYSICAL THERAPISTS

Health professionals expect visual signs of pain and a physical cause of pain. Both patients and health care providers tend to downplay or altogether ignore the inter-relationship of the emotional, cognitive, and physical aspects of pain. The patient and the professional are both affected by their own culture, age, gender, personal pain history, beliefs, and expectations. The patient may expect to be cured without active participation. The rewards for an external locus of control combine well with the traditional acute biomedical model. A passive, "good" patient does not complain, tells health professionals what they want to hear, and gets better. The pain is relieved by the professional's best efforts, and, if it is not relieved, the fault lies with the patient, not with the professional. Should a patient be so unfortunate as to experience pain relief by "placebo," the pain is obviously not real. Furthermore, the problems of a patient who has a lifestyle or attitude different from the mainstream are often considered illegitimate. A drug abuser may be punished and receive less medication and treatment owing to his or her lifestyle. A sickle cell crisis is seen as less painful when it is the third, fourth, or tenth occurrence. The patient is expected to become accustomed to the pain, and pain is often assessed through the eyes of an individual who experiences and reacts to pain differently.

Expanding on these ideas, McCaffery has written about misconceptions that hamper pain assessment (McCaffery 1995). Although her work relates to people with acute and cancer pain, the misconceptions apply to chronic pain as well. Table 1.3, which is adapted from McCaffery, explores the myths about pain and the correct professional behavior required to dispel these myths.

There are many problems in pain assessment and treatment that relate to the knowledge and beliefs of those responsible for pain management. There is a lack of formal education for health professionals regarding pain management, particularly in the area of chronic pain management. The total number of hours devoted to pain in physical therapy training amounts to approximately 4 hours (!) mostly included in modalities classes (Simmonds, personal communication 2000). Inappropriate use of currently available knowledge also occurs (Wolff et al. 1991). Physical therapists are not alone in having insufficient educational and attitudinal preparation for working with patients with chronic pain. Nurses and physicians also have been found to not understand basic concepts of pain management (Myers 1985, Bonica 1978a, 1978b). Editorials in journals have lamented the insufficient number of hours applied to pain education and propose a curriculum for medical students that would increase exposure to pain theories and management (Liebeskind and Melzack 1988, Pilowsky 1988).

The correlation between insufficient knowledge and antiquated attitudes is detrimental to quality patient care. Inappropriate attitudes result in less than adequate pain management (Halfens et al. 1990, Hauck 1986, Myers 1985, Wolff et al. 1991). These studies strongly suggest the need for expanded education of health professionals concerning basic mechanisms of pain, pain assessment, and pain management. Positive attitudes about pain control also need to be taught and fostered in both patients and health professionals.

CONCLUSION

There is much that is still not known about pain, making the task of managing chronic pain patients and chronic pain syndrome patients a daunting one for physical therapists. As emphasized by a consensus of the members of the American Pain Society, "Mismanagement of intractable pain has tragic

Table 1.3. Common Myths of Pain

1.	Pain authority: health team versus family or patient	
	Myth	The patient is malingering, trying to fool you, or lying.
	Correction	Believe the patient.
2.	Acute pain model versus adaptation	
	Myth	It is always possible to see that someone is in pain.
	Correction	Physiologic and behavioral adaptations occur. Lack of expression does not mean lack of pain. The ability to sleep does not mean that one has no pain.
3.	Known physical cause of pain versus unknown cause	
	Myth	Pain in the absence of a known organic cause is a symptom of psychological problems.
	Correction	Most pain is a combination of physical and emotional stimuli. The cause of pain cannot always be determined by today's assessment techniques. (An inaccurate or incomplete diagnosis was recorded in 66.7% of patients with chronic pain at a diagnostic center [Hendler and Kozikowski 1993].)
4.	Labels and biases versus care without biases	
	Myth	The care provided to people in pain is the same regardless of the clinician's personal values, preferences, or painful experiences.
	Correction	Recognize your own biases and guard against them when treating pain.
5.	Pain threshold: uniform versus variable	
	Myth	Everyone perceives the same intensity of pain from the same stimuli.
	Correction	Personal physiologic differences, plus factors that contribute to higher or lower endorphin levels, will affect the pain threshold.
6.	Pain tolerance: high versus low	
	Myth	Experience with pain habituates a person to it.
	Correction	Increased pain experiences will likely make one more fearful. Expectations that pain will not be controlled will affect tolerance.
7.	Pain relief from placebos	
	Myth	A placebo response is proof that the pain is not real.
	Correction	Placebo responses are not well understood and can be powerful. (Thirty-five percent of patients will experience pain relief from placebo [Goodwin et al. 1979].)
8.	Control of analgesia	
	Myth	The health care team controls the patient's pain.
	Correction	The patient should be given the opportunity to assist in pain control.

Source: Data from M McCaffery. Pain: assessment and intervention in clinical practice. Continuing education course syllabus, Spring 1995.

and costly consequences: disability, depression, overuse of diagnostic services and procedures, hospitalizations, and surgery, and overuse of inappropriate medications" (1994). The complexity of nociceptive transmission and transformation into pain perception is still incompletely understood. One of the most important things to remember in treating patients with pain is that pain is a subjective experience, and the patient's experience should be respected.

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Chapter 2

Sociocultural Considerations in Chronic Pain and Its Management

Kathryn Eilene Lasch

The concept of pain is as old as recorded history, but the ways in which people think about and treat pain have varied across space and time. While the experience of pain may be built on anatomic and physiologic data, cultural and social factors are the foundation for its expression and treatment (Rey 1998). For example, we would think the notion that dental caries were caused by worms burrowing into the teeth is odd, but this was a commonplace idea in ancient Egypt (Rey 1998). It was only in 1986 that textbooks asserted (and clinician practices and attitudes reinforced) the notion that infants could not experience pain as adults do (Barr et al. 2000).

In the United States, 2000–2010 has been called The Decade of Pain, reflecting the fact that pain is increasingly considered an important component in the delivery of health care and the education of health care professionals. Unfortunately for patients, much education to date as to how best to treat or manage pain has been either nonexistent or incorrect, or has created ambivalence on the part of the student (Lasch et al., in press). Nowhere is this more the case than in the management of chronic pain. Educating professionals to better manage pain has been processed through a sociohistoric filter that only recently is being examined with an eye to changing the ways we manage chronic pain. This filter includes the role of pain in Western biomedicine, the use of opioids to treat pain (and their potential for abuse), and the inconsistency of research findings on the social and cultural factors related to the experience of pain and its management.

Worldwide, the broad sociohistorical context of pain has changed since 1980. Ministries in France, the World Health Organization, and, recently, the Joint Commission for the Accreditation of Healthcare Organizations in the United States, as well as others, have urged a more proactive approach to the alleviation of pain (Baszanger 1998). These organizations have emphasized the notion that pain is a biopsychosocial phenomenon. As the research on the biology and neurobiology of pain has given us new ways to think about and manage pain, research into the psychological and social factors that are related to the incidence and prevalence of certain types of pain syndromes has been keeping pace. This chapter presents what is known and not known about how social factors, especially cultural, may affect the experience of pain, its expression, and receptivity to its treatment.

DEMOGRAPHIC CHANGE AND THE MANAGEMENT OF PAIN BY PHYSICAL THERAPISTS

Our increasingly changing and multicultural population represents a significant challenge to the U.S. health care system in general and the effective management of pain in particular. The design and assessment of effective health care interventions to alleviate pain for culturally diverse patients (both long-term patients and new waves of immigrants and refugees) present a complicated task for physical therapists.

The "new" immigrants, increasingly coming from nontraditional regions such as southeast Asia and Latin America, are even more heterogeneous than their predecessors (Lasch 2000). Individuals within the same ethnic group come from all "walks of life," with differing educational, occupational, and economic statuses, all of which affects the degree to which they are ethnically identified and maintain their cultural responses to health and illness.

The cultural composition of the United States changed dramatically in the 1980s, as the immigration rates for the decade were only surpassed by the peak years of immigration prior to World War I (Lasch 1999). Often, our new immigrants do not speak English, contributing to the already difficult task of assessing and managing chronic pain appropriately and effectively. The new immigrants frequently face numerous economic, social, and health problems. A substantial proportion of the new U.S. immigrant population is made up of refugees, and they have lived in several resettlement camps, sometimes in different countries, before gaining refugee status in the United States and have been devastated by the impact of war, trauma, and torture (Espenshade and Fu 1987).

Estimates from the 2000 Census reveal the continuing change in the composition of the U.S. population, as well as the problem of identifying an individual as belonging to a certain group (Schmitt 2001). For example, the Hispanic population increased by 58% since the last Census in 1990, making them on rough parity with blacks as the nation's largest minority population; non-Hispanic whites are now a minority in California. In Florida and California, Hispanics now outnumber blacks. Given the option to identify themselves as belonging to more than one census race (ethnicity) category, nearly seven million people, or 2.4%, of the nation described themselves as multiracial.

INFORMATION SOURCES FOR THIS CHAPTER

The information found in this chapter is based on an extensive review of the race, ethnicity, culture, and pain literature; my own research on culture, cancer pain, and professional education; and my experience working collaboratively with 14 different ethnic groups on cancer pain education. From 1992 through 1995, the National Cancer Institute funded the Boston Cancer Pain Education Program to design, implement, and evaluate a cancer pain education program for inner city patients (and their nurses) from diverse cultural groups. We provided education to more than 500 nurses across the care continuum, and, collaboratively with community representatives, developed cancer pain education booklets for black, Chinese, Haitian, Latino, low-literacy white, Italian, Portuguese, Russian, Cambodian, Vietnamese, and Laotian patients (Lasch 1999, 2000, Lasch et al. 2000a, 2000b). The National Cancer Institute also funded the Cancer Education Module for the Management of Pain program, which integrated a cancer pain education module with a cultural sensitivity component into the curricula of two medical and three nursing schools (Lasch et al., in press). To introduce cultural sensitivity into the curriculum of one of the family practice residencies, the Cancer Education Module for the Management of Pain program worked with Penobscot Indian and French-Canadian representatives around cancer pain issues. In 2001, a pharmaceutical company funded the development of a cancer pain education booklet for Japanese patients. In addition, for the HIV Homecare Handbook, I conducted interviews in 1994 with representatives from Latino, Haitian, and black community-based agencies concerning cultural awareness when working with human immunodeficiency virus and acquired immunodeficiency syndrome patients (Lasch 1999).

IMPORTANCE OF DISTINGUISHING ETHNICITY, CULTURE, AND RACE

Currently, the issue of the health of minorities has gained much ascendancy in the policy arena. Although disparities in morbidity and mortality by minority status in the United States have been documented for decades (Lasch 1999, U.S. Department of Health and Human Services 1990, Zierler and Krieger 1997, Molina and Aguirre-Molina 1994), only in recent years have significant resources been put toward understanding and eradicating them. The Healthy People 2010 initiative has two main goals: (1) to increase the quality and years of healthy life, and (2) to eliminate health disparities (U.S. Department of Health and Human Services 2001). Disparities in health status based on socioeconomic class, insurance status, or cultural background are increasingly recognized as factors that should be taken into account in health care, clinical trials, and health services research (Nickens 1996).

The terms *race*, *ethnicity*, and *culture* are often used interchangeably in health care and health care literature, when in fact they are very different words. In addition, there is controversy over how one should use these concepts. Prior to the early 1980s, most definitions of *race* used in the social sciences reflected a biological understanding of race (Williams 1997). These definitions did not question the validity of the concept of race (Williams 1997). Starting in the mid-1980s, most social scientists started referring to *race* as an unscientific term when scientists began to find that "there are no biological criteria that can be universally applied to assign persons to specific racial groups" (Williams 1997, 323).

Although it has become increasingly recognized in the scientific community that "race" is a social fact or a socially constructed category, definitions of *race* in the biomedical science and public health literature continue to conceive of race as meaning genetic homogeneity (O'Loughlin 1999, Pfeffer 1998). However, even within these fields there is a growing body of researchers who criticize the use of *race* in medicine and public health (Cooper and David 1986, Osborne and Feit 1992). Others have argued that we should continue to use "racial" categories to examine the incidence, prevalence, and mortality rates of conditions, diseases, and health care use (Williams 1997). Doing so alerts us to disparities in health in subgroups of the population and racism and institutionalized discrimination in the delivery of health care services, because race (to date) has played a major role in the social organization of this country (Williams 1997).

Ethnicity, derived from a Greek word meaning *tribe*, generally implies that a group of people within a larger society shares an ancestral origin or social background, culture, and traditions, which are maintained between generations and provide a sense of identity to the members of an ethnic group (Senior and Bhopal 1994). In addition, they generally have a common language and religious tradition (Senior and Bhopal 1994). They may have one or more of these characteristics to be perceived by themselves and others as an ethnic group, and ethnicity can change over time and place. How closely individuals identify with their ethnic group and its cultural characteristics depends on a number of factors, including how long they have lived in the United States, their ties to their mother country, how often they go home, whether they live in an isolated enclave of their own group or are more integrated into the rest of the community, their educational and socioeconomic status level, their primary language, their age and generation, their gender, and others. There are as many intra-ethnic group differences as there are differences between groups. Few studies take this diversity in ethnicity into account. It is important for clinicians not to stereotype patients and make what may be false assumptions based on a patient's apparent ethnicity alone.

Culture has been defined in many different ways, but it usually refers to the behavioral norms, attitudes, and meaning systems of a group of people (communities, neighborhoods, groups of families). The worldviews, religions, and rituals of a group of people can be considered culturally constituted—that is, they are shaped by the cultural forces within which they are embedded (Geertz 1973). When applied to health and medical care, *culture* usually includes "beliefs about sickness, the behaviors exhibited by sick persons, including their treatment expectations, and the ways in which sick persons are responded to by family and practitioners" (Kleinman 1980, 38).

ETHNICITY AND THE TREATMENT OF PAIN

Racism has played an especially injurious role in the treatment of pain. Historically, it was believed in this country that blacks did not experience as much pain as white patients with similar illnesses and injuries. Recent studies suggest that the disproportionate cancer burden of minorities (which has been documented since the influential 1985 report of the Secretary of the U.S. Department of Health and Human Services Task Force on black and

Minority Health) may not merely be in terms of incidence and mortality rates, but also in terms of quality of life domains, such as pain (Anderson et al. 2000, Gordon 1997). There have been many reports of the undertreatment of cancer pain (Miaskowski 1994, Ferrell et al. 1993, Von Roenn et al. 1993). Distressingly, studies are beginning to report that minority patients with cancer may be at even greater risk for inadequate pain management (Bernabei et al. 1998, Cleeland et al. 1997).

Several studies have suggested that minorities may be at risk for inadequate pain treatment in other diseases and conditions as well (Martin 2000, Streltzer and Wade 1981). Todd and collaborators (2000), found, for example, that blacks with extremity fractures were less likely to receive emergency department analgesics than white patients, even with similar records of pain complaints in their medical records and after controlling time of day seen in the emergency room and other factors (Todd et al. 2000).

In studies like those mentioned above, however, it is difficult to know whether these differences are owing to differences in the experience of pain and pain behavior or differences in staff perception and treatment of patients' pain. Several studies have provided clues to the answer to this question, however. Cleeland and colleagues (1997) found that patients seen at centers that predominantly treated minorities were three times more likely than those treated elsewhere to have inadequate pain management according to guideline recommended analgesics (Cleeland et al. 1994). A small study comparing eight European and 14 Asian patients found that Asian patients made 24% fewer demands for analgesia postoperatively and had a smaller mean pethidine consumption compared with European patients (Houghton et al. 1992). This study suggests that Asian patients may actually require and demand less analgesics.

A review of studies concerning opioid requirements and responses in Asians, however, found that unlike findings in earlier studies, recent larger studies of patient-controlled analgesia found a similar usage of opioids postoperatively between Asians and whites (Lee et al. 1997). Ng and colleagues (1996) also found no interethnic differences in amount of patient-controlled analgesia self-administered, but they did find differences in the amount prescribed for postoperative pain among Asian, black, Hispanic, and white patients. even after controlling for age, gender, preoperative use, pain site, and insurance status (Ng et al. 1996). In another study led by Ng, of 250 consecutive patients hospitalized for open reduction and internal fixation of limb fracture, there were significant differences in analgesics prescribed, with whites receiving 22 mg of morphine equivalents per day, Hispanics receiving 13 mg per day, and blacks receiving 6 mg per day, even after controlling for other variables (Ng et al. 1996). There is an obvious need for further research into why we see differences in pain treatment based on ethnicity.

The treatment of a patient may be related to the ethnicity of the clinician. Harrison and colleagues found, for example, that in a sample of 50 hospitalized patients who received care from Arabic and non-Arabic–speaking nurses, only nurses sharing the patients' language gave pain ratings that were statistically significantly correlated with those of the patients (Harrison et al. 1996).

ETHNICITY AND EXPERIMENTAL STUDIES OF PAIN

Ethnicity is used as a term to signify group membership in the medical and public health literature in general, and in the pain literature in particular. Researchers have looked at the relationship between ethnicity and pain tolerance, pain threshold, and pain response, including the feeling of unpleasantness with pain (Bates 1987). The classic studies on pain and group membership described how ethnic standards or norms in terms of appropriate pain behavior influenced the ways in which members perceived, interpreted, and responded to pain (Bates 1987, Zola 1966, Zborowski 1952). However, experimental studies (those conducted in laboratories) have produced inconsistent results when investigating the relationship between ethnicity and pain.

Ethnic Differences in Clinical Studies of Pain

Clinical studies also have reported ethnic differences in pain perception and response. For example, Carragee and colleagues compared patients in two U.S. hospitals with closed femoral shaft fractures treated with intramuscular rod fixation within 1 week of injury with a matched group of patients in three urban hospitals in Vietnam (Carragee et al. 1999). They found that, over a 15-day period, the Vietnamese were given, on average, 0.9 mg of morphine-equivalent units versus the 30.2 mg that was given to patients in the United States (Carragee et al. 1999). Interestingly, only 8% of the Vietnamese patients reported that their pain control had been inadequate, whereas 80% of the American patients did so (Carragee et al. 1999). In addition, Vietnamese patients were more likely to have an accurate impression of how much a femur fracture would hurt prior to the injury than were U.S. patients (76% vs. 4%, respectively) (Carragee et al. 1999).

Similarly, Chaturvedi and colleagues (1997) found that, when they presented a case scenario to a randomly selected group of patients, there were no differences in identifying pain as cardiac in origin between European, Hindu, and Sikh patients, or in perceptions of the need to seek immediate care (Chaturvedi et al. 1997). South Asians, however, tended to be more anxious about pain than Europeans (Chaturvedi et al. 1997). Using a 10-cm visual analog scale (VAS), Faucett and colleagues found that Europeans reported less severe postoperative pain than did black or Latino patients (Faucett et al. 1994). Jordan and colleagues (1998), on the other hand, found no significant difference in pain severity or negative effect when they compared black and white women with arthritis. However, blacks in this study tended to be less active (Jordan et al. 1998). As physical therapists, it may be important to be aware that cultural background may determine the kinds of coping strategies clients use. In the study mentioned above, blacks with rheumatoid arthritis used more coping techniques involving diverting attention and praying and hoping, whereas whites used more coping techniques involving ignoring pain (Jordan et al. 1998).

Studies have found that age, gender, indicators of socioeconomic status, and acculturation may mediate the relationship between ethnic background and pain. For example, Koopman and colleagues (1984) found that only female Italian-American patients seen in an outpatient setting over the age of 60 years tended to report pain more than Anglo patients (Koopman et al. 1984). Ethnicity was not found to be significantly related to emotional distress and requests (Koopman et al. 1984). Similarly, Neumann and Buskila (1998) found significant differences in the perception of pain in female Israeli fibromyalgia patients (70 Sephardic and 30 Ashkenazic women), only among older subjects (Neumann and Buskila 1998). Lipton and Marbach (1984), using a 35-item scale to measure patients' pain experiences, found no significant differences between black, Irish, Italian, Jewish, and Puerto Rican facial pain patients (Lipton and Marbach 1984). However, they did find interethnic differences in emotionality (stoicism vs. expressiveness) in response to pain and how much pain interfered with daily functioning (Lipton and Marbach 1984). In addition, they found that the degree of medical acculturation for black patients, degree of social assimilation for Irish patients, duration of pain for Italian patients, and level of psychological distress for Jewish and Puerto Rican patients mediated the pain responses of these groups (Lipton and Marbach 1984).

USE OF FOLK REMEDIES

We found in the Boston Cancer Pain Education Program that the U.S. medical system was the last resort as a system of care for patients from minority cultures residing in the United States. Their traditional healers and remedies were sought out first and often continued with the delivery of Western medicine. For example, Latinos might have sought the counsel of a *cuerandero* (traditional healer), a black might consult an expert in voodoo, and a Chinese patient might seek an herbalist who specialized in herbal medicine. Our findings are more than echoed in the literature. Risser and Mazur (1995), for example, studied 51 Hispanic caregivers, mostly mothers in a pediatric primary care facility in Houston, and found that cultural beliefs were widely maintained (Risser and Mazur 1995). Folk illnesses treated included *mal ojo* (the evil eye), *empacho* (blocked intestine), *mollera caida* (fallen fontanelle), and *susto* (fright) (Risser and Mazur 1995). Remedies used included both herbs and pharmaceuticals. Teas were most commonly used for colic, upper respiratory tract symptoms, and abdominal pain (Risser and Mazur 1995).

It is important in your work as physical therapists to ask your patients about other sources of help that they may be receiving for their pain. To build and maintain the trust of your patient, for better compliance, and ideally for better health care, the physical therapist should show respect for the patient's culture, traditional healers, and remedies. The importance of cultural sensitivity in the provision of care to patients from cultures other than one's own is brought poignantly home in a book about Lia Lee, a Hmong child with epilepsy, entitled *The Spirit Catches You and You Fall Down*, by Anne Fadiman (Fadiman 1998). Ms. Fadiman, a journalist, spent years talking to and observing Lia's family and her American doctors, and wrote a very readable, heart-wrenching book about Lia's caregivers' challenges in and opportunities for understanding the Hmong culture as Lia moved through diagnosis, episodes of care, and eventually death.

Culture has a vital influence on illness beliefs and behaviors, health care practices, help-seeking activities, and receptivity to medical care interventions (Good et al. 2001, Harwood 1981, Kleinman 1980, Leininger 1991, Meinhart and McCaffery 1983, Spector 1991, Varricchio 1987). Western-trained clinicians will view the medical care system as technologically sophisticated and helpful in the curing process; patients may fear hospitals as places to die and may distrust diagnostic tests as simple as routine blood tests because of their beliefs about blood and the wholeness of the body. Patients may perceive a battery of tests as inadequate attention from the doctor or view treatments as unhelpful because, from their perspective, the root cause of the illness is not being addressed.

ONSET OF CULTURAL INFLUENCES

Culturally mediated response to acute pain has been reported in infants as young as 2 months of age (Rosmus et al. 2000). One well-conducted study measured acculturation in Chinese mothers in Canada by the Suinn-Lew Asian Self-Identity Acculturation (SL-ASIA) scale, pain in their infant by the Neonatal Facial Coding System, and cry expression through fast Fourier transformation of digitized sounds analyzed through CSPEECh, a software package that measured acoustic features (Rosmus et al. 2000). This study found that Chinese babies exhibited greater behavioral reactivity to pain than did Canadian babies of non-Chinese extraction (Rosmus et al. 2000).

Very little work has been done to date to examine the contribution of genes or environment (culture), or both, on the expression of pain. One suggestive study of monozygotic and dizygotic adult twins, however, reported that pressure pain thresholds are strongly related in both types of twins, with monozygotic twins exhibiting only a slightly higher correlation within pairs (MacGregor et al. 1997). With our increasing knowledge of human genetics and the biology of pain, as well as the contribution of social factors to health and illness, future studies have the potential to increase our understanding of pain as a biocultural or biopsychosocial phenomenon.

ETHNICITY, CULTURE, AND CHRONIC PAIN

Although experimental and acute pain has been studied more than chronic pain, the research that has been conducted suggests that cultural factors are also related to the chronic pain experience. Our own work on cancer pain with diverse cultures suggests that cultural background may influence pain expression, pain language, lay remedies for pain, social roles and expectations concerning matters of health, and perceptions of the medical care system (Lasch et al. 2000).

PAIN ASSESSMENT AND MEASUREMENT

You may be asking yourself at this point, *How can we assess or measure a person's pain accurately if his or her cultural background affects the way he or she responds to pain and expresses pain, and even affects the words used to describe pain*? Fortunately for us, researchers have also asked this question and come up with some interesting answers. When the McGill Pain Questionnaire (MPQ) was administered to a group of Hispanics, American-Indians, blacks, and whites, it was found that all cultural groups distinguished pain from ache and hurt, with pain rated as the most intense descriptor (Gaston-Johansson 1990).

In a study validating the Brief Pain Inventory (BPI), the investigators found that the Taiwanese version of the BPI was reliable but only valid for adult patients with high education levels or patients in an early stage of disease. They suggested that the BPI for those patients with low literacy levels needed further study (Ger et al. 1999). The BPI was also validated for Hindi patients, and it was found to be a reliable measure of pain and its impact on cancer patients (Saxena et al. 1999). The authors conclude, however, that this version of the BPI is only validated for Hindi-speaking patients, and that there was a need to validate it in the many other languages spoken in India. In a study of patients treated for cancer pain using graphic rating scales and the MPQ, Greenwald (1991) found no significant differences between ethnic identity and measures of pain sensation, but did find differences in the affective subscales of the MPQ (Greenwald 1991). Most of the patients in this study, however, were fairly acculturated into mainstream American society and did not vary in stage of cancer.

Pain is considered a multidimensional phenomenon, including a sensory component, as well as an emotional and affective reaction to the pain sensation. The English language offers a rich pain vocabulary—for example, *shooting*, *flickering*, *grueling*, and *unbearable* (Harrison 1988). Physical therapists have to rely on the patient's description of their pain to suggest techniques that might help them. Improvement in the patient's condition often depends on a change in the verbal descriptions of the patient's pain.

Because the MPQ captures the multidimensional nature of pain, including sensory, affective, and evaluative pain descriptors, it is widely used in clinical care and research. The MPQ has been found to increase patient satisfaction with the clinical interview and increase the patient's ability to convey the pain they are experiencing and changes they have noticed (Harrison 1988). Finnish, Italian, Spanish, and German versions of the MPQ have been developed using methods to determine the linguistic appropriateness of particular pain terms used in English. However, the words and linguistic structures that individuals use to describe pain vary with cultural background. For example, *punishing* can describe intensity of pain in English but would not be used in Finnish. An ethnographic study of pain descriptors of 25 Chinese and 60 Western subjects (25 Anglo-Americans and 35 Scandinavians) provided the data to use multidimensional scaling techniques (Moore and Dworkin 1988). Overall, this study found that the dimensions of time, intensity, location, quality, cause, and curability were found in all three cultures. Some concepts, however, were found to be culture specific. For example, only the Chinese used the concept *suantong*, which is a multidimensional concept used to describe bone, muscle, joint, tooth, and gingival pain (Moore and Dworkin 1988).

You may remember, from the descriptions of ethnicity, culture, and race, that it is often unclear what some of these differences may actually describe. In a study of 372 chronic pain patients, Bates et al. (1993) used the Ethnicity and Pain Survey (EPS), which attempted to define just what they meant by *cultural background*. The EPS ask for the language and religion in the parent's childhood home; birthplace of the patient, parents, and grandparents; and the patient's primary ethnic group identification. It also measured heritage consistency within their groups by a set of questions eliciting the strength and kind of attachment to one's ethnic group. Most of the study patients had chronic low back pain. The study found that ethnocultural affiliation was associated with the variation in chronic pain perception and response (Bates et al. 1993).

CULTURAL ASSESSMENT

There are differences between and within cultural groups and within groups (Harwood 1981, Kleinman 1983, Lee and Fong 1990, Meinhart and McCaffery 1983, Rowell 1990). Because of diversity both between and within cultures, it is important for the clinician not to make stereotypic judgments based on a person's ethnic heritage. Rather, the clinician should conduct a cultural assessment of the patient, paying attention to inter- and intracultural differences. Using Kleinman's (1980), Lasch's (1988), and Lee and Fong's (1990) tools, Lasch (2000) provided a tool that nurses could use to elicit a patient's health beliefs about

Table 2.1. A Tool to Elicit Health Beliefs about Chronic Pain

What words would you use to describe your pain?
Where do you think this pain came from?
Why do you think it happened when it did? Why do you think it has lasted this long?
Do you think this pain will go away? If it goes away, what will make that happen?
What are the main problems your pain causes for you?
Have you gone to any other healer for this pain? With what remedies did they try to help you? Are you still using what they recommended? Do you still see them?
Who, if anyone, in your family or circle of friends knows about your pain and its treatment? What do they know? What do you want them to know?
How do your family and friends react to your pain? What do they think about it?

pain (Lasch 2000). Given the kind of caring that a physical therapist provides to a patient, the therapist could use Table 2.1 as a guideline.

This set of questions can be asked as you get to know your patient and while you are providing the kinds of therapy that a physical therapist provides. The idea is to know and relate to your patient. For example, suppose you have a Chinese patient with a hand injury that requires ultrasound—that is, providing heat. This patient believes, however, that the pain is caused by a hot condition, and within traditional Chinese medicine, the goal is to balance yin and yang within the body—in this case, hot and cold. Your therapy may seem extremely inappropriate, and the patient may appear resistant to your method. What you may have regarded as noncompliant behavior may stem from a difference in cultures. However, if you are aware of, and attuned to, and respectful of differences, your interactions with the patient will indicate this and be more fruitful for both of you.

WORKING CROSS CULTURALLY

Because of demographic changes, during the 1990s, researchers, physicians, nurses, social workers, and other allied health personnel started writing about delivering culturally sensitive, culturally competent care that is in attunement with the divergent beliefs, norms, and value systems represented in our multicultural population (Weaver 1999, Felder 1996, Chen 1997, Hoskins 1999, National Center for Education in Maternal and Child Health 1998, Steward 1999, Ersek et al. 1998). However, Steward points out that awareness of cultural differences in and of itself is not enough to produce empathic caregiving with patients from cultures other than one's own (Steward 1999). Authors who prefer the concept *cultural competence* are generally referring to acquiring a body of knowledge, a set of skills, and values. Included in these values is the notion that to be professionally competent, a professional must value diversity and understand the dynamics of difference (Weaver 1999). In addition, he or she must be aware of their own values, biases, and beliefs (Weaver 1999).

Others have tended to use the expression *cultural sensitivity* (Lasch 1999, Lasch 2000, Chen 1997). Cultural sensitivity usually includes the dimensions of self-esteem, self-monitoring, open-mindedness, empathy, interaction, involvement, and nonjudgment when patients exhibit behaviors and express values that are different from one's own (Chen 1997). One definition of it is "an individual's ability to develop a positive emotion towards understanding and appreciating cultural differences that promotes an appropriate and effective behavior in intercultural communication" (Chen 1997, 5). This definition includes the idea of the relationship with the patient from another culture. Using the word *attunement* goes even further to emphasize the need to relate to "the other" and to include the five processes that can lead to attunement. These include acknowledging the pain of oppression, as minorities, by definition, are oppressed in the dominant society. It also includes "engaging in acts of humility," "acting with reverence," "engaging in mutuality," and "maintaining a position of 'not knowing' " (Hoskins 1999, 77).

Communication and access to care issues may prevent patients from minority cultures from receiving appropriate preventive and curative care. One black in our Boston Cancer Pain Education Program told us that the first response of a patient from her culture upon entering a health care facility is "discrimination." Consequently, you may have to be especially sensitive to the needs of those who may have had access issues in the past.

It is also extremely important, if at all possible, to choose the appropriate interpreter. Children of patients will often be used, because they speak the language of the patient. However, this can be very inappropriate, depending on the roles and status of different family members in particular cultures. For example, in Latino families, with their hierarchical family structure and machismo, it would be inappropriate for female children to play the role of interpreter. Cultures vary in their members' willingness to disclose a diagnosis of a terminal illness (Mitchell 1998). As a result, children or parents acting as interpreters may not tell the patient what the health care worker is actually saying. Family members acting as interpreters may filter what they tell the health care worker for various reasons, such as embarrassment or not believing the pain is as severe as the patient says it is.

Religious beliefs will affect the appropriateness of care for a given patient. For example, physical therapists may have to take the patient's mode of dress as dictated by one's religion into account when planning exercises or routines. A culture's view of sexuality and privacy is another important factor when working cross culturally. For example a patient with a different sense of what constitutes privacy and how important it is may not come back for physical therapy for a pain in the shoulder if, when the physical therapist works with her, her breasts are revealed. Cultures will vary as to whether members feel comfortable with physical therapists of a different gender.

Being on time for appointments, which seemingly varies by culture, is often the bane of American health caregivers, especially in these days of managed care. In the literature, this is often referred to as *time-orientation*, suggesting that Latino and Italian Americans, for example, tend to have a present-time orientation, making them less goal oriented and hence, less punctual (Migliore 1989), and also wanting to seek immediate relief for pain. In a very important and interesting ethnographic study of Sicilian-Canadians, Migliore (1989) found that the participants in his study were very future oriented for themselves and for their families and hence, he argues, present-time orientation cannot explain being late for appointments. Rather, Migliore suggests that those from a Sicilian background have a different view of punctuality and, depending on other circumstances, will arrive early or late as culturally appropriate. In addition, he suggests that the reality of their waiting room experience may affect their tendency to arrive either early or late. What he is suggesting is that, unlike the rest of us who grumble about waiting room time and the inconvenience of appointments, and have been socialized since early childhood on to arrive at dinner, school, or the clinic at the time set by professional authority, patients from other cultures may not share this mindset. One solution would be to take this into account when scheduling appointments for patients with different frames of reference regarding time.

Increasingly, one can find information and bibliographies that can improve cross-cultural health care. The American Medical Association, for example, through its new Cultural Competence Compendium, in 1999 provided a Web site resource, the Cultural Competence Compendium, to develop a "fifth competence—the ability to provide culturally competent care to our patients" (American Medical Association 1999). The American Society of Pain Management Nurses will soon publish its pain curriculum guide, which includes a chapter on cultural sensitivity. The City of Hope, a well-known cancer center, has a bibliography on culture and pain as part of the Mayday Pain Resource Center (Mayday Pain Resource Center 2001). At the national level, The Office of Minority Health and the Intercultural Cancer Council have been formed to work to improve the health of minority populations in the United States. Each of these has a Web site with information on the health of minorities (Office of Minority Health 2000). The 1996 National Association of Social Workers Code of Ethics dedicates a full section to cultural competence (Weaver 1999). In 1999, President Clinton issued the executive order that established the Interagency Working Group of the White House Initiative on Asian-Americans and Pacific Islanders to direct attention and resources to the health of these populations, including Native Hawaiian community groups (Office of Minority Health 2000).

OTHER FACTORS RELATED TO PAIN AND ITS TREATMENT

Factors such as age, race, gender, occupational status, and other workplace-related variables have also been found to be related to pain, especially back pain. In this section, I briefly mention these factors and only cursorily review studies to give you a glimpse of how much what we do and who we are affect our health, including pain. Because of its prevalence and the high costs associated with its treatment, researchers have looked at the correlates of back pain and back-related disability. Hurwitz and Morgenstern (1997) briefly review some of the major studies that have shown the relationship between back problems and occupational status (Hurwitz and Morgenstern 1997). Individuals in certain occupations, such as truck drivers, material handlers, nurses, nurses' aides, miners, farmers, road workers, customer service representatives, physical therapists, helicopter pilots, unskilled laborers, construction workers, mechanics, repairmen, floorhands, roustabouts, derrickhands, restaurant workers, retail sales workers, light laborers, and health care workers are at greater risk for low back pain and related conditions (Hurwitz and Morgenstern 1997).

Studies have identified specific activities or physical work exposures that may explain why these occupations are riskier. However, psychosocial factors have also been found to be related to increased risk of back problems. These have included factors such as a monotonous job (Heliovaara et al. 1991), race (Deyo and Tsui-Wu 1987), and low job satisfaction (Damkot et al. 1984). Hurwitz and Morgenstern (1997), in their analysis of the 1989 National Health Interview Survey, found those aged 25–74 years, male, non–high school graduates, unemployed, and living in the West, with disabling non-back morbidities and body mass index and weight above the fiftieth percentile to have greater risk of a disabling back condition (Hurwitz and Morgenstern 1997).

CONCLUSION

In this chapter, I have reviewed the rich and varied literature on social factors, emphasizing cultural dimensions that are related to the experience, expression, and management of pain. I have not reviewed the social and economic consequences of chronic pain, but as you may know, they can be devastating. I hope you find information here that will be useful to you in your practice.

Physical therapists can make a world of difference in the improvement of chronic pain problems, but they can only do so if they can attend to and respect the world of their patients. There is a need to treat each chronic pain patient as an individual, because for the most part that pain is the pain of an individual and not a group. I remember the surprise I had in reading Mary-Jo Delvecchio Good's chapter entitled "Work as a Haven from Pain" in a book she coedited, *Pain as Human Experience* (Good et al. 2001). In it, she moves from the conventional view of work as stress that causes or amplifies pain, to a view expressed to her by the chronic pain participants (who happened to be professionals in her study) that work is a place where they could forget that they are in pain. Once again, her results reflect that who we are and what we do is the context for our pain experience.

If there is one thing that I would like you to take with you from this chapter, it is that with all your resources (e.g., literature, interpreters, community-based organizations, Web sites), you need to listen to, hear, and relate to your patients. They may speak in a different voice, they may show their respect to you in different ways, but they are individuals in pain, and they want to share that pain with you so that you can help them. Working with 14 different ethnic groups taught me a lot about my biases, my own culture, and myself. My wish for you is that you meet the challenges and opportunities in working with people whose circumstances and background may differ from yours, and that you enjoy it as much as I have.

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Chapter 3

Pathophysiology of Pain: A Primer

Andrew Sukiennik and Harriët Wittink

Pain is a universal experience of humans and other species of animals, and is consistent with a developed nervous system. Its usefulness is to promote and maintain survival of the organism. In a purely medical context, pain is a clinical sign of disease mandating an investigation into its etiology. After its initial appearance, heralding an abnormal state, its uncontrolled continuance no longer is appropriate to the individual. Most of the time, an organic cause is clearly evident, as in the case of a fractured leg; other times, it is shrouded by a multitude of factors, including the patient's premorbid physical and psychological state, or the inability of a clinician to exercise the scientific method owing to a dearth of clinically verifiable evidence or knowledge about a particular pain state. As scientists continue to explore the mechanisms of pain, many unclear causes of pain are slowly coming into focus. For instance, it has often been seen that some patients with a limb that is sensitive to touch and is swollen and painful may temporarily benefit from sympathetic ganglion blockade with local anesthetics, whereas others with a similar presentation do not. Some clinicians have rightly attributed this to a placebo effect, misdiagnosis, or the patient's psychological state. Recently, researchers showed that with peripheral nerve injury, sympathetic nerve endings grow around the dorsal root ganglia (McLachlan et al. 1993). There is also a change in the phenotype of neurons. A-delta fibers start to produce substance P, they begin to sprout into lamina II of the rat dorsal horns, and there is an increase in $\alpha 2$ adrenergic receptors on these fibers (Binder 1999, Woolf et al. 1992). The increased presence of noradrenaline-containing nerve endings around these ganglia is intriguing, suggesting a role in producing (under certain conditions) human complex regional pain syndromes. It is quite plausible that after a sympathetic nerve block with local anesthetics, and a resultant decrease in sympathetic fiber release of norepinephrine to the sensory ganglia, sensory axonal activity to the posterior horns may be lessened. If this is the case, spinal cells (wide dynamic-range neurons) responsible, in part, for maintaining chronic pain states might return to their normal state.

Whatever the etiology of pain and suffering, an earnest attempt to treat it should be made, just as one would treat any other perturbation in a patient's physiology and psyche. The cost to society of not treating pain correctly is staggering. A study conducted by Louis Harris discovered that American industry loses an estimated $17 billion a year for sick days taken owing to pain (Harris 1996). John Bonica (1990) estimated that in terms of lost productivity and the treatment of pain, the economic cost to society alone is in the order of 400 billion dollars. Unfortunately, the relationship between the science and art of pain management, and the financial support provided it, is discordant.

The intent of this chapter is to provide the practitioner with an overview of the basic and clinical science of pain physiology. We, like many of you, struggle with the data (or lack thereof) in an attempt to make some sense as to why people hurt, and whether we do them any justice with our care and therapy. To this end, major neural pain pathways are discussed with occasional side comments stressing new developments, clinical implications, and our own prejudices. It is a brief summary at best, and information is left out for the sake of brevity, but it serves as a starting point for continued study of the subject.

DEFINITION OF PAIN

A task force of the International Association for the Study of Pain (Merskey and Bogduk 1994) describes *pain* as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage." Clearly, pain, by the above definition, is a perception, and therapeutic interventions need to be tempered by this fact.

PHYSIOLOGY OF PAIN

It is useful to conceptualize pain as Fields (1990) does, as transduction of a "painful" stimulus that is transmitted to the spinal cord and to higher centers, where it is processed, modified, and eventually perceived by the mind and brain.

There are two major categories of pain: *nociceptive* and *neuropathic*. Although somewhat arbitrary, they afford the practitioner with a general schema for evaluation. *Nociceptive* (Latin; *noceo*, to hurt, injure) pain occurs when peripheral end organs of axons, known as *nociceptors*, are stimulated. When a stimulus is repeated, nociceptors exhibit *sensitization*, in that there can be a reduction in the threshold for activation, an increase in the response to a given stimulus, or the appearance of spontaneous activity, all of which promote pain. *Hyperalgesia* refers to an extreme response to painful stimuli and can be static or dynamic in its behavior. *Allodynia* is a painful response to an innocuous stimulus, such as simply stroking the skin with a feather.

Peripheral Mechanisms of Nociceptive Pain and Inflammation

When C and A-delta fiber nociceptors, acting as signal transducers, are stimulated by noxious stimuli, such as distension of a viscus (mechanoreceptors), burns (thermal receptors), algogens (like bradykinin or histamine), or substance P (tachykinin), to mention a few, a depolarization, or transduction of a stimulus, occurs (Bessou and Perl 1969, Burgess and Perl 1967). Some receptors, which are silent, respond weakly to a stimulus (feline bladder distension) until the right conditions occur, such as an inflammatory state (Habler et al. 1990). Other receptors, called *polymodal receptors*, respond in a graded manner and to a variety of stimuli. These receptors are vital to normal tissue function, but they may also promote chronic pain (Kumazawa 1996).

Stimulation of A-delta fibers, which are myelinated and faster conducting, results in pain perceived to be sharp, stabbing, and well localized. Second pain, transmitted by slower-conducting unmyelinated C fibers, is less well localized and perceived as a burning and aching sensation. Another major type of receptor, known as a *polymodal nociceptor*, reacts to a wide range of stimuli and in graded fashion.

Axons of these nociceptors originate from neuronal cell bodies within *spinal ganglia*. These ganglia are embryonically developed from the neuroectoderm, situated between the neural tube (future spinal cord) and the surface ectoderm (Moore 1982). There are 31 pairs of ganglia, and each ganglia contains thousands of neurons, on average. Each neuron may send one or more axons to the periphery and is responsible for their respective receptive fields (Willis 1985). It is well known that there are excitatory amino acids, such as glutamate and neuropeptides (substance P), that are secreted at the postsynaptic cleft in the spinal cord by primary afferent neurons, but there are also neuropeptides secreted antidromically (away from the spinal cord, toward the periphery), which are involved with pain and inflammation in the periphery (Battaglia and Rustioni 1988, Daemen et al.1998). Factors released from small-caliber nerve fibers, including peptides such as substance P and calcitonin gene-related polypeptide, also appear to play important roles in the generation of the inflammatory response. Several of these substances activate free nerve endings and may contribute to the long-lasting hyperalgesia that usually accompanies an intense stimulus. For instance, nerve growth factor, up-regulated by the process of inflammation, increases the excitability of nociceptors, which leads to hyperalgesia (McMahon and Bennett 1997).

In general, a noxious stimulus applied to normal skin will elicit a *triple response*, consisting of a red flush at the site of stimulation, a surrounding red flare due to arterial dilation, and local edema due to increased vascular permeability (Lewis 1942). Many factors contribute to this inflammatory response. Damaged tissue itself activates the arachidonic cascade, resulting in local release of a variety of inflammatory mediators, including prostaglandins and leukotrienes, which can directly activate nociceptive fibers. Increased vascular permeability at the site of injury results in extravasation of plasma proteins and fluid (local edema), as well as cellular components such as mast cells, which result in activation of kinin pathways, with local formation of bradykinin, histamine, and 5-hydroxytryptamine. Bradykinin strongly excites polymodal nociceptors (Kumazawa et al. 1996). *Throbbing*, *aching*, and *gnawing* are some of the adjectives used to describe nociceptive pain.

Acute nociceptive pain is usually easily treated with opioids and anti-inflammatory agents, such as ibuprofen and corticosteroids. Techniques that also may be of benefit include those that promote reduction of local pain (e.g., local anesthetics and ice), and those that promote increased blood flow to remove algogens and supply tissues with factors that promote healing.

Joint and Muscle Pain—Examples of Nociceptive Pain

Important to and frequently encountered by physical therapists are arthralgias and muscle pain syndromes. Articular tissues are innervated by nociceptive afferents as well as by large-diameter, fast-conducting primary afferents. The latter are associated with low-threshold receptors that respond to non-noxious mechanical stimuli or movements. Many of the group III and IV primary afferents, and perhaps some group II afferents, are involved in responses to noxious stimulation of articular and other musculoskeletal tissues. These afferents, which can be activated by chemical and mechanical stimuli, terminate in the peripheral tissues as free nerve endings and encode a nociceptive stimulus. Recent studies have shown that some of these afferents may respond instead to low-threshold, non-noxious mechanical distortion of articular tissues (Schaible and Grubb 1993).

The term *sensitization* refers to a situation in which the activation threshold of the afferents is lowered by the application of substances, such as bradykinin or prostaglandins. An enhancement of articular afferent activity has also been shown in animals with experimentally induced arthritis: Articular afferents become responsive to gentle, innocuous movements or develop an increased resting discharge. The period of the increased excitability of the nociceptive afferents corresponds closely with the onset and duration of pain behavior and hyperalgesia in these animals. In addition to the enhanced responsiveness of nociceptive afferents, the experimental arthritis appears to be associated with mechanosensitivity in afferents previously unresponsive to joint movement or local stimulation, and with an enhanced response of some low-threshold, non-nociceptive afferents. These various features of the responses of articular afferents point to peripheral mechanisms that may contribute to our ability to code the intensity of articular pain, to the hyperalgesia and allodynia that can occur in a traumatized or inflamed joint, and to the spontaneous and movement-related pain that is commonly seen in a damaged or inflamed joint (Sessle and Hu 1991).

Muscle Pain

Small-diameter afferent (sensory) fibers have to be activated to elicit pain from muscle. These fibers are either thin myelinated (A-delta or group III fibers) or unmyelinated (C or group IV) fibers. Group IV fibers are thought to terminate exclusively in free nerve endings, whereas group III fibers supply both free nerve endings and other types of muscle receptors. Free nerve endings in skeletal muscle (which include all nociceptors) typically end in the adventitia surrounding arterioles. The marked sensitivity of the free nerve endings to chemical stimuli, particularly those accompanying disturbances of microcirculation, may be related to their location on or in the walls of the blood vessels (Mense and Simons 2001b). Muscle fibers proper are not supplied with free nerve endings, which may explain the clinical experience that muscle cell death (e.g., muscular dystrophy) usually is not painful (Mense 2001). Muscle nociceptors are activated by chemical stimuli of algesic substances, such as bradykinin, prostaglandins, serotonin, and high concentrations of potassium ions, which may or may not result in sensitization. Nociceptors may exhibit a preferential sensitization to mechanical stimuli, such as stretches, contractions, or both. Innocuous stimuli could, under an inflammatory state, become painful. This may explain the local tenderness and pain on movement seen with inflamed muscle.

Ergoreceptors (Kniffki et al. 1981) are non-nociceptive group III and IV receptors that respond vigorously during active contractions and show an almost linear characteristic between muscle force and discharge rate (Kaufman et al. 1983). They are supposed to mediate respiratory and circulatory adjustments during physical work. Whether the ergoreceptors have a nociceptive function is unknown, but they appear to play a role in activating the pain inhibiting the descending system (Lundeberg 1995).

Causes for local muscle pain include trauma (a blow to the muscle, a muscle tear, local hematoma due to anticoagulation therapy, or other iatrogenic causes), ischemia, metabolic muscle diseases, and postexercise soreness. Postexercise soreness is associated with disruption of the myofibrillar structure caused by mechanical overload, resulting in local inflammation of muscle. Lactic acid was shown to be ineffective as a stimulant for muscle nociceptors; therefore, accumulation of lactic acid does not appear to play a role in postexercise soreness (Kniffki et al. 1981).

At forces of 20–30% of maximum voluntary contraction, the blood flow is increased during the activity and increased further immediately after the end of the contraction, apparently indicating a "blood flow debt." At forces exceeding 30% of maximum voluntary contraction, there is a decrease in blood flow, and at 70% of maximum voluntary contraction, the blood flow is completely interrupted (Astrand and Rodahl 1986). Hypoxia, or a drop in oxygen tension, results in increased discharge of muscle nociceptors, much like an inflammatory process, and is considered a sensitizing factor for nociceptors (Mense 2001).

One widely held belief is the *pain-spasm-pain* cycle. This belief holds that pain increases the motor neuron activity that is responsible for spasm, and spasm causes more pain. However, there is good evidence that pain inhibits muscle electromyographic (EMG) activity (Wang et al. 2000, Sohn et al. 2000, Zedka et al. 1999, Rossi and Decchi 1997, Graven-Nielsen et al. 1997). Graven-Nielsen et al. (1997) performed an experimental pain study in which they found that muscle pain significantly decreased EMG activity in static and dynamic contractions. In dynamic contractions, the EMG activity of the (painful) agonistic muscle was reduced, and a significant increase in muscle activity of the antagonistic muscle was seen. The authors concluded that muscle pain seems to cause a general protection of painful muscles during both static and dynamic contractions. The increased EMG activity of the muscle antagonistic to the painful muscle is probably a functional adaptation of muscle coordination to limit movements. Modulation of muscle activity by muscle pain could be controlled via inhibition of muscles agonistic to the movement, or by excitation of muscles antagonistic to the movement, or both. Their findings were in agreement with the pain-adaptation model put forth by Lund et al. (1991). They postulate that changes seen in motor activity (inhibition of the agonist and facilitation of the antagonist) from pain result in a reduction of force production, as well as the range and velocity of movement of the affected body part. They further suggest that this is a normal protective adaptation and not a cause of pain.

One theory regarding the etiologies of myofascial pain syndromes is that they belong to a group of muscle disorders characterized by the presence of hypersensitive points, called *trigger points* (TPs) (Travell and Simons 1983). TPs may be the result of muscle weakness, muscle imbalance, trauma, stress, and visceral pathology. These points occur within one or more muscles, the investing connective tissue, or both. They are associated with a syndrome of pain, muscle spasm, tenderness, stiffness, limitation of motion, weakness, and, occasionally, autonomic dysfunction (Sola and Bonica 1990). A TP is so named because its stimulation produces effects at another place, called the *area of reference*. TPs can develop in any muscle in the body and can be active or latent. An active TP is associated with spontaneous pain at rest or with motion that stretches or overloads the muscle. A latent TP does not cause spontaneous pain but can be diagnosed by applying discrete pressure on the TP that is likely to refer pain locally and to the area of ref-

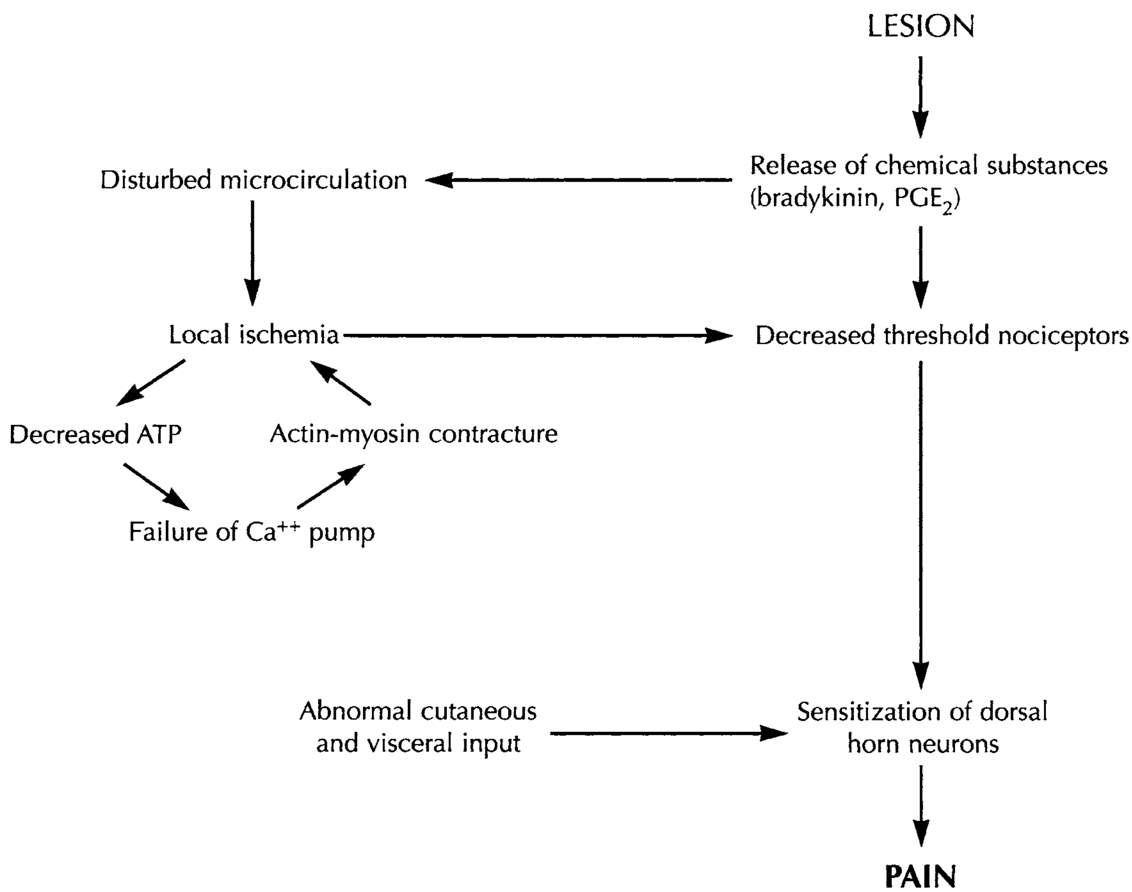


Figure 3.1. Model of myofascial pain generation. (ATP = adenosine triphosphate; PGE_2 = prostaglandin E.)

erence. It is still unclear exactly what TPs are, how they become hypersensitive, and how they produce pain. A hypothesis is outlined in Figure 3.1.

Neuropathic Pain

Described by patients as *shooting*, *burning*, *lancinating*, and *electrical*, the etiologies of neuropathic pain are better understood today than in the earlier part of the twentieth century. With a more sophisticated appreciation of neuropathology and pharmacology, many new drugs and techniques have appeared or are in development to combat suffering from these disorders.

Pharmacologic treatment traditionally relied on anticonvulsants, antidepressants, local anesthetics, gabanergic drugs, and opioids—often in combination. Newer therapies introduce α-adrenergic agonists, calcium and sodium channel antagonists, and amino acid receptor antagonists, which also appear to be important adjuncts to fight this type of pain. Modulation, rather than destruction, of the nervous system seems to be the preferred way to treat neuropathic pain. Neurosurgical procedures, such as spinal column or deep brain stimulation, subarachnoid infusions of medication, and a few destructive techniques, such as dorsal root entry zone, have also been successful in some cases. Neurodestructive injection techniques are mostly reserved for patients with a limited life expectancy. Injection techniques, such as epidural steroid injections, have been used to treat radiculopathy from acute disk herniations.

Neuropathic pain is categorized by location. Peripheral injury to nerves can be associated with

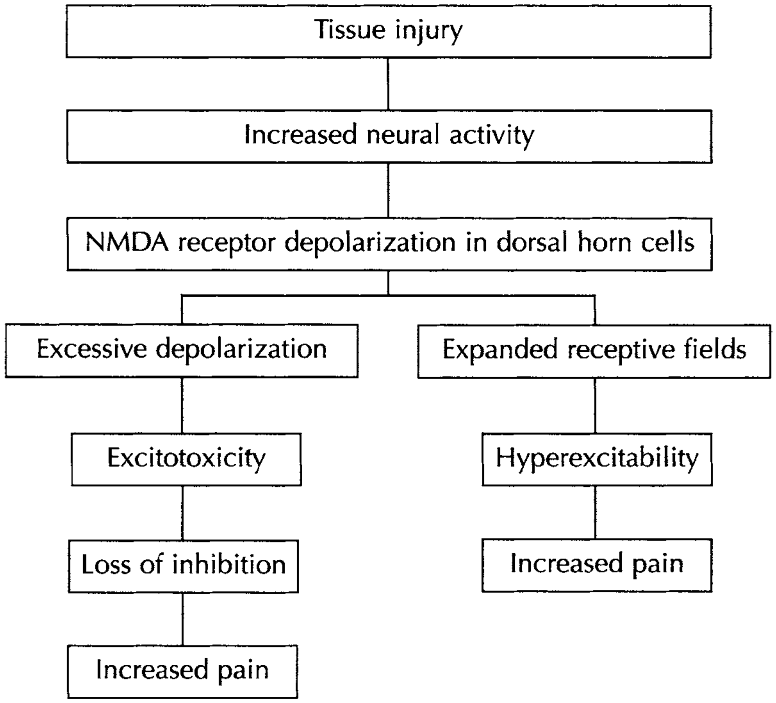


Figure 3.2. Potential series of events in central sensitization after peripheral activation. (NMDA = *N*-methyl-D-aspartate.)

trauma, infection, vascular disease, metabolic and endocrine diseases, paraneoplastic syndromes, and side effects of medication.

Pain Due to Peripheral Nerve Injury

Acute injury to peripheral nerve rarely produces clinical pain, as cutting or compressing the trunk of an undamaged nerve produces only a brief discharge in the severed axons (Bennett 1993). Within a few days after trauma to a peripheral nerve, however, burning pain and mechanical sensitivity can develop at the site of injury; the injury to the nerve is associated with paresthesias in the distribution of the affected nerve. The regenerating tip of a cut peripheral nerve contains numerous small-diameter sprouts that develop the capacity to discharge spontaneously or with subtle stimuli, possibly caused by increased ionic permeability in the sprout. If the path for regeneration is blocked, a neuroma forms. Sprouts within a neuroma are sensitive to mechanical stimulation (Tinel's sign). Another form of sprouting may occur when a completely denervated area receives collateral innervation from neighboring intact primary afferents (*collateral sprouting*). Animal experiments demonstrate allodynia and hyperalgesia to mechanical stimuli in skin innervated by collateral sprouts (Vallin and Kingery 1991). Similar changes may also occur with chronic compression of nerve in the absence of actual transection. The abnormal activity in such chronically damaged axons is a potential source of clinical pain after nerve injury. Neuropathic pain clinically manifests as an intense electrical, shooting, and searing pain and is associated with abnormal tactile and thermal responses that may be extraterritorial to the injured nerve. Tactile allodynia is likely to be mediated by A-delta fibers and is not susceptible to modulation by spinal opioids, whereas thermal hyperalgesia is mediated by C fibers and is sensitive to blockade by spinal opioids (Ossipov et al. 2000). Deafferentation pain mechanisms are associated with this phenomenon. *Deafferentation* refers to the cessation of normal peripheral input from the periphery due to a crush injury or severance of peripheral nerve and results in the spontaneous firing of dorsal horn neurons (Figure 3.2).

Additionally, peripheral neuropathic pain can occur when the *nervi nervorum* (small nerves to larger nerve sheaths) are activated, as seen in carpal tunnel syndrome or when an injured nerve sprouts (Bove and Light 1995). Tumor necrosis factor, released by macrophages that migrate to an inflamed area, can also increase discharge of nociceptors (Sommer et al. 1998).

As stated earlier, injury of a peripheral nerve may be associated with increased amount of neuronal sodium channels and sprouting of sympathetic fibers around these neurons.

Ochoa and Yarnitsky (1994) identified conditions in which the nociceptors themselves are dysfunctional and elicit similar clinical presentations associated with "sympathetically mediated pain," yet have nothing to do with sympathetic activity (see below).

CENTRAL MECHANISMS OF PAIN

As described in their seminal work on the gate control theory in 1965, loss of input from large myelinated axons to the spinal cord can exacerbate pain. Stimulation of these axons, as with transcutaneous electrical nerve stimulation (TENS), actually decreases pain. This highlights an important point: Central neuronal disease, whether it occurs in the spinal cord or brain, destroys the normal projections and input to the central nervous system (CNS), and, secondarily, creates CNS reorganization that may be responsible for central wind-up and reorganization (see below).

Posterior root ganglia and their respective axons synapse in the posterior horns of the spinal cord, with second order neurons in posterior horn laminae identified by light microscopy in the 1950s by Rexed (1952). Laminae I–V are most involved in pain signal processing or modulation, although connections to deeper laminae are also seen and seem to be more complex (Figure 3.3) (LaMotte et al. 1990, Willis and Coggeshall 1991).

Axons of the superficial layer of the dorsal horns, also known as *Lissauer's tract*, or the *marginal layer*, travel rostrally and caudally for several segments before they penetrate dorsal horn gray matter. Many of these fibers (including many sensory fibers from skin and muscle) project intersegmentally and to the thalamus. Laminae II and III are known as the *substantia gelatinosa*, with a large amount of synapses with A-delta and C fibers, many of which input thermal and mechanical stimuli. There also is an abundance of opioid receptors at this level.

The *nucleus proprius*, laminae IV–V, contain many A-delta and low-threshold A- and C-fiber synapses with wide dynamic range (WDR) neurons. When stimulated at the right frequency and intensity, these neurons (linked to chronic pain states) begin to depolarize (at supernormal amplitudes and at subthreshold stimulation), exhibit automaticity, and recruit neighboring neurons in their activity. This condition is known as *wind-up*. Fibers from muscle and other deep tissues have been found to form presynaptic terminals, mainly in laminae I, IV, and V (i.e., in the same laminae where the nociceptive dorsal horn cells are located).

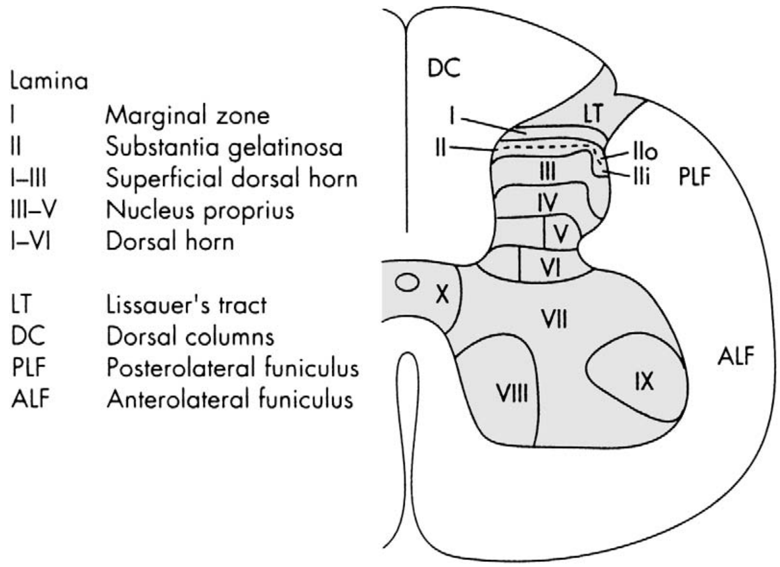
Lamina X, which is adjacent to the central canal, receives input from afferents with small receptive fields and nociceptors, which respond to high-threshold temperatures.

Spinal Cord Connections

Cell Types

There are two main types of nociceptive cells seen in the spinal cord: *nociceptive specific* and *WDR neurons*. There is also an abundance of opioid receptors in the more superficial laminae, rich in C-fiber synapses. Nociceptive-specific neurons have well-localized receptive fields to include skin and muscle. They usually respond to high-threshold stimulation and to a specific type of stimulus, although some may respond to one or more types of stimuli, such as heat and mechanical stimulation.

WDR neurons are predominantly found in deeper laminae (V–X). These cells respond to a wide variety of stimuli, can respond to low- and high-threshold stimuli from A-delta and C fibers, and are somatotopically arranged to involve other anatomically separate and distinct areas (visceral with somatic). The above qualities of these neurons, together with their complex somatotopic neural connections with other neurons, allow for *stimulus convergence*, or what clinicians signify as referred pain and wind-up.



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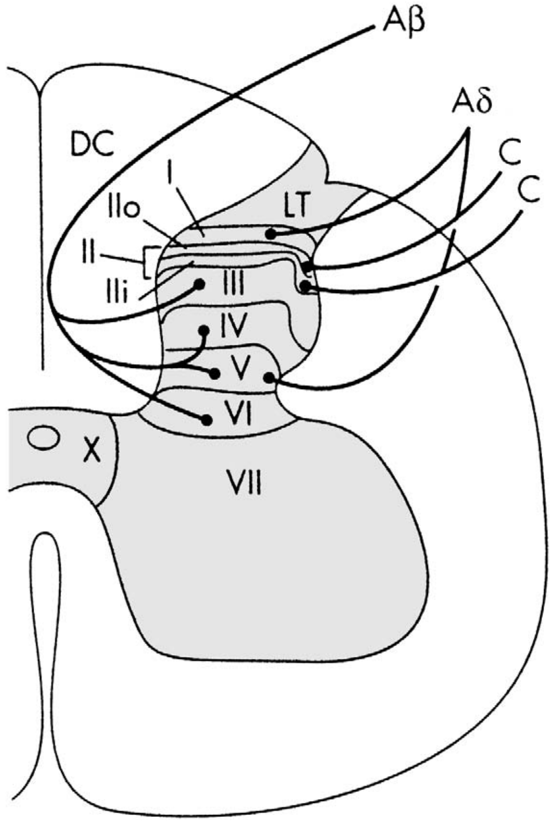


B

Figure 3.3. A. Rexed lamination. The schematic illustrates the organization of the spinal gray matter in the lumbar enlargement. The principal anatomic subdivisions correspond to the more detailed lamination patterns defined by Rexed (1952). Marginal zone: lamina I; substantia gelatinosa: lamina II, which is further divided into II outer (IIo) and II inner (IIi); nucleus proprius: laminae III to V; motor horn: laminae VII to IX; and the central canal is surrounded by lamina X. The majority of descending bulbospinal modulatory pathways travel in the posterolateral funiculus (PLF), whereas axons of the more prominent ascending projection systems are in the anterolateral funiculus (ALF). Finely myelinated and unmyelinated fibers ascend and descend in Lissauer's tract (LT). **B.** Pattern of afferent fiber projection into the dorsal horn. Schematic displaying organization and specific laminar terminations of cutaneous afferent A-beta, A-delta, and C fibers. (Adapted from SE Abram [ed], Mechanism of Pain Processing: Pain Management. Vol 6. Atlas of Anesthesia. Philadelphia: Churchill Livingstone, 1998.)

Stimulus Convergence or Referred Pain

Many of the dorsal horn neurons with muscle input have additional input from other sources, such as cutaneous and other deep receptors. Many of these convergent cells can be excited by mechanical stimulation of small areas of both skin and muscle (i.e., they exhibit multiple separate receptive fields in the skin and deep tissues). In contrast to cutaneous nociception, which is partly mediated by nociceptors in the skin, nociception from muscle and viscera seems to operate without dorsal horn cells that are exclusively driven by muscle and visceral nociceptors. The extensive convergence at the level of the spinal neurons is one possible explanation for the poorly localized nature of muscle and other forms of deep pain. Input convergence at the spinal level is considered to be the chief neuroanatomic basis for pain referral and is essentially a mislocalization of pain (Mense and Simons 2001a). One example of input convergence was shown by Stohler et al. (2001), who demonstrated that muscle pain resulted in reduced cutaneous threshold–level mechanosensitivity at the site of pain.

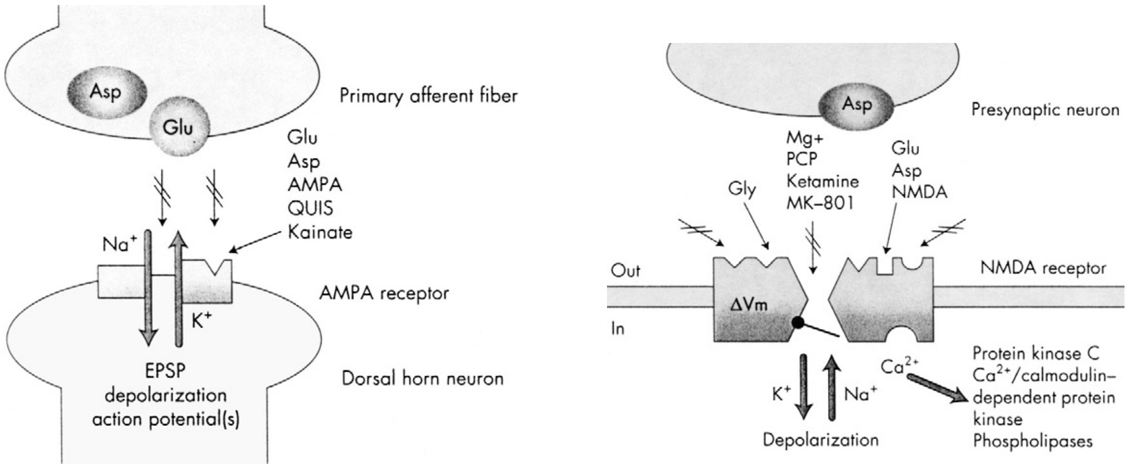
Wind-Up

Wind-up may occur in some WDR neurons that have C-fiber input that is greater than 0.33 Hz, as typically can occur after an operation. These cells become "wound-up" and fire automatically, with a greater level of amplitude, and spread their receptive fields involving other neurons (Mendell 1996). For some unknown reasons, input via muscle C fibers is more effective than cutaneous input in inducing prolonged changes in neuronal behavior (Mense 1993, Wall and Woolf 1984). Some researchers have observed actual spinal cell injury and death during a barrage of intense and painful stimuli in animals (Sugimoto et al. 1990). It is thought that the facilitation of wind-up is due to neurokinin and excitatory amino acid release. In particular, blockade of "second" pain due to wind-up is facilitated by the use of *N*-Methyl-D-Aspartate (NMDA) receptor antagonists (Price et al. 1994). Dextromethorphan (sold over the counter as Delsym, a cough suppressant), amantadine, and ketamine (which blocks the NMDA receptor) are examples of medications currently available to reduce wind-up. The NMDA receptor is one of three currently known glutamate receptors. The amino acid glutamate is the principal neurotransmitter of primary afferents (Kandel et al. 1991). When glutamate is released from these primary afferent axon terminals across the synaptic cleft, it binds to second-order neurons in the dorsal horns. This causes rapid depolarization of these neurons by an influx of sodium into the cell. A cumulative depolarization produced by nociceptive-evoked slow synaptic potentials leads to suppression of the magnesium blockade of NMDA channels, thereby allowing calcium to enter the cytoplasm. When this occurs, phosphorylation of calcium-dependent protein kinases accelerates (Baranauskas and Nistri 1998) (Figure 3.4).

Phosphorylation is a powerful cellular mechanism to effect cellular regulation (Nestler et al. 1994). After activation of several kinases by the influx of calcium, protein kinase C (PKC) translocates the nucleus and messenger RNA, and proteins are translated to ultimately produce sensitization and wind-up (Coderre 1992). Such activity is heralded by the appearance of proto-oncogenes c-fos and c-jun. Simultaneously, arginine is converted to nitric oxide (NO) that diffuses out of the cell to surrounding neurons, initiating increased levels of cyclic adenosine monophosphate linked to hyperalgesia in the periphery (Aley et al. 1998). In addition, protein kinase C-delta appears to be the final step in neuropathic pain. Knockout mice who do not have the gene to produce this enzyme do not seem to develop much neuropathic pain behavior, yet still respond to nociception (Malmberg et al. 1997). It should be mentioned that input from the peripheral and bulbospinal pathways input can also inhibit wind-up when pain occurs.

The requirement for high-frequency afferent input and NMDA receptor activation is like that of long-term potentiation in hippocampal neurons. Long-term potentiation represents a neuroplastic change that is characterized by a long-lasting, high-frequency increase in neuronal excitability after a short burst of high-frequency input. Long-term potentiation is thought to be an important component in learning processes.

Nerve injury results in a delayed loss in sensory neurons, an effect that is more prominent for C- than for A-fiber neurons (Coggeshall et al. 1997). In addition, there is a central organization of A fibers, which sprout from their deep dorsal horn laminar location up to that part of the spinal cord where C fibers nor-



A **B**

Figure 3.4. Postsynaptic actions of excitatory amino acid (EAA) agonists. **A.** The α-amino-3-hydroxy-5-methylisozole-4-proprionic acid/kainate receptor is thought to be postsynaptic to the primary afferent fiber, as well as located throughout the nervous system. Release of EAA is followed by receptor binding and opening of an ion channel, leading to depolarization. Antagonism can be at the binding site or via channel blockade. **B.** The *N*-methyl-D-aspartate receptor complex is not postsynaptic to primary afferent fibers and is necessary for spinal sensitizations (enhanced responsivity). This receptor is only activated if the membrane is already depolarized (voltage sensitive). This can be accomplished by prior activation of α-amino-3-hydroxy-5-methylisozole-4-proprionic acid or substance P receptors. The EAA agonist must bind to its receptor, and glycine must also act on a second binding site within the complex. This glycine site is not sensitive to strychnine. Activation of the complex allows Na^+ influx, leading to depolarization. In addition, there is an influx of Ca^{2+}. Increased intracellular Ca^{2+} can activate a variety of second messengers, leading to plasticity and long-term changes. (AMPA = α-amino-3-hydroxy-5-methylisozole-4-proprionic acid; Asp = aspartate; EPSP = excitatory postsynaptic potential; Glu = glutamate; Gly = glycine; NMDA = *N*-methyl-D-aspartate; PCP = phencyclidine; QUIS = quisqualate; ΔVm = change in membrane voltage.) (Reprinted with permission from SE Abram [ed], Mechanism of Pain Processing: Pain Management. Vol 6. Atlas of Anesthesia. Philadelphia: Churchill Livingstone, 1998.)

mally terminate and make functional synaptic contacts (Woolf et al. 1992). This mechanism is thought to underlie allodynia. In clinical practice, the use of TENS to reduce pain is based on the assumption that loss of peripheral inhibitory control after injury to primary afferent fibers is in some fashion replaced by TENS (Willis 1984). With regard to bulbospinal descending inhibitory control, the use of tricyclic antidepressants to treat a variety of neuropathic and musculoskeletal conditions is well documented. It is thought that one of the major effects of antidepressant medication is its ability to increase synaptic concentrations of serotonins and norepinephrine, which can act as membrane stabilizers, thereby reducing the magnitude of depolarization. In contradistinction to inhibition, under the right circumstances, the bulbospinal pathway may also facilitate nociception. Neuropeptides like neurotensin (at the rostral ventromedial medulla [RVM]) and cholecystokinin (in the spinal cord) are mediators (Urban and Gebhart 1997). Inhibition involves descending neural systems that secrete norepinephrine and acetylcholine at the level of the dorsal horns.

Ascending Tracts or Supraspinal Levels

Nociceptive input from A-delta and C fibers synapse with second-order neurons, which, either directly or by additional synapses, cross over a few segments higher and travel in the *lateral spinothalamic tract,* but additional tracts also exist. The spinothalamic tract can be functionally divided into two parts: (1) the direct system, which travels directly to the thalamus, where it ends up in a topographic fashion in the ventral posterolateral nucleus (VPL) (Figures 3.5 and 3.6) and (2) the spinoreticulothalamic tract.

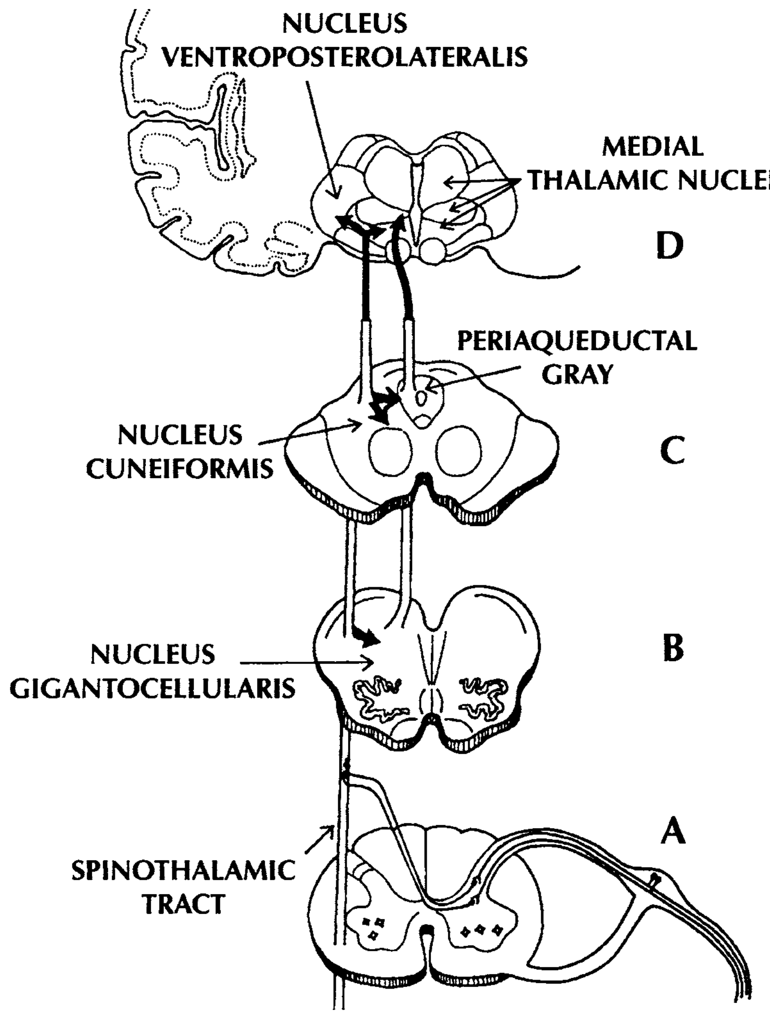


Figure 3.5. Ascending pain pathways. **A.** Dorsal horn. **B.** Brain stem. **C.** Midbrain. **D.** Thalamus.

Within the VPL, spinothalamic afferents terminate in a somatotopic fashion, which overlaps the major terminal field of the lemniscal system that relays light touch and joint sensation. This suggests the VPL may be involved in the sensory-discriminative function of pain sensation, as well as coding for the location, nature, and intensity of pain. This is supported by the fact that cells in the VPL project principally to the somatosensory cortex.

The other system, the *spinoreticulothalamic tract* (deriving most of its fibers from lamina I) terminates heavily in the brain stem (reticular systems), including the nucleus gigantocellularis and the periaqueductal central gray (PAG). More rostrally, it terminates in the hypothalamus, the intralaminar complex and posterior group nuclei of the thalamus. Here, there is no topographic organization, and because these sites have projections to the frontal lobe and limbic neocortex, this system is thought to be responsible for the affective response to pain, general arousal, and autonomic system activation.

Many of the slowly conducting muscle afferents, including the nociceptive ones, project to the subnucleus caudalis and interpolaris of the trigeminal spinal tract nucleus. There is extensive convergence at these sites, including masticatory muscles, temporomandibular joint, facial or intraoral skin, and cervical viscera. The extensive convergence and large receptor field size in the subnucleus caudalis have been considered the neurophysiologic basis of the diffuse nature and referral that are typ-

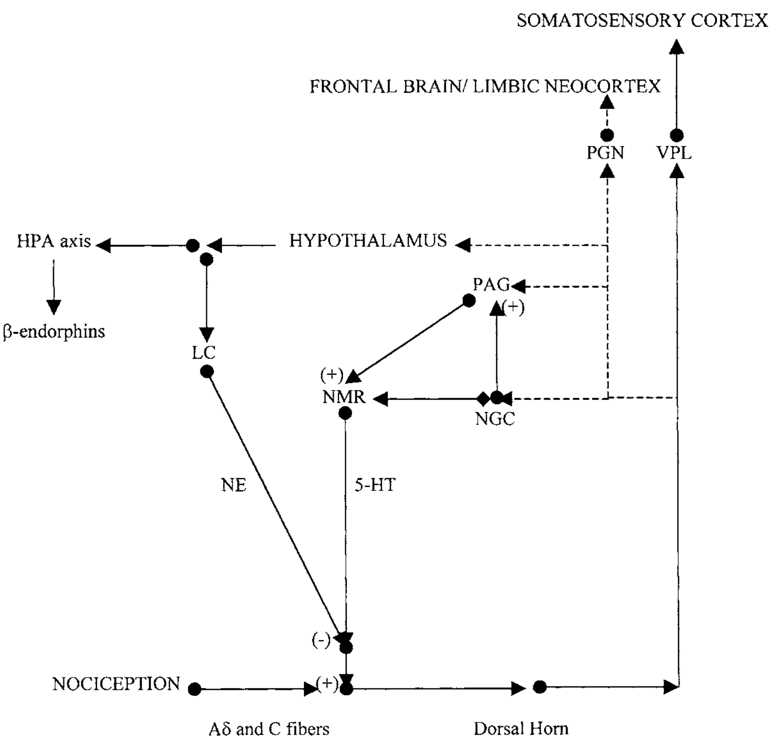


Figure 3.6. Diagram of ascending and descending pain pathways. (5-HT = serotonin; LC = locus ceruleus; NE = norepinephrine; NGC = nucleus gigantocellularis; NMR= nucleus raphe ragnus; PAG = periaqueductal gray; PGN = posterior group nuclei thalamus; VPL = ventro posterior lateral nucleus thalamus; – = inhibition; + = excitation. Ascending systems: ⟶ = spinothalamic tract; - -▶ = spinoreticulothalamic tract.)

ical features of craniofacial and temporomandibular joint pain (Mense and Simons 2001a).

Nociceptive input to the reticular activating system, which is involved in awareness and behavioral activities, can explain why patients in pain cannot sleep. The nociceptive input to the reticular activating system also explains why a patient may be on high doses of opioids for severe pain, yet remain awake without respiratory depression. In cases in which local anesthetic neural blockade or neurosurgical procedures have been performed on opioid-tolerant patients with severe pain, the opioid dose must be reduced to prevent opioid-induced apnea after the painful stimulus is reduced or eliminated.

Novel techniques of positron emission tomography and functional magnetic resonance imaging now allow us to investigate blood flow and metabolism of the brain in both experimental pain conditions and in patients with chronic pain.

The neuroplasticity of the brain has best been shown in patients with amputations (Flor et al. 1995, Borsook et al. 1998, Ramachandran et al. 1999, Grusser et al. 2001) and patients with repetitive strain injury (Lenz and Byl 1999, Byl et al. 1996, 1997). For instance, Ramachandran and Rogers-Ramachandran (2000) refer to cortical reorganization after deafferentation as the *remapping hypothesis*. They tested 18 patients with either arm amputation or brachial avulsion and found that eight patients systematically referred sensation from the face to the phantom limb. In many of the patients, there was a topographically organized map of the hand on the lower face region. Because the hand area in the Penfield map is flanked on one side by the upper arm and on the other side by the face, this is precisely the arrangement of points that one would expect if the afferents from the upper arm, skin, and face were to invade the hand territory from either side.

Using a mirror to "trick the brain" into believing their amputated hand was visible and moving, patients were able to feel movements emerging from their phantom limb. Some were able to unclench a painfully clenched phantom hand (Ramachandran and Rogers-Ramachandran 1996). Byl and McKenzie (2000) used a similar technique for the treatment of repetitive strain injury. McCabe et al. (2000) reported on a "phantom sensation of swelling" in patients with rheumatoid arthritis (i.e., the patient complains of swelling but there is no objective evidence of such). In rheumatoid arthritis, fine nociceptive nerves in the superficial synovial structures are absent. The authors proposed that this deafferentation of the joint makes it susceptible to phantom responses. The pain and swelling were reportedly reduced by repetitive visualization, or having the patients actively look at their affected joints.

Harris (1999) proposes that disorganized or inappropriate cortical representation of proprioception may falsely signal incongruence between motor intention and movement, which results in pathologic pain in the same way that incongruence between vestibular and visual sensation results in motion sickness. He proposes that visual monitoring for the treatment of repetitive strain injury (Byl and Melnick 1997), phantom limb pain (Ramachandran and Rogers-Ramachandran 1996), and stroke (Miltner et al. 1999, Liepert et al. 2000, Weiss et al. 2000, Kopp et al. 1999) is directed at the restoration of the integrity of cortical information processing and is more appropriate than treating the affected body part with medications.

PAIN INHIBITION AND DESCENDING SYSTEMS

Inhibition of nociception, like many other processes of the nervous system, depends on interactions between neurons that influence each other by secretion of a variety of substances, such as substance P; cholecystokinin and other neuropeptides; endorphins; enkephalins; dynorphins; noradrenergic substances. such as norepinephrine; glutamate and other amino acids; serotonin, γ-aminobutyric acid; acetylcholine; and neurotensin. Nociception is influenced by where these substances are released and by their amount. Generally, nociception is processed or influenced at a number of levels, starting at the periphery.

In the periphery, during inflammation, primary afferent nerve endings are exposed to endogenously released opioid peptides. These opioids are released both locally, from cells that accumulate at the site of the inflammation, and systematically, from the adrenal and pituitary glands (Stein 1995). An inflammatory state seems to be required to enable opioids to exert the peripheral antinociceptive effect, and the inhibitory effects of these opioids are possibly enhanced by the increased expression of opioid receptors on primary afferents that also occurs during inflammation. Thus, the pattern of activity of the primary afferent nerve fibers is dynamically sculpted before it ever reaches the spinal cord (Reichling and Gold 1996).

In 1965, Melzack and Wall proposed the *gate control theory*. This theory proposed that (1) the substantia gelatinosa functions as a gate control system that modulates the afferent patterns before they influence the central transmission cells; (2) the afferent patterns in the dorsal column act, at least in part, as a central control trigger that activates selective brain processes that influence the modulating properties of the gate control system; and (3) the transmission cells activate neural mechanisms that comprise the action system responsible for response and perception. According to this theory, the opening or closing of the gate at a spinal level was determined by the relative contribution of the A-delta and C fibers on the one hand, and the A-delta fibers on the other hand. As a consequence to this theory, TENS and dorsal column stimulators were developed. Thirty years later, Wall (1996) writes, "I overdid the economy," meaning that the modulating pain system at the level of the spinal cord was much more complex than he originally suspected.

There is emerging evidence that, at the level of the spinal cord, a local modulatory system using amino acids and peptides affects the transmission of nociceptive input through the spinal cord. It is thought to act both pre- and postsynaptically, and may use complex interneuronal chains and excitatory cells. In addition, it is possible that transmissions through lamina I neurons and deep dorsal horn neurons are modulated through different mechanisms (Lima 1996).

Melzack and Wall (1965) specified very little about the central control mechanism influencing the gate, mainly because very little was known about it at that time. Since then, the most extensively studied modulatory circuit includes the midbrain PAG and the adjacent nucleus cuneiformis. The PAG receives major afferent input from the hypothalamus, the frontal lobe, and the amygdala, as well as brain stem inputs from the reticular formation neurons at the level of the medulla and pons, including the locus ceruleus (LC). In 1969, Reynolds showed that with electrical stimulation of the midbrain PAG, whole-body anesthesia could be achieved without behavioral changes, both in animals and in humans. The PAG has no direct connections with the spinal cord and appears to mediate its analgesic effect through the RVM that consists of the nucleus raphe magnus (NRM) and its nuclei. Fibers from the RVM (of which 80% are serotonergic) run caudally in the dorsolateral fasciculus to terminate heavily in the laminae I, II, and IV–VI (from which the spinothalamic tract arises) to execute a powerful inhibitory stimulus (see Figure 3.6).

The dorsal horn regions that receive RVM input contain μ, γ, and κ opioid receptors, as well as enkephalinergic interneurons and terminal fields, and RVM axon terminals contact enkephalinergic dorsal horn neurons. Budai and Fields et al. (1998) demonstrated that endogenous opioids acting via spinal μ-opioid receptors contribute to brain stem control of nociceptive spinal dorsal horn neurons, apparently in part through presynaptic inhibition of afferents to dorsal horn neurons. Because opioid antagonists only partially reverse the inhibition of spinal nociceptor reflexes by stimulation of the RVM, it is likely that other neurotransmitters contribute to the control of spinal nociceptive transmission of the PAG-RVM pathway.

The nucleus reticularis paragigantocellularis, which is part of the RVM, receives a major projection of the PAG and projects to the LC. Stimulation of the dorsolateral pons in the region of the LC and the parabrachial nuclei produces behavioral analgesia in experimental animals and patients with clinical pain (Katayama et al. 1985).

The projection from this region of the pons is the source of a dense noradrenergic innervation to many zones of the spinal cord, including the dorsal horn. Norepinephrine may therefore be another important transmitter in the descending control of nociception, because the behavioral analgesia produced by LC stimulation can be suppressed by adrenergic blockers applied at spinal levels. There is a dense concentration of both norepinephrine (Dahlström and Fuxe 1965) and α2 adrenergic receptors (Nicholas et al. 1993) in the dorsal horn. Direct spinal application of adrenergic agonists produces behavioral anesthesia and inhibition of dorsal horn neurons through α2 adrenergic receptors (Peng et al. 1996). In findings consistent with the antinociceptive role postulated for the LC-dorsal horn projection, Mokha et al. (1985) have shown that electrical stimulation of the LC inhibits the nociceptive responses of dorsal horn neurons, although LC stimulation has little effect on non-nociceptive cells. Budai et al. (1998) showed that PAG neurons inhibit nociceptive dorsal horn neurons through a presynaptic α2 adrenoceptor mechanism.

Additionally, basic research demonstrates that alternative pathways from the spinal cord exist that transmit nociception. For example, Al-Chaer et al. (1988) have demonstrated a direct pathway of visceral pain transmission along the dorsal columns in monkeys to the thalamus.

Thalamic connections and projections to other areas of the brain further modulate and integrate nociceptive input. In turn, stimulation of these areas, such as the frontal cortex and limbic system, provides the patient with cognitive and emotional nociceptive experiences. This can lead to an awareness of pain and the need to escape from it, with fear and anxiety if unable to do so. A memory of these perceptions exists not only in higher cortical centers, but also in the thalamus, which can influence present and future responses to nociception on a cellular and behavioral level.

EFFECTS OF EXERCISE ON PAIN

A number of studies have shown that exercise plays a role in increasing pain tolerance in healthy subjects (Haier et al. 1981, Janal et al. 1984, De Meirleir et al. 1985, Gurevich et al. 1994). Both single sessions of exercise (Atkinson 1977, Ekbom and Lindahl 1970) and a regular aerobic exercise regimen (Fitterling et al. 1988, Lockett and Campbell 1992) have been shown to reduce the intensity, frequency, and duration of migraine headache. Patients with rheumatoid arthritis or osteoarthritis who participate in an aerobic exercise regimen show significant improvements in pain tolerance and overall joint pain (Ike et al. 1989). Dental pain thresholds have been elevated by aerobic exercise in healthy subjects (Petrovaara et al. 1984, Droste et al. 1991, Gurevich 1994).

The analgesic effects of exercise are generally attributed to the production of beta-endorphins during physical exercise (De Meirleir et al. 1985, Janal et al. 1984). Peripheral blood concentrations of plasma beta-endorphins have been shown to increase during exercise. These increases tend to be dependent on intensity and duration (>30 minutes). The hypothesis that endorphins are necessary to mediate exercise-induced analgesia is called into question by recent evidence that a significant elevation in circulating beta-endorphins occurs only at exercise intensities of 75–80% maximum oxygen consumption ($\dot{V}O_2max$) or above (Donovan and Andrew 1987). Analgesic effects of exercise have been found at submaximal work loads of around 63% of $\dot{V}O_2max$, however (Gurevich et al. 1994). Droste et al. (1991) found that pain threshold elevations were most pronounced during maximal exertion, when the subjects reported the greatest fatigue. Elevations in pain threshold were correlated with rating of perceived exertion. This exercise-induced elevation in pain threshold did not appear to be directly related to plasma endorphin levels. It appears that pain inhibition through exercise can be mediated through the opiate and the nonopiate systems.

Rhythmic exercise stimulates the A-delta (or group III) afferents arising from muscle. Histologically, A-delta (or group III) afferents are a prominent group of fine myelinated fibers located in skeletal muscle nerves. More recent investigations indicate that these afferents respond to muscle stretch and contraction with low-frequency discharge (Thoren et al. 1990). For this reason, Kniffki et al. (1981) called the endings of these afferents *ergoreceptors*. Group III afferents do not respond to small movements of the limb and, therefore, are unlikely to be of major importance in motor control (Thoren et al. 1990). Thoren et al. (1990) and Lundeberg (1995) hypothesize that rhythmic exercise activates the ergoreceptors. Impulses are then transmitted to the spinal cord and reach the PAG, hypothalamus, and thalamus through ascending pathways. The thalamus has opiate receptors of several types and contains enkephalinergic nerve cells. As described earlier, the PAG and NRM are part of the descending pain modulatory system and are involved in the central nervous system regulation of blood pressure. Both the midbrain PAG and the brain stem NRM are rich in opiate receptors. In the NRM, the descending inhibitory serotonergic neurons to the spinal cord are stimulated. The terminals of the descending fibers synapse on enkephalin-containing neurons, which inhibit spinal neurons that mediate pain sensation.

Other nonopioid mechanisms of pain modulation include descending norepinephrine. Elevations of blood pressure, or the stimulation of baroreceptors, inhibit pain in humans. As shown by Budai et al. (1998), PAG neurons inhibit nociceptive dorsal horn neurons through a pre-synaptic $\alpha 2$ adrenoceptor mechanism. It is plausible that analgesia during exercise results from overlapping pain and cardiovascular mechanisms. The relationship of blood pressure and pain is further discussed in Chapter 6.

Both a single session and repeated brief sessions of aerobic exercise have been shown to induce marked postexercise decreases in blood pressure that often last for several hours (Thoren et al. 1990). This decrease has been linked with inhibition of sympathetic nerve activity (Thoren et al. 1990).

There is some recent evidence that pain modulation mechanisms may have gender differences (Touchette 1993). Men may have more powerful opiate-dependent pathways than women. Men and women may have gender-distinct nonopiate pathways (Mogil et al. 1993).

The results from the studies described may not be directly transferable to patients with chronic pain states. Pain elicited in a laboratory setting in healthy volunteers may or may not be comparable to clinical pain states. Bruehl et al. (1999) postulate that patients with chronic pain have altered pain regulatory systems. He reports that when compared to non-pain controls, patients with chronic pain have consistently demonstrated diminished rather than elevated opioid levels, both in the periphery and centrally. Almay et al. (1978) reported that pain duration correlated negatively with cerebrospinal fluid enkephalin levels in a manner consistent with a progressive opioid dysfunction model. Bruehl et al. (1999) postulate that chronic pain results in progressive changes in the endogenous opioid system, resulting from some combination of opioid depletion, decreased biosynthesis, and receptor down-regulation, which eventually results in a failure of the endogenous opioid-mediated antinociceptive system. Bruehl suggests that nonpharmacologic pain control techniques and exercise may somehow "normalize" dysregulated endogenous opioid systems in patients with chronic pain.

Mense (2000) hypothesizes that fibromyalgia is a result of a dysfunction of the descending inhibitory systems. Animal research has shown that an interruption of the descending systems leads to hyperactivity of spinal nociceptive neurons, lowering of the stimulation threshold, and increase in response magnitude to noxious stimuli. Marchand (American Pain Society 2001) also proposes that this mechanism underlies fibromyalgia. These opinions are supported by Russell (2001), who states that fibromyalgia is a manifestation of abnormal central nociceptive processing, based on findings of low serotonin and elevated levels of substance P found in these patients (Russell et al. 1994), most consistent with a pain amplification syndrome. Failure of antinociception could result from low met-enkephalin or low serotonin levels, both observed in fibromyalgia.

NEUROMATRIX

The last 35 years of pain research have been influenced by Wall and Melzack's gate control theory of pain (Melzack and Wall 1965*).* Melzack further refined this epoch-making theory, and subsequent research, with the concept of the *neuromatrix.* The *neuromatrix* is defined as the entire nervous system, from its genetic underpinnings to its mature state, influenced by its environment via sensory inputs. Specific *neuromodules* develop, which are specialized systems of the neuromatrix that impart smaller, more specific subsignatures on the general architecture and behavior of the global *neurosignature.* The *neurosignature* is the way the nervous system functions, and developed as a result of repeated sensory processes that took place in the neuromatrix. Our appreciation and how we relate to this input, and the neurosignature, are due to projections to the mind/brain known as the *sentient neural hub.*

The concept of the neuromatrix is borne out in some patients who develop phantom limb pain after amputation. In this case, there is a cessation of sensory input to the neuromatrix from the missing part. Clinically this may develop into deafferentation pain and alter the neurosignature. Researchers clearly demonstrated that cortical reorganization occurs (Birbaumer et al. 1997). Clinical studies suggest that pre-emptive analgesia may ameliorate phantom limb pain in amputees by placing a lumbar epidural and infusing local anesthetic (Bach et al. 1988). If the limb was associated with pain to begin with, then the neurosignature may not change or may take on a different neuropathic characteristic. The author has seen and heard of patients who had their bladders removed because of intractable interstitial cystitis pain, who continued to have bladder pain after the operation. In addition, their new bladders, constructed of intestine, developed similar interstitial cystitis-like lesions. This begs the question of a possible role for centralization of chronic pain to the central nervous system.

How we treat pain will continue be modified as we learn more about its mechanisms. Future successful therapies will be based on these principles and rely on several specialists to carry them out. Pharmacologic therapies will most likely take advantage of several combinations of medications to affect a modification in the neurosignature. Technologies that detect and target areas of modification of the neuromatrix will also advance as we become more sophisticated in our knowledge and detection of pathophysiology. It is an exciting time for specialists treating pain—one filled with hope for our patients.

SUGGESTED TREATMENT PLANS FOR COMMON PAIN PROBLEMS

The goal of the following suggested treatment plans is to introduce the physical therapist to neural blockade techniques. When nociception interferes with the execution of the therapeutic plan, the physical therapist may consider referring patients to the anesthesiologist to be evaluated for this procedure to facilitate the continuation of therapy. More than 40 years ago, Dr. John Bonica, an anesthesiologist, helped establish the concept of a multidisciplinary pain clinic. As an anesthesiologist, he recognized the usefulness of neural blockade techniques to help control pain but realized that there were limitations in this approach. Neural blockade can decrease nociception, but by itself is not always sufficient in improving function. It can be argued, in fact, that nerve blocks have no place at all in treatment strategies for certain chronic pain states.

Pain management is a recognized subspecialty of the American Board of Anesthesiology. Completion of training in the diagnosis and management of pain in an accredited fellowship program is mandatory for anesthesiologists to sit for the extended qualifications examination and become certified in pain management. Nerve block procedures are taught during fellowship, along with other modalities and facets of pain management. The use of neuroaugmentive procedures, such as dorsal column stimulation, peripheral nerve stimulation, and subarachnoid opioid infusions, is discussed because patients may occasionally be treated with these implanted devices.

Epidural Steroid Injections

Epidural steroid injections are considered by some to be without proven effectiveness in the treatment of back pain (Fordyce 1995). Although no double-blind, crossover, randomized study has been done, there is a body of clinical evidence that suggests a role for this procedure in pain management.

The epidural space is a potential space filled with blood, lymphatic vessels, fat, and nerves traversing from the spinal cord to exit the neural foramina. During epidural steroid injections, the epidural space is entered, with or without fluoroscopy, by a technique termed *loss of resistance*. Constant pressure is applied to the plunger of the syringe as a Tuohy needle is advanced. When the tip of the needle passes into a less-resistant area, loss of resistance occurs, indicating that the needle tip is within the epidural space. At this point, a corticosteroid is injected alone or with a local anesthetic, and the needle is removed. Fluoroscopy is used to place the solution at a specific level (depending on the patient's signs, symptoms, and magnetic resonance imaging findings) when the patient has a spondylitic spine and to ensure proper needle placement, because false positives occur due to needle placement.

The best indication for an epidural corticosteroid injection is nerve root compression secondary to disk herniation that does not require surgery (White et al. 1980). Nerve root compression by a disk fragment is rarely helped by this procedure and may need more invasive treatments. Other spinal pain conditions are rarely helped. One exception might be the septuagenarian who has severe spondylosis, is a poor surgical candidate, and cannot tolerate drugs. In my experience, months of relief can be obtained with a series of injections (a maximum of three) in some of these patients.

There are two parts to the theory of the mechanism of corticosteroid action in reducing pain in a radiculopathy due to disk herniation. Corticosteroid acts as a membrane stabilizer and reduces nerve root swelling, allowing for less mechanical impingement of the nerve as it passes through the intervertebral foramen. Indirectly, corticosteroids reduce cellular and humoral mediators of inflammation. It has been shown by Saal (1995) that a certain enzyme within the nucleus pulposus, obtained at time of diskectomy, is 20,000 times more active than in tissue taken from an injured knee at the time of arthroscopic surgery.

The patient must not be anticoagulated before the procedure. Complications of the procedure include postdural puncture headache (1%) and permanent nerve damage (0.002%) (Abram and O'Connor 1996). The headache is postural, and it is intensified by a sitting or standing position. If conservative measures fail to alleviate the headache, a blood patch is performed. The nerve damage requires rapid (within 4–6 hours) neurosurgical decompression. Occasionally, patients may complain of increased low back pain lasting up to 3 days after the procedure. This may be due to needle trauma to the soft tissues or to the steroid solution itself. No clinical signs of neurologic impairment are found as a result of the procedure, but the physician should be made aware of the patient's having increased blood pressure. Although there have been questions raised about the safety of steroids, an overwhelming record of safety has been seen in our clinic and by others performing this technique. Patients are usually able to resume their physical therapy the next day. Saal and Saal (1989) reported the efficacy of combining epidural steroid injections with spinal stabilization exercise by an over 80% return-to-work rate.

Myofascial Trigger Point Injections

Although much has been written about the diagnosis of myofascial pain disorders, their pathophysiology is still unclear. Trigger point injections used in conjunction with intensive physical therapy and stress relaxation techniques probably provide patients with the best means of managing their pain (Travell and Simons 1983). When a particularly troublesome myofascial area is refractory to physical therapy treatment, a local anesthetic injection into the trigger point should be considered.

Pain is usually reduced within 5 minutes, and relief may last for more than 3 days. If needed, repeat injections can be performed twice weekly, as long as they result in improved function. Some centers use a corticosteroid and local anesthetic solution; others use a dry needle inserted into the muscle. Patients should resume physical therapy as soon as possible or the same day of injection.

Peripheral Nerve Blocks

Occasionally, a patient may experience such severe pain or dysfunction in a particular extremity that it is difficult or next to impossible for the patient to progress in physical therapy. For instance, a patient may have developed a frozen shoulder along with severe myofascial pain involving neck and arm musculature. To maximize soft tissue mobilization techniques, it may be necessary to reduce nociception and relax spastic musculature by injecting a weak solution of local anesthetic into the brachial plexus. Patients with a neuroma can also benefit from a combination of peripheral nerve injections and physical therapy. Some patients develop neuromas after foot surgery. This is an infrequent occurrence, but it can be quite devastating. Patients with severe complaints of neuralgic pain (e.g., shooting or electrical pain, allodynia) will inevitably avoid using their affected limb, causing deconditioning and neuromuscular imbalance. Local anesthetic blockade of the affected nerve proximal to the neuroma and around it with a corticosteroid and local anesthetic mixture usually helps to decrease pain so that the patient can more easily participate in physical therapy. When conservative methods fail, a patient may benefit from a peripheral nerve stimulator.

Nerve block procedures carry a small risk of nerve damage as a result of trauma to the nerve during needle placement, injection, or both. Currently, local anesthetic solutions used for injection allow for no longer than 10–12 hours of analgesia. New delivery technologies are being tested that may allow for a much longer duration blockade (3 days) after a single injection. The therapist must remember that proprioception may also be decreased with these injections. Avoidance of excessive ranges of motion and protection of the extremity from trauma must be monitored closely in these patients. Coordination between the therapist's schedule and the physician's schedule must be done to properly carry out this combined plan of management.

Sympathetic Nerve Blockade

The diagnosis and management of reflex sympathetic dystrophy are controversial topics in pain management. Traditionally, whenever a cold, hot, allodynic, hyperpathic, edematous, or atrophic extremity was seen, this syndrome came to mind. In 1995, however, a task force of the International Association for the Study of Pain released a new terminology for reflex sympathetic dystrophy-like states in order to decrease confusion (Stanton-Hicks et al. 1995). Complex regional pain syndrome (CRPS) I (reflex sympathetic dystrophy) and II (causalgia) are diagnoses now used to indicate that the appearance of the affected limb can be a manifestation of several disease states. Three different schools of thought exist. The first believes that there is no evidence to support the concept that the sympathetic nervous system has anything to do with nociception. Ochoa and Verdugo (1993) cogently argue against the sympathetic model of pain. Much of Ochoa's work has looked at the function of the nociceptor (peripheral sensory organ) as a cause of CRPS (Ochoa 1986, Ochoa et al. 1989, Ochoa and Yarnitsky 1994, Ochoa and Verdugo 1993). Ochoa and others believe that the patient's "mind-brain" can also be partly (if not completely) responsible for the patient's clinical presentation. They admonish the medical community for holding onto invalid arguments and for the harm that these views have caused patients. The second group believes that experimental studies and clinical work support some role for the sympathetic nervous system in pain. Janig (1992) cites numerous experimental data that seem to implicate the sympathetic nervous system's involvement. The third group takes a moderate view. Members of this group are aware of the discrepancies in evaluation and outcomes and still subscribe to the idea of some role of the sympathetic nervous system, but with less certainty. As stated earlier, the effects of sympathetic blockade in CRPS may be rooted in its affect at the level of the dorsal root ganglion and dorsal horns, and not specifically at the peripheral noradrenergic receptor.

It is important to differentially diagnose conditions that present as CRPS. A sound evaluation of the pathophysiology of the nervous system and the psychology of the patient should be completed. A team approach in managing these patients is necessary for an optimal outcome. Often, patients require a hybrid program of functional restoration after their medical condition is treated.

The two most common sympathetic nerve blocks used are the cervicothoracic (stellate ganglion) and lumbar sympathetic blocks. The patient's skin temperature is monitored in both limbs to determine whether a sympathetic block has occurred. A rise of at least 3°C signifies a successful block. The patient is told that placebo will be used at some point in the series of blocks. The patient is asked to score his or her pain on a 0–10 scale after approximately 30 minutes. We have witnessed in a patient a graded response to the density of sympathetic blockade, as measured by temperature, lasting well beyond the local anesthetic or placebo effect.

Neurolytic Procedures

The use of neurolytic procedures in pain management has decreased with the increasing use of subarachnoid opioid infusions and spinal column stimulation. Generally speaking, these techniques interrupt transmission of neuropathic or nociceptive pain and can selectively affect a single nerve (intercostals), a plexus of nerves (celiac), or major spinal cord pathways (percutaneous cordotomy). They are useful at times in cancer pain management and in certain benign chronic pain problems. Often, after neuroablation, pain is markedly reduced, necessitating a rapid reduction in opioid dosage to avoid excessive sedation or respiratory depression.

The use of radiofrequency (RF) lesions to treat cervical facet joint pain was conclusively shown to be effective in controlling pain. Compared to placebo, in this double-blinded trial, patients were pain free for up to a median of 263 days when pain returned to 50% of baseline (Lord et al. 1996). The use of RF-applied energy is further advanced by the addition of pulsed RF lesions. Pulsed RF seems to work equally well and without as much neural destruction. Sluijter and colleagues pioneered a technique that elevates local tissue temperatures to approximately 42°C, compared to traditional RF, which uses temperatures as high as 70°C. It is thought that C fibers are more affected than other nerve fibers at these lower temperatures (Sluijter 2000, Sluijter et al. 1998).

Some specialists use neurolysis to destroy the sympathetic innervation for months at a time. In some individuals with severe lower extremity spasticity who have lost bowel and bladder function and are wheelchair bound, subarachnoid infusion can be quite effective in reducing pain. For this procedure, the patient is placed in a sitting position, and phenol is injected into the subarachnoid space. Because phenol is denser than cerebrospinal fluid, it will bathe the cauda equina, resulting in their destruction. Peripheral nerve destruction is used less often, owing to potential neuroma formation and deafferentation pain.

Nowadays, neuromodulatory techniques are used for chronic pain in place of neurodestructive techniques. Spinal infusions and spinal column stimulation are two of the most frequently used techniques to accomplish this task.

Subarachnoid Opioid Infusions

After all conservative measures fail, it may be necessary to treat a patient with subarachnoid opioid infusions to control pain. After a successful trial period of subarachnoid opioid injections, a catheter is placed in the subarachnoid space in the lumbar region and is attached to a subcutaneous pump, usually located in the abdominal region at the anterior axillary line. Morphine is often the drug used with this procedure, because it travels up and down the neuraxis, exerting potent inhibitory effects on neurons located near the spinal cord's surface. Patients who undergo these procedures are usually those who cannot tolerate opioids and other medications at doses found effective to control neuropathic pain. Pain from collapsed vertebrae of an osteoporotic spine and from failed back surgery is often helped by subarachnoid morphine infusions. Paice et al. (1996) found that 61% of patients were relieved by these infusions. Activity of daily living measures increased, and approximately half the patients noted moderate to significant improvement. Prospective studies identifying the outcomes and risks of long-term chronic opioid infusions have not been published. There are no contraindications for this technique. Spinal opioids are commonly used today to treat a variety of pain problems, but are most successful in the treatment of visceral pain (Paice et al. 1996). In conjunction with other epidural or intrathecal medications (e.g., clonidine, neostigmine), severe pain often due to neuropathy is controlled and suppressed (Carr and Cousins 1998). Most recently, Atanassoff (2000) studied the use of ziconotide, an N-type calcium channel blocker, to treat postoperative pain. It was shown to be effective in lowering opioid requirements. It is hoped that this will prove to be another useful addition to intrathecal medications to treat chronic pain.

Spinal Column Stimulation

Spinal column stimulation is effective in treating pain from vascular insufficiency and neuropathic pain, which is burning and aching in character and constant (Meglio et al. 1981, Jones 1992). Its mechanism of action appears to be secondary to neurochemical effects in the spinal cord and brain induced by stimulation (Barolat 1998). This technique allows for cessation of pain medication, or at least a marked reduction in dosage if it is successful in covering the area of pain. Spinal column stimulators are electrical devices that block nerve pain through electrical stimulation of the somatic nerve proximal to the injury. These fairly wide electrodes must be surgically placed immediately over the nerve by cutdown and exposure. A generator is placed in the extremity and tested for efficacy. The usefulness of this device lies in its ability to target only specific nerves.

Spinal column stimulation has gained popularity with the advent of multiple-lead catheters and sophisticated microprocessor-controlled, electricity-generating devices. A percutaneously inserted catheter with the width of a plastic pen ink refill is placed behind the posterior columns of the spinal cord, within the epidural space. The position of the catheter varies with the dermatomal level of nociception. For instance, in lumbar-related radiculitis, the catheter is placed so that its tip (0-electrode) lies at T-10. The small electric generator is connected to the catheter and buried subcutaneously in the abdominal wall along the anterior axillary line. Sometimes, an antenna is placed subcutaneously, and the generator is external with the electrical energy transmitted to the antenna underneath the skin. This device can be used successfully for patients not helped by back surgery with associated radiculitis, plexopathies, and peripheral vascular disease (North et al. 1993). The pattern of stimulation changes with position, although ever so slightly. The patient is instructed not to participate in aggressive activities for 1 month. After this time, the device is fairly secure in its position. North et al. (1993) reported that 47% of patients are helped moderately by this procedure and that approximately 25% of these patients (10% of the sample) returned to work.

Over the last couple of years, intradiskal electrothermal annuloplasty and percutaneous laser diskectomy have become popular. Intradiskal electrothermal annuloplasty relies on the introduction of a wire into the disk that is purported to be responsible for diskogenic pain. Heating of the wire is thought to modify the nucleus pulposus' structure and possibly reduce leakage of this highly inflammatory matter to the wall of the disk, which is a highly innervated structure.

Percutaneous laser diskectomy is supposed to alleviate pain by vaporizing disk material, causing a collapse away from the nerve root of the herniated disk, thereby alleviating radiculopathy.

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Chapter 4

Pharmacologic Treatment of Chronic Pain

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Chronic pain is a difficult challenge faced by millions of people worldwide each year (Gureje 1998, Taimela 1997, Becker 1997, Côté 1998, Cassidy 1998, Elliott 1999, Blyth 2001). For many of these people, pharmacologic treatment is an important part of their treatment. Even when the cause of pain is not clearly obvious, drugs often provide some benefit. The purpose of this chapter is to provide a general overview of issues related to pharmacologic treatment of chronic pain, including treating elderly persons with medications, a description of some of the drugs commonly used to treat chronic pain, and available evidence regarding the use of complementary and alternative medicine (CAM) to treat chronic pain.

DRUG SELECTION

Selecting the appropriate analgesic agent is based on the type of pain and severity (Arner and Arner 1985). Nociceptive pain originates from activation or injury to central and peripheral nociceptors and may be somatic or visceral (Wall and Melzack 1999). Somatic pain is often well localized and described as *aching* and *gnawing*. Types of somatic pain include joint, myofascial, inflammatory, and ischemic. Visceral pain is often poorly localized, often referred to the skin surface and described as *squeezing* and *pressure-like*. Types of visceral pain include gallstones, kidney stones, bladder distention, and bowel obstruction. These types of pain typically respond well to opioid and nonopioid therapies, such as anti-inflammatory medications. Neuropathic pain originates from injury to the central or peripheral nervous system, may travel along a nerve pathway (but not always), and is described as *sharp*, *shooting*, or *lancinating*. Examples of neuropathic pain include sciatica, postherpetic neuralgia, diabetic neuropathy, and postamputation pain. This type of pain typically responds to nonopioid medications, neuroleptics, small doses of opioids, and anti-inflammatory agents (Leland 1999).

PAIN ASSESSMENT

All persons have the right to appropriate pain assessment and management, and the Joint Commission on Accreditation of Healthcare Organizations required all health care institutions pursuing accreditation to integrate pain assessment and management into their facilities per January 2001 (Joint Commission on Accreditation of Healthcare Organizations 2001). Still, the numerous published reports of inadequate pain management suggest a continuing need to assimilate this information into everyday clinical practice (Carr et al. 1992, American Society of Anesthesiologists 1995, Marks and Sachar 1973, Donovan et al. 1987, SUPPORT Principal Investigators 1995, Wolfe et al. 2000, Morgan and Murphy 2000, Cleeland et al. 1997, 1994, Anderson et al. 2000).

Reluctance to prescribe opioids contributes to inadequate pain management. Prescribers may fear iatrogenic addiction; exacerbating a history of drug or alcohol abuse; or side effects, such as respiratory depression; or they may simply underestimate the individual's pain and disability (Brown et al. 1996). To remedy this problem, a number of guidelines on the prescription of opioids have been published (see Web sites at the end of the chapter), and definitions of terms such as *drug addiction*, *pseudoaddiction*, and *drug dependence* have been clarified (Weissman 1989).

PAIN TREATMENT FOR ELDERLY PERSONS

The elderly may pose a specific challenge to medication management. Studies reveal that elders are taking an average of seven different medications; thus, concern over drug-to-drug interactions may impede the prescribing of another medication (Gloth 2000).

Medication distribution is altered in the elderly, owing to decreases in muscle mass, total body water, and albumin production, coupled with an increase in body fat. When prescribing medications, these factors must be taken into account (Gloth 2000). Gastrointestinal motility and gastric pH are decreased, which can lead to an increased risk of irritation, bleeding, and ulceration when nonsteroidal anti-inflammatory drugs (NSAIDs) are ordered. Hepatic function decreases, resulting in an increased risk of accumulation of medications and metabolites, leading to toxicity. This phenomenon requires adjusting medication doses such that they are given at longer intervals in an older person as compared to a younger counterpart. Decreased hepatic and renal blood flow, glomerular filtration rate, and tubular reabsorption results in decreased clearance and elimination of medications and accumulation of drugs and metabolites, leading to toxicity (McCaffery and Pasero 1999).

Many patients with chronic pain self-medicate with herbal and homeopathic substances. Patients should be asked which prescription medications they are taking and the dosage, as well as what they are taking over the counter. Many patients believe that over-the-counter medications or preparations are harmless and are unaware that herbal and homeopathic preparations may interfere with the actions of the medications they are prescribed. As health care providers, we have a duty to educate our patients, but can only do so if we are educated ourselves.

NONOPIOID AGENTS

Nonopioid analgesics include acetaminophen and NSAIDs and are considered the first line of choice for mild to moderate pain (World Health Organization 1986). NSAIDs are useful medications to treat a wide variety of inflammatory conditions. They are useful adjuncts with opioids for severe pain, and they add analgesic synergism. They reduce inflammation by blocking cyclooxygenase, thereby reducing prostaglandin production. Older-generation NSAIDs block prostaglandins that regulate blood flow at the macula densa, affect the integrity of the gastrointestinal mucosa, and inhibit platelet aggregation. In the orthopedic literature, NSAIDs are implicated in decreased bone growth and are avoided by some physicians. New NSAIDs that preferentially inhibit cyclooxygenase-2 (COX-2) reduce inflammation effectively and have a marked decrease in the above side effects, with the exception of loss of some bone growth. Gastropathy is thought to occur less frequently with COX-2 inhibitors than the nonselective NSAIDs, but there is no difference in the occurrence of nephropathy between the COX-2 inhibitors and the nonselective NSAIDs. Anecdotally, one of the authors (A.S.) has observed that COX-2 inhibitors are not as effective as ketorolac, especially in bone pain owing to malignancy. Ketorolac is currently the only injectable NSAID available in the United States; however, COX-2 inhibitors for parenteral use are now in development.

In the older patient, caution should be taken with the use of NSAIDs, owing to common side effects, including gastrointestinal bleeding, nephrotoxicity, hypertension, and edema (Griffin 1991, Ling and Bathon 1998). Acetaminophen, an analgesic without anti-inflammatory properties but found to be reasonably safe and efficacious in older persons, may be used instead (Moreland and St Clair 1999, Bradley et al. 1991). Doses should not exceed 4 g per day in persons with otherwise healthy hepatic and renal function. Both acetaminophen and NSAIDs have a ceiling-dose effect, in which exceeding the maximum recommended dosage results in toxic effects without a subsequent increase in analgesic effect (Pappagallo 1999). Care in the administration of acetaminophen should be exercised owing to hepatotoxicity, with chronic use of acetaminophen at doses exceeding 6 g per day (Brasseur 1997). For this reason, caution should be used when administering acetaminophen to patients with liver disease or persons with current or past history of alcohol use or abuse.

The nonselective NSAIDs should be avoided in patients with a history of peptic ulcer disease or renal disease, or who are on anticoagulation therapy, such as warfarin (Coumadin). Only one NSAID at a time should be used. Be aware that several NSAIDs are available over the counter, and patients may be taking two different NSAIDs without realizing it. This fact emphasizes the importance of taking a good history and reviewing all medications being taken. Other options for elderly persons who need anti-inflammatory medication include the nonacetylated salicylates, such as choline magnesium trisalicylate or salsalate (Leland 2000).

As indicated earlier, particularly useful in elders are COX-2 inhibitor agents, such as rofecoxib (Vioxx) and celecoxib (Celebrex). These drugs are NSAIDs; however, they selectively inhibit COX-2. The COX-2 inhibitors provide anti-inflammatory effects with diminished adverse gastrointestinal effects, although the COX-2 inhibitors do not cause less nephropathy than the nonselective NSAIDs. Given their recent development, however, longitudinal studies are lacking on the use of these medications in the elderly. Celecoxib is contraindicated in patients with sulfa allergy (Gloth 2001).

Tramadol is a nonopioid drug used for treating nociceptive pain. The mechanism of action is not clearly understood, but it is thought to be related to μ receptor activity and also inhibition of the reuptake of norepinephrine and serotonin. It is dosed as a 50-mg tablet taken orally three times a day, up to a maximum recommended dosage of 400 mg per day. Older patients may experience common side effects of nausea and dizziness. This medication should not be used concurrently with antidepressants, as this relationship has been reported to lead to seizure activity (Kahn et al. 1997).

Table 4.1. Selection of a Short- or Long-Acting Opioid

Short-Acting Opioids	Long-Acting Opioids
Morphine sulfate (e.g., MSIR)	Sustained-release morphine (e.g., Kadian, MS Contin, Oramorph SR)
Meperidine (Demerol)	Sustained-release oxycodone (e.g., OxyContin)
Propoxyphene (Darvon)	Transdermal diuragesic (fentanyl)
Codeine (Tylenol 3)	Methadone
Hydrocodone (Vicodin)	
Oxycodone (e.g., Percocet [includes Tylenol], Roxanol)	
Hydromorphone hydrochloride (Dilaudid)	

MSIR = morphine sulfate immediate-release.

OPIOIDS

Opioid analgesic agents are recommended for use in treating moderate to severe pain and have proven to be effective in managing nociceptive pain. The selection of a short- or long-acting opioid (Table 4.1) is determined by whether the pain is intermittent or continuous. Initially, a short-acting preparation may be taken around the clock to treat continuous pain. A 24-hour assessment of the total dosage can be determined, and a conversion to a long-acting preparation can be completed. Once a long-acting preparation is in place, short-acting rescue breakthrough medication should be made available if needed. Patients need to be educated on the difference between long- and short-acting opioids and how to take them appropriately. Patients should also understand that crushing or chewing eliminates the sustained action of long-acting opioid, which can lead to rapid and uncertain absorption and toxicity.

Acetaminophen and NSAIDs are often combined with opioids, most commonly codeine, oxycodone, or hydrocodone. These combination drugs are very convenient; however, acetaminophen and NSAIDs have upper-dose limits, which must be observed owing to toxicity. These dose limits mean that the usefulness of opioids combined with acetaminophen or NSAIDs is limited. In contrast, doses of single-drug opioids have no such ceiling effect; thus, doses can be increased until the patient experiences side effects.

Methadone, a long-acting opiate, is well known as the medication of choice for addiction maintenance. It is also effective for nociceptive or intractable neuropathic pain. It contains *N*-methyl-D-aspartate receptor antagonist properties useful in treating complex pain syndromes. Owing to its prolonged elimination half-life, it is not recommended for routine use in the older person.

Owing to the changes in absorption, distribution, metabolism, and elimination in the elderly, special considerations for using opioids require initial dosage adjustments, with frequent assessment and titration of these medications. Polypharmacy is always a concern in the elderly, but managing chronic pain is difficult to accomplish with one single agent. Sometimes, small doses of a few medications along with nonpharmacologic treatments achieve the best result (Leland 2000).

Some important points must be considered for persons who use transdermal fentanyl. This medication has an onset of action of 12–18 hours and, when removed, has a duration of approximately the same range of time. Short-acting medications should be prescribed when initiating therapy. If discontinuing therapy and changing to another long-acting opioid, an allotment for the serum levels to decrease for the 12- to 18-hour range must be figured into the pain management plan. This route of administration may not be convenient for elderly persons, as they may lack the dexterity and eyesight to use them. Opiate-naïve adults should not be started on the fentanyl patch. A basic prescribing principle in pain management is to use the oral route when available, as this is the simplest route (Foley 1985).

Common fears regarding addiction, physical dependence, and tolerance should be addressed. One of the authors (A.M.B.) has suggested morphine many times to older patients in pain and found them resistant because they are afraid of becoming addicted. Their fear is unfounded, as approximately 0.04% of patients actually experience addiction when acute pain is being managed by opioids in patients without prior substance-abuse issues (Porter and Jick 1980, Carr et al. 1992). The side effects of opiates (nausea, vomiting, constipation, pruritus, and urinary retention) need to be presented, and strategies for managing them should be discussed with the patient.

Opioids are the cornerstone of therapy for pain owing to many reasons. They have little obvious organ toxicity, but evidence is mounting that opioids may influence cellular activity quite profoundly. For instance, opioids can inhibit activity of natural killer cells, affect glutathione concentrations in the brain, and even may affect neuronal regeneration. It is clear that complex intracellular systems are widely affected by the binding of opioids to their respective receptors, and their actions influence more than just pain.

Opioids reduce pain by decreasing calcium influx presynaptically, thereby reducing the amount of neurotransmitter released into the synaptic cleft (Wall and Melzack 1999). Postsynaptically, they increase potassium currents into the cell, thereby decreasing resting membrane potential and thus the action potential.

There are specific idiosyncrasies associated with some opioids, as well as medical conditions that can impact their long-term use and warrant discussion. Generally speaking, opioids are safe, and tolerance to their analgesic effects is not usually a clinical problem. Analgesia balanced with nociception appears to reduce the occurrence of tolerance. Patients who have hypothyroidism, liver or renal disease, or who are elderly or morbidly obese (especially with sleep apnea) are at risk for opioid-induced side effects, such as respiratory depression, and will need close monitoring, especially if they are opiate naïve. The half-lives of morphine, meperidine, hydromorphone, and oxycodone are all approximately 3–4 hours.

Although tolerance to analgesia and respiratory depression with opioids have been reported, tolerance to constipation typically does not occur. Therefore, persons being treated with opioids require appropriate bowel care, including a stimulant laxative. Using only a stool softener to treat or prevent constipation is inappropriate.

Routes of administration and delivery are numerous and include oral, transdermal, subcutaneous infusion, intravenous, rectal, epidural, and intrathecal. With the birth of long-acting opioid preparations, oral opioid therapy has made a major improvement in accessibility and pain control. Long-acting oral opioid preparations, such as methadone, morphine sulfate controlled-release (MS Contin), morphine sulfate (Oramorph SR), morphine sulfate sustained release (Kadian), and oxycodone HCl controlled-release (OxyContin) are commonly available. Although not promoted by a substantial marketing force like other long-acting opioids, methadone is inexpensive and an excellent alternative for analgesia in many patients.

Rectal administration is useful when drugs cannot be given by mouth. The opioid most often used rectally is morphine. Bioavailability by this route of administration is approximately 30%, similar to that seen when morphine is given by mouth. The rectal veins carry the opioid to the portal circulation via the superior rectal veins, whereas the middle and inferior rectal veins empty into the vena cava by way of the internal iliac veins.

Subcutaneous opioid administration is easy to maintain and can be chosen when the intravenous and oral routes are not available or inappropriate. Usually, a concentrated amount of opioid, such as morphine or hydromorphone, is used for continuous and bolus infusions. Dosing intervals of 15–20 minutes between boluses account for the longer time for uptake. Volumes of 10 ml per hour are usually well tolerated. A 27-gauge subcutaneous butterfly needle can be rotated every fourth day to an area that allows for little needle movement, such as the subclavicular area.

Intravenous routes provide reliable means to provide analgesia to patients. Often, delivery by this route is managed by a patient-controlled analgesia (PCA) pump. The advantage of this microprocessor-controlled pump is its safety. The settings are programmed for the bolus amount given, the interval between bolus doses (usually 6–8 minutes), a 4-hour limit, and, if the patient was previously on opioids, a continuous infusion. Continuous infusion of opioids should not be used in opioid-naïve patients. Rather, rescue boluses of an opioid may be administered to the patient. Adjunctive analgesic medications, such as NSAIDs, should be used whenever possible to decrease opioid requirements and side effects. The reason that PCA analgesia is superior to other modes of delivery is that intra- and interindividual differences exist regarding analgesic requirements at any one point in time. Because the therapeutic range for opioids is relatively narrow, with side effects of respiratory depression, nausea, and vomiting if the dose is too high, or pain if the dose is insufficient, hospitalized patients unable to take oral medications should be provided with this option. Another advantage in using a PCA pump is that the patient's 24-hour dose can easily be determined by interrogating the pump's memory. This dose is then converted to its oral equivalent, in the form of long- and short-acting medications. For example, 40 mg of morphine given intravenously in 24 hours is equivalent to approximately 120 mg of morphine given by mouth, based on its 30% bioavailability. This may be given as a 60-mg tablet of a long-acting opioid preparation every 12 hours, with a short-acting version, such as 15 mg of morphine sulfate immediate release, every 2–3 hours for breakthrough or incidental pain.

The transdermal delivery system of medication is well described for fentanyl. It is an excellent choice for patients unable to take oral medication or in those patients who do not want to take their medications with them wherever they go. The transdermal delivery system delivers a fairly consistent amount of fentanyl on an hourly basis. The surface area of skin exposed to the drug is one of the major ways by which fentanyl absorption is regulated. A concentration gradient driving fentanyl across the skin is provided by 10 mg of fentanyl per patch. Therefore, patients must be careful to dispose of used patches carefully. After entering the subcutaneous tissues, the drug enters systemic circulation. Absorption of the drug may be increased in persons with fever or irritated skin. For every degree Celsius above normal, as much as a 10% increase in serum concentration can occur.

Fentanyl serum levels approach steady state approximately 18 hours after application of the Duragesic transdermal delivery system; therefore, supplemental opioids must be given. An example of this would be to decrease the continuous infusion by one-half 10 hours after starting the patch, still allowing for the patient to still bolus him- or herself using a PCA delivery system if he or she has increased pain.

An iontophoretic device is being developed to deliver fentanyl. It is proposed to deliver a continuous amount, like the transdermal fentanyl patch, and also have the ability to allow patients to bolus themselves by pressing a button. A current generated between cathode and anode electrodes will drag the charged fentanyl molecule under the skin faster than waiting for simple diffusion.

Caution should be made regarding the use of intravenous fentanyl. Patients who are given rela-

Table 4.2. Conversion Table for Common Opioid Medications

1 Percocet (oxycodone and acetaminophen)	5 mg morphine
10 mg sustained-release oxycodone (OxyContin)	10 mg morphine
1 Vicodin	5 mg morphine
100 μg fentanyl	8–10 mg morphine/hr
5 mg methadone	5 mg morphine

tively small amounts (~100 μg) intravenously as a bolus may develop chest wall rigidity. One cannot ventilate the patient in this situation, and the patient may need neuromuscular blockade and airway management to reverse this situation.

Codeine, meperidine, and propoxyphene should be avoided whenever possible. Codeine is approximately 30% bioavailable and is metabolized by cytochrome P-450 2D6 enzymes to morphine; however, only 10% of a dose is converted to morphine. Thus, 30 mg of codeine is equivalent to approximately 1 mg morphine. Furthermore, codeine is a prodrug and does not provide analgesia until it is converted to morphine, and a substantial portion of the population cannot metabolize codeine owing to genetic polymorphism (Michalets 1998). Meperidine is approximately one-tenth as potent as morphine, is approximately 30% bioavailable, and is approximately 70% bound to α-1 glycoprotein. Meperidine also has a long history of inappropriate dosing (Marks 1973). Meperidine has an active metabolite, normeperidine, and should be avoided in patients with a history of seizures or renal dysfunction. Normeperidine has an elimination half-life of approximately 40 hours; thus, it accumulates and can cause seizures that must be treated with anticonvulsant therapy. The combination of meperidine and monoamine oxidase inhibitors can be lethal by causing malignant hyperthermia. The elderly and the young are prone to exaggerated responses to meperidine analgesia, possibly owing to decreased α-1 glycoprotein. Propoxyphene has an active metabolite, norpropoxyphene, which accumulates and can cause central nervous system excitation and seizures. In postoperative pain, 400 mg of ibuprofen provides better pain relief than does 65 mg of propoxyphene (McQuay 1998).

Morphine is the prototypical opioid. It was synthesized by Serturner in 1816 and is approximately 30% bioavailable. It is hydrophilic and tends to distribute more to muscle than fat. Only 35% of a dose is bound to serum protein. It can release histamines and should be avoided in patients with pheochromocytoma to prevent a hypertensive crisis. Morphine is metabolized mainly in the liver, but also in the kidneys, brain, and gut. Two metabolites exist that can impact clinical response to the drug. Morphine 3-OH glucuronide is the predominant metabolite, and its formation can be reduced if a patient is on monoamine oxidase inhibitors, possibly increasing the parent molecule's concentration. Morphine 6-OH glucuronide is a more potent analgesic than its parent molecule and may accumulate in renal-failure patients.

Methadone is a long-acting synthetic opioid with excellent bioavailability (50–80%) used to treat pain and opioid addiction. It binds avidly to tissues, accounting for its long elimination half-life of 30–40 hours. Methadone's inactive metabolites are excreted in bile and urine. This drug may be given once daily or split into two doses. It can accumulate in renal failure, so caution is advised. Its long half-life can result in delayed-onset respiratory depression with continued use at the beginning of therapy. Initially, it is advisable to give the patient 50% less than what the patient needs, supplementing it with short-acting analgesics, until steady state is achieved. If one initially doses at a fixed dosage, it may accumulate beyond the patient's analgesic requirement and cause respiratory depression.

Hydromorphone is a more potent and lipophilic drug than morphine and has a bioavailability of 60%. It is a good choice for patients with decreased renal function, because its metabolite is excreted in the bile. Hydromorphone will soon be marketed in the United States in a long-acting form.

The conversion of one opioid to another requires equianalgesic calculations. To aid in this process, Table 4.2 provides the conversion factors for many opioid analgesics.

LOW-POTENCY AND AGONIST-ANTAGONIST OPIOIDS

Low-potency and agonist-antagonist opioid drugs have a somewhat limited application because they have a ceiling effect, and, if used in a patient already receiving opioids, they may produce abstinence syndrome (withdrawal). Kappa agonists like butorphanol and dezocine (a weak μ and δ agonist) may play a role in facilitating μ opioid analgesia. There is not yet enough clinical evidence to make any recommendations.

Buprenorphine, a partial agonist, is different from other opioids in that it binds noncompetitively to an opioid receptor and may prevent adequate analgesia if used with full μ receptor agonists, like morphine. If it is given in amounts causing respiratory depression, it cannot be reversed with naloxone, owing to its noncompetitive nature.

ADJUNCTIVE PAIN MEDICATIONS

Adjuvant agents are useful for treating neuropathic pain. Neuropathic pain can be the most daunting of all types of pain to treat. Multimodal therapy is usually required. Agents such as anticonvulsants, tricyclic antidepressants, and antiarrhythmics have been reported to be useful in managing this type of pain.

Tricyclic antidepressants at optimal dosing appear to be the most efficient (Sindrup and Jensen 1999) for treating neuropathic pain. Amitriptyline and desipramine act through the mechanisms of decreasing norepinephrine and reducing serotonin reuptake and are noted to be more efficacious in reducing neuropathic pain than serotonin-specific reuptake inhibitors, such as fluoxetine, sertraline, paroxetine, citalopram, and fluvoxamine. The tricyclic antidepressants reduce pain irrespective of their effects on depression. Other analgesic actions have been ascribed to tricyclic antidepressants based on animal data. Intrathecal injections of antidepressants bind to *N*-methyl-D-aspartate receptors and may, therefore, exert an analgesic effect by blocking this receptor's function (Eisenach and Gebhart 1995). They seem to be effective when used to treat paresthesias, hyperpathia, and unprovoked, spontaneous pain, and may be effective to treat pain related to neuromas, radiculopathy, human immunodeficiency virus, diabetic neuropathy, sympathetically maintained pain, central pain, and fibromyalgia. Of this class of medications, nortriptyline and desipramine have the best side effect profile and are recommended for use in managing neuropathic pain in the elderly (Gloth 2001, Freedman and Peruvemba 2000). The anticholinergic side effects such as hypotension, blurred vision, dry mouth, urinary retention, and sedation make this class of medication difficult to tolerate for some patients.

Anticonvulsants such as carbamazepine (Tegretol), phenytoin (Dilantin), valproic acid, gabapentin (Neurontin), lamotrigine, and clonazepam (Klonopin) have been used to treat neuropathic pain by stabilizing neuronal membranes through a variety of mechanisms. Carbamazepine is well known to be effective in the treatment of trigeminal neuralgia; it and other drugs have been used to treat pain symptoms described as *lancinating* or *electrical*, which are also associated with hyperalgesia. Gabapentin seems to act by facilitating inhibition of the pain signal. Thus, it is useful in those states when there is loss of inhibitory modulation, such as occurs with peripheral nerve damage. Gabapentin has a very favorable side effect profile and has been used successfully to treat diabetic neuropathy and postherpetic neuralgia.

Newer neuroleptic agents, such as gabapentin, have been proven effective in the treatment of diabetic neuropathy in the elderly (Freedman and Peruvemba 2000). The most frequently noted side effects are dizziness, somnolence, and ataxia, leading to increased risk for falls in the elderly. When initiating this therapy in an older adult, begin dosing at 100 mg, titrating up slowly to three times a day. Studies confirming the most effective dose and maximum range in this population are lacking.

Local anesthetics are excellent drugs to reduce spontaneous pain from peripheral nerve injury. Infusions of local anesthetics have been reported to reduce central pain from cerebral vascular accidents. Mexiletine, an oral cardiac antiarrhythmic drug that has local anesthetic properties, was proven to be an effective analgesic in diabetic neuropathy, with few side effects (Freedman and Peruvemba 2000). Recently, lidocaine applied via a transdermal delivery system (Lidoderm patch 5%) has proven helpful in treating pain due to herpes zoster infections.

Clonazepam, a benzodiazepine, has been used for a variety of conditions and seems to work at the γ-aminobutyric acid receptor for paroxysmal neuropathic pains. The authors use it in conditions that have musculoskeletal and neuropathic components of pain. Additionally, it is an excellent anxiolytic and can reduce myoclonus associated with high doses of opioids. Anti-anxiety agents, such as benzodiazepines, are often misused in the treatment of chronic pain. They are indicated for the treatment of anxiety and have been proven effective for this disorder. Use in chronic pain has led to dependence and overuse (Feinberg 2000).

Baclofen has long been considered an important drug to reduce muscle spasticity and is also effective in treating trigeminal neuralgia. Its analgesic properties are exerted via the γ-aminobutyric acid receptors and inhibit primary afferent neurotransmitter release to the dorsal (posterior) horns. When nerve damage occurs, both γ-aminobutyric acid and opioid receptors are down-regulated, allowing for an unopposed excitatory impulse into the dorsal horns. Baclofen may stimulate these receptors and decrease pain when combined with other medications, such as local anesthetics and antidepressants.

As discussed in Chapter 3, *N*-methyl-D-aspartate antagonists have proven to be effective in reducing second pain and pain associated with wind-up.

Phenothiazines have also been used as adjunctive medications for treating lancinating pain but have fallen out of favor owing to their side-effect profile. In the 1960s, methotrimeprazine was found to have analgesic properties equal to morphine at low doses, possibly owing to alpha-2 receptor stimulation. Methotrimeprazine is no longer available in the United States.

Clonidine, an alpha-2 adrenergic agonist, is used to treat hypertension, decrease general anesthetic requirements, and reduce abstinence syndrome symptoms and neuropathic pain. Oral and transdermal routes are used, starting with the lowest dose and observing for hypotension and sedation. Recently, it has also become popular for treating severe neuropathic pain to use clonidine in the epidural and intrathecal spaces (it has only been approved by the U.S. Food and Drug Administration for epidural use). Similar medications are being developed that produce fewer side effects.

Topical agents, such as capsaicin cream, have been found to provide analgesia in neuropathic pain (Freedman and Peruvemba 2000). Capsaicin is derived from the chili pepper and works by depleting substance P at the site of application. Burning usually occurs, so gloves must be worn to apply the cream, and caution taken to avoid the eyes and mouth. The cream must be applied at multiple daily applications for 3–4 weeks to be effective. But because of the burning sensation, use of the cream is often poorly tolerated and therefore discontinued in one-third of patients. Using a 5% lidocaine ointment to pretreat the area can help to decrease the burning. It is recommended as a first line of treatment for postherpetic neuralgia in the elderly patient (Freedman and Peruvemba 2000). The Lidoderm patch (5% lidocaine gel in an adhesive patch) is a simple application with a low side-effect profile. It has been proven effective for the treatment of pain associated with postherpetic neuralgia and may be a good choice for elders with this condition (Freedman and Peruvemba 2000, Rowbotham 1996).

Compounded creams and gels that contain combinations of drugs have been used to treat painful neuropathies, but controlled trials to determine efficacy and dosing are lacking. These therapies are often not covered by standard insurance plans and are sometimes costly.

Invasive therapies, such as nerve blocks, spinal column stimulators, and implantable infusion pumps, may be an alternative for some intractable cases of chronic pain. Referral to a pain management specialist who can advise in the use of these devices is suggested.

COMPLEMENTARY AND ALTERNATIVE PHARMACOLOGIC TREATMENT OF PAIN

The purpose of this review is to evaluate the recent evidence-based literature on the pharmacologic treatment of pain with herbs and homeopathic preparations. The information presented here is intended to provide the reader with a general view of the topic and reflects a thorough, but not exhaustive, search of the literature.

To identify the pertinent literature, we searched the Allied and Complementary Medicine database, from 1985 to the present; the Cochrane Library 2001, issue 2; Embase Drugs and Pharmacology database, from 1990 to 2001; and PubMed. PubMed is an online service of the National Library of Medicine and includes Medline from 1965 to the present, as well as out-of-scope citations from certain Medline journals, citations that precede the date that a journal was selected for Medline indexing, and some additional life science journals that submit full text to PubMedCentral and receive a qualitative review by the National Library of Medicine.

We used these search terms: *alternative medicine*, *complementary medicine*, *herbs*, *homeopathy*, and *pain*. All nondrug interventions (i.e., devices, massage, acupuncture, chiropractic intervention) were excluded, as were papers that reported only physiologic results, rather than outcomes such as pain relief or functioning. The search was limited to results in humans and articles published in English. Well-designed meta-analyses, systematic reviews, and trials evaluating a single agent were emphasized over single trials and studies of combined treatments.

Arthritis

Three extensive reviews of randomized, controlled trials evaluating the use of herbs or alternative medications to treat osteoarthritis (OA) and rheumatoid arthritis (RA) have been published in the Cochrane Library (Little CV 2001, Little C 2001, Towheed et al. 2001). One of the OA reviews and the RA review focused on herbs, specifically tipi, capsaicin, Reumalex, and avocado-soybean unsaponifiables (ASUs), whereas the other OA review evaluated glucosamine (Little CV 2001, Little C 2001). Reumalex is a licensed, proprietary, over-the-counter herbal medicine that contains guaiacum resin, black cohosh, white willow bark, sarsaparilla, and poplar bark as its main ingredients.

In the first Cochrane review of herbal OA treatments, a tipi tea was compared to placebo in 20 persons with knee and hip OA, with a weeklong washout period (Little CV 2001). Persons who used approximately 9 g of tipi per day showed improvement in outcomes that included pain measurement and time to walk 15 m, as did persons who used placebo, although the study author did not report which measurements were improved. Between-group differences were not significant.

Capsaicin was compared to placebo in 101 persons with OA or RA of one or both knees (Little CV 2001). Outcomes of interest were pain intensities, measured on a visual analog scale, a four-point categoric pain scale, and a physician's five point global assessment. Persons who used 0.025% capsaicin cream on one painful knee four times a day had a larger improvement than when using placebo, although differences were not statistically significant for any outcome. Nearly one-half of patients on capsaicin reported topical burning, an expected side effect of this compound.

Persons with chronic arthritis pain due to OA or RA who took Reumalex (two tablets at a time for 2 months) had statistically significant improvement in arthritis pain score, compared to pain score averaged over the prior 2 months (Little CV 2001). Patients' articular index scores were also significantly lower for some persons with OA, and analgesic use was slightly less compared to persons who used placebo, according to patient diaries.

In two studies included in this Cochrane review, 327 persons with OA who required treatment with NSAIDs received placebo or 300-mg ASUs daily for 3 months and an NSAID for the first 45 days (Little CV 2001). The primary outcome measure was resumption of NSAID intake after the first 45 days of the study. Other outcomes included total NSAID dose, global assessment by patient and investigator, pain measured using a visual analog scale, and functioning. Persons who used ASUs had lower cumulative dosages of NSAIDs throughout the studies, fewer days spent on NSAIDs, and lower mean daily NSAID dosages. There were also significant improvements in pain (measured on a visual analog scale), functioning, and global evaluation by the patient, physician, or investigator.

Although persons who used Reumalex, capsaicin, or ASUs reported some improvement, the authors of this review concluded that the current available evidence regarding the use of herbs to treat OA was limited and insufficient to make a reliable assessment of efficacy (Little CV 2001). ASUs may provide long-term symptomatic relief for persons with chronic, stable OA of the hip and may help decrease NSAID consumption.

Glucosamine, a natural product that is considered the building block of the ground substance of the articular cartilage, was studied in a Cochrane review of 16 randomized controlled trials (RCTs)

(Little C 2001). Of these, 13 were comparisons of glucosamine to placebo. Four trials compared glucosamine to NSAIDs. Glucosamine was considered superior to placebo in all but one RCT, superior to NSAIDs in two RCTs, and equivalent to NSAIDs in two RCTs. Twelve of the trials were performed in the European Community, three took place in Asia, and one took place in North America.

The main outcomes measured across these RCTs were pain, range of motion, functioning, global assessments, and glucosamine toxicity (Little C 2001). All the trials included in this review were double-blind, randomized, parallel-group design, with a total sample size of approximately 2,000 people. Mean age of the participants was 61 years, and 75% of the group were women. Approximately 50% of the group received glucosamine, and 50% received either placebo or an NSAID. Glucosamine was given by mouth only in 12 studies, intra-articularly and intramuscularly in one trial each, and by multiple routes in two studies.

Among outcome measures of interest, there was a large pooled effect for pain reduction associated with glucosamine (Little C 2001). The pooled effect for functioning associated with glucosamine was considered moderately large. Overall, the authors of this review concluded that these studies provided good evidence that glucosamine is effective and safe to treat OA, although long-term effectiveness, toxicity, and potential differences between manufacturers have yet to be determined.

Eleven studies of five interventions were included in the review of herbal treatment of RA (Towheed et al. 2001). The herbs studied with RA were γ-linoleic acid (GLA), feverfew, Tripterygium wilfordii hook F (T2), capsaicin, and Reumalex.

Persons who took feverfew showed no improvement in grip strength, whereas T2 use was associated with decreased joint tenderness, joint swelling count, morning stiffness, and time to walk 15 m (Towheed et al. 2001). Relative to placebo, persons who used capsaicin reported lower pain-intensity scores on visual analog and categoric scales. Data for Reumalex were not reported separately for persons with RA; however, arthritis pain scores at the end of treatment were lower in the treatment group.

Three studies evaluated the use of GLA with mixed results (Towheed et al. 2001). In one trial, neither morning stiffness nor grip strength was improved in persons who used GLA, although most persons who used evening primrose oil (EPO) as a source of GLA reported a subjective improvement. After a 3-month washout phase, 80% of the persons who used EPO experienced a relapse to at least baseline functioning levels. In contrast, the other two studies reported significantly reduced morning stiffness with a nonsignificant trend toward improvement in other clinical outcomes for persons who used EPO or blackcurrant seed oil. Relative to EPO, persons who used placebo reported significantly decreased articular index scores and pain, less morning stiffness, and unchanged well-being. Compared to blackcurrant seed oil, persons who used placebo experienced no clinical effect.

As with the review of herbal treatment of OA, these reviewers concluded that currently, available evidence is limited and insufficient to reliably assess efficacy of these treatments, although the studies of GLA deserve additional study (Towheed et al. 2001).

Migraine

A Cochrane review of feverfew for the treatment of migraine has also been published (Pittler et al. 2001). In this review, four double-blind RCTs of feverfew extract as a single-ingredient product were evaluated. A total of 194 patients participated in the trials.

Feverfew was superior to placebo in two of the three trials that were considered to be sufficiently large (Pittler et al. 2001). The number of migraines experienced was decreased by feverfew in two trials, whereas the study with the highest methodologic quality showed no such effect. Migraine severity was decreased in one study, but not in the other two. Nausea and vomiting were decreased in two studies.

Overall, these authors concluded that the currently available evidence supports feverfew over placebo (Pittler et al. 2001). Efficacy has not yet been clearly proved, and long-term safety is still uncertain.

Homeopathy refers to the practice of using very small doses of substances expected to cause symptoms similar to the one being treated (Vickers and Zollman 1999). For example, raw onion generally causes watery eyes, stinging and nasal irritation, and clear nasal discharge. Using homeopathic principles, a very small amount of raw onion (or its essence) might be given to treat people with allergic rhinitis or hay fever.

A recent systematic review evaluated the use of homeopathy to prevent headache and migraine (Ernst 1999). Only RCTs were included; however, only four such studies could be found. Two of these trials defined *migraine* according to International Headache Society criteria, whereas one did not define *migraine*, and the other included either *migraine* or *tension headache*. Each of the studies allowed considerable flexibility in treatments used. For example, two studies evaluated the effect of 4 or 11 30-C potency homeopathics given by mouth, whereas one allowed a choice of 60 remedies in three potencies prescribed individually, and one allowed a free choice of individualized remedies for 12 weeks.

Three of the four trials included in this systematic review showed no intergroup differences (Ernst 1999). The study considered to be of lowest quality showed significant improvement in all variables; however, this was the trial that did not clearly define *migraine*, nor were outcomes of interest identified. Overall, these authors concluded that homeopathic remedies are not superior to placebo for preventing headache or migraine, although the generalizability of this conclusion is limited by the very few trials in the review.

Oral Surgery

Homeopathy has also been tested in persons undergoing oral surgery for impacted wisdom teeth (Lokken et al. 1995). Twenty-four persons who required prophylactic surgical removal of impacted third molars were treated with D30 (dilution $1{:}10^{30}$) concentrations of six homeopathic drugs: arnica, hypericum, staphisagria, ledum, phosphorus, and plantago. A randomized, placebo-controlled design was used for the trial. Participants were treated 3 hours after surgery was completed, with three tablets chosen by the homeopaths. Signs and symptoms were evaluated 24 hours later, and evaluation continued for 5 days. Outcomes of interest were pain (rated on a visual analog scale), facial swelling, and maximum ability to open the mouth.

There were no statistically significant between-group differences in postoperative pain. Swelling was greater in 12 persons who received homeopathy than in 12 who received placebo. Persons who received homeopathy were less able to open their mouths relative to persons in the placebo group.

Intermittent Claudication

A systematic review evaluated the use of ginkgo biloba for the treatment of intermittent claudication (Pittler and Ernst 2000). Eight randomized, double-blind, controlled trials were identified from the biomedical literature. Seven of the studies showed a positive effect for ginkgo biloba, with 95% confidence intervals that did not include zero. When data were pooled, pain-free walking distance for persons on ginkgo biloba was increased by 34 m, a statistically significantly increase compared to placebo. The clinical significance of this finding is unclear, however.

Fibromyalgia

Ascorbigen (AGN) is a compound found in homogenized or cooked cruciferous vegetables (Bramwell et al. 2000). It has also been tested for possible effect in persons with fibromyalgia. In one such study, 500 mg of a 20% AGN–broccoli powder blend was used to provide 100 mg of AGN. The concentration of AGN in the powder was determined by high-pressure liquid chromatography. Sixteen women with fibromyalgia participated in this trial, and the outcome of interest was threshold pain values. Physical functioning, work difficulty, pain, fatigue, morning tiredness, stiffness, anxiety, and depression were measured by asking participants to complete the Fibromyalgia Impact Questionnaire.

Mean threshold pain scores were improved in persons who took AGN (Bramwell et al. 2000). Statistically significant decreases were also observed in physical impairment and total impact scores, suggesting a benefit from AGN treatment. Despite these observations, however, the authors concluded that the study lacked the size and design needed to conclude that AGN is more efficacious than placebo in persons with fibromyalgia.

Conclusion

Use of herbal and homeopathic products as a part of health care is extremely common. There are many reasons for this phenomenon, including users' desire to use more "natural" products and an interest in taking a more active role in their own health. The benefits of these products are said to be a gentler and more natural approach to treating disease, and many of the agents cause few or no notable adverse effects. Despite the willingness of many people to use these products, the evidence supporting their use is still limited, particularly in the treatment of pain and painful conditions.

WRAP-UP

Pain is a universal experience that helps to define us as human beings. Since the late 1970s, huge advances have been made in terms of understanding what causes pain and how to treat it. There is a wide variety of tools to treat pain available to health care providers, some of which are old, such as morphine, whereas other drugs and devices have only recently become available to health care providers and patients.

Pain is a highly individual experience, with wide intra- and interpersonal variation; thus, care must be taken to assess and monitor patients. This observation is particularly true for people who are at increased risk of experiencing adverse effects of medications, such as the elderly. We have presented information about pain assessment and analgesic use in the elderly as a starting point. Much of the information can be applied to other groups of people, as well as the elderly, and is presented as a starting point for physical therapists to use to treat their patients who have pain.

Last, the use of CAM is a widespread and rapidly growing practice, and the information presented here is designed to provide some insight into this common activity. As people become more involved with their own medical care, this trend is likely to increase, and we strongly encourage health care providers to ask patients if they use CAM techniques (and which ones) and to find an unbiased source of information to help understand the role of CAM in the treatment of pain. There is relatively little information available to help health care providers understand which CAM interventions provide benefit and which do not or, worse, which may cause harm.

WEB SITES TO VISIT

The American Academy of Pain Medicine, the American Pain Society, and the American Society of Addiction Medicine. Definitions of addiction, physical dependence and tolerance. Available online at: http://www.asam.org/ppol/paindef.htm.

The Use of Opioids in the Treatment of Chronic Nonmalignant Pain. Available online at: http://www2.rpa.net/~lrandall/opioids.html.

The use of opioids for the treatment of chronic pain: a consensus statement from the American Academy of Pain Medicine and the American Pain Society. Available online at: http://www.pain.com/news/consensus.cfm.

Use of opioid analgesics for the treatment of chronic noncancer pain—a consensus statement and guidelines from the Canadian Pain Society. Available online at: http://www.pulsus.com/Pain/03_04/opio_ed.htm.

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Chapter 5

Evaluation of Patients with Chronic Pain

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Assessment of pain is the key to successful management of chronic pain. It is significant in the diagnostic reasoning process, in evaluating treatment effectiveness, and in optimizing outcomes. In the patient with chronic pain, assessment should be an ongoing process—multidimensional, paralleling the nature of pain. Pain is an experience that is sensory, emotional, and cognitive. Complex neuroanatomic and neurochemical processes are understood to integrate actual or potential tissue damage with emotions, memories, and thoughts. For pain assessment to be effective in a variety of chronic pain states, multiple dimensions must be taken into account. Yet, for practicality, pain assessment cannot be a long process that is taxing to the patient or difficult to score or interpret. In this chapter, a number of different pain assessment approaches are presented with some guidelines on how to choose among them. Some of the measures are purely of the sensory dimension and may be more limited to applications in an acute pain setting. Many are cognitive-behavioral and include aspects of functional or disability assessment that go beyond the description of pain in terms of tissue damage.

A distinction can be made between *pain assessment* and *outcome assessment* in the population of patients with chronic pain. *Pain assessment* is essential in the process of evaluating and diagnosing patients and in formulating a prognosis. It continues to be important during a course of treatment for chronic pain and is, in fact, mandated by Joint Commission on Accreditation of Healthcare Organizations. An *outcome assessment* is required to evaluate the efficacy of a treatment, an approach to therapy, or a multidisciplinary pain management program. To a certain degree, these are distinguishable processes of measurement, but there may be considerable overlap in the choice of tool or approach. In the current chapter, more emphasis is placed on the assessment of the patient who presents with chronic pain, and in the chapter on outcome assessment (see Chapter 19), the global approaches, which are useful for the evaluation of interventions, are presented.

Chronic pain is a multidimensional condition and therefore involves a wide range of parameters that should be considered in its evaluation. Because pain is also a subjective experience unique to the individual, it presents a challenge to the person who evaluates it. Melzack and Casey (1968) suggest that pain is a sensory experience with motivational and affective properties. The following inclusive listing of assessment parameters was developed by McGuire and Sheidler (1993).

Physiologic: Location, onset, associated factors, duration, type of pain, syndrome, anatomy, and physiology
Sensory: Intensity, quality, and pattern
Affective: Distress, anxiety, depression, mental state, perception of suffering, irritability, and agitation
Cognitive: Meaning of pain, thought processes, coping strategies, knowledge, attitudes, beliefs, previous treatments, and positive or negative influencing factors
Behavioral: Communication with others, interpersonal relationships, activities of daily living,

behaviors (pain related, preventive, or controlling), use of medications, sleep and rest patterns, and fatigue

Sociocultural: Ethnocultural background; family and social life; work and home responsibilities; environment; familial attitudes, beliefs, and behaviors; and personal attitudes and beliefs

ASSESSMENT OF CHRONIC PAIN PATIENTS

To assess chronic pain, as much as possible must be learned about the patient as a whole. Chronic pain is measured by breaking it down into component parts: intensity, quality, timing, and location. These parts are then quantified to have a basis for comparison with pain measurement at other times. The following purposes of evaluation can then be achieved:

1. Establish a baseline from which to plan and begin interventions.
2. Assist in the selection of appropriate interventions.
3. Make possible the evaluation of efficacy of interventions.

It is clear from this list of pain dimensions that assessing the patient with chronic pain is not a simple and straightforward task. A number of problems is encountered when one is assessing pain in patients. The most significant problem is that it is sometimes difficult to see the pain from the patient's point of view. Patients are the foremost experts on their pain. McCaffery and Beebe (1989) have suggested their own definition of pain, as quoted in Chapter 1. They emphasize that "the person with the pain is the only authority about the existence and nature of the pain, since the sensation of pain can be felt only by the person who has it" (McCaffery and Beebe 1989, 6).

Another problem encountered when assessing clinical pain is its variable nature and instability. Patients with identical etiologies do not experience pain in the same way. The individual perceptions of and responses to pain are diverse. Awareness of this makes it less likely for the clinician to fall into the trap of assuming how the pain must feel to a patient based on previous experience with similar patients or pain states. Furthermore, it is impossible to validate or invalidate any statements a patient makes about his or her pain. Particular measures of pain may mean different things to different people, and a patient's rating of his or her pain cannot be verified by comparison with another measure, a different pain state, or another person's opinion.

A number of different patient characteristics influence the assessment of pain, such as educational level; the nature of the problem; presence of affective disorders; biobehavioral influences, such as psychological, cognitive-perceptual, behavioral, and psychophysiologic factors (Feuerstein and Beattie 1995); age; motor coordination; visual acuity; and ethnic background (McGuire 1988). Environmental factors, including the presence or absence of family members and friends during the assessment and the establishment of a therapeutic relationship between assessor and patient, also influence the assessment of pain. The degree to which the patient experiences suffering as a result of his or her pain is a significant factor. *Suffering* is paired with *pain* when the patient feels out of control of his or her life, the source of pain is unknown, the pain is especially serious, or the pain is chronic (Moon 1985).

Physical therapists are often comfortable with assessment of physical impairments related to flexibility, strength, and endurance. The difficulty arises when these common assessment techniques are applied to the patient with chronic pain who demonstrates *illness behaviors*. There is often a discrepancy between the physical findings and the patient's functional abilities; the patient with chronic pain is much more disabled than one would have predicted based on physical impairments alone. Responding to the complexities of performing impairment measures in the population of chronic pain patients, Waddell et al. (1992) have commented on the inadequacies of a variety of clinical assessments of nonspecific low back pain patients and have developed their own approach (Appendix 5.1). They have tried to develop a tool that provides a clinical assessment of impairment based solely on objective physical signs; examination techniques that are reliable; findings that are clearly separable from cognitive, psychological, or behavioral features of illness; findings specific to low back pain; and physical findings that are a cause of disability. In their efforts to develop such a tool, they also suggest that the most difficult task is separating physical disease from illness behavior. Among the numerous physical tests they used, many test results strongly correlated with behavioral signs. Based on this work with chronic low back pain patients, Waddell (1984) has published a table comparing symptoms and signs of physical disease with abnormal illness behaviors in chronic low back pain (Table 5.1).

The mismatch between physical findings and illness behavior has been described with various terms, including *abnormal illness behavior*, *symptom magnification*, and *disability exaggeration*. Many such cases may be generated by an unconscious desire for financial gain, attention, care, or an excuse to avoid work. Assigning these motives implies malingering on the part of chronic pain patients; however, deliberate malingering is relatively rare among people with pain-related work disability (Ogden-Niemeyer 1989).

Despite efforts to evaluate the purely physical causes of pain, the final physical impairment scale developed by Waddell et al. was more closely related to the affective scale of the McGill Pain Questionnaire (MPQ) than to the sensory scale, and more to the various measures of illness behavior than to pain itself (Appendix 5.2). They believe the only measure that ensures recognition of the impact of physical impairments is the performance of adequate cognitive and behavioral assessments to determine their contribution to disability as well. This separation of physical signs and symptoms from behavioral disability is evident in patients who show real physical improvement with treatment yet continue to be crippled by chronic pain. They do still have potential for rehabilitation, because their primary disability is that of functional limitations rather than specific impairments.

Disability may be regarded as *learned avoidance* or *fear-avoidance behavior*, which means patients have learned to avoid certain movements or functional activities based on past experience of pain. By avoiding activities, the patient's repertoire of social, job, recreational, or role-related tasks is reduced. The result is most likely deconditioning—that is, loss of the physiologic support for performance of more tasks or higher energy-cost tasks. By avoiding certain movement patterns, the person develops secondary physical impairments of muscle-strain patterns and weakness, which can directly lead to new pain onset. Thus, new acute pain may be superimposed on the original chronic pain condition by secondary impairments. For this reason, overall body condition should be evaluated, with specific attention to patterns of muscle use and disuse.

Table 5.1. Comparison of Symptoms and Signs of Physical Disease and Inappropriate Illness Behavior in Chronic Backache

	Physical Disease	Inappropriate Illness Behavior
Symptoms		
Pain	Localized	Tailbone pain Whole-leg pain
Numbness	Dermatomal	Whole-leg numbness
Weakness	Myotomal	Whole-leg loss of function
Time pattern	Variable	No pain-free intervals
Response to treatment	Variable benefit	Intolerance of treatment Emergency admissions
Signs		
Tenderness	Localized	Superficial, widespread, nonanatomic
Simulated rotation	No pain	Pain
Simulated axial loading	No pain	Pain
Raising straight leg	No change or distraction	Improves with distraction
Sensory	Dermatomal	Regional
Motor	Myotomal	Regional
General reaction	Appropriate reaction to pain	Over-reaction to pain (e.g., crying out, facial expression, muscle tension, sweating, collapsing)

Source: Reprinted with permission from G Waddell, M Bircher, D Finlayson, CJ Main. Symptoms and signs: physical disease or illness behaviour? BMJ 1984;289:739.

A questionnaire was developed for use in chronic low back pain patients to measure patients' fear-avoidance beliefs about physical activity and work (Waddell et al. 1993). Test-retest reliability was good, with a kappa of 0.74. Validity comparisons between the Fear-Avoidance Beliefs Questionnaire and severity of pain, location of pain, and duration were not significant, but the Fear-Avoidance Beliefs Questionnaire scores were strongly correlated with self-reported functional limitations and disability (loss of work). Thus, this measure of fear avoidance may help to identify chronic pain patients who will become more disabled by their pain condition (Appendix 5.3).

The challenge to the physical therapist who assesses the patient with chronic pain is to identify all of the essential components of the total pain picture for the patient and develop a complete picture of the whole person within his or her environment, rather than a sense of a specific pain. To do so requires a thorough patient interview, a physical examination to identify impairments, a careful selection of pain measurement tools, and a disability evaluation. The information acquired must then be integrated with the information retrieved by other members of the health care team, especially information from psychosocial assessments. There are three major areas requiring evaluation in patients presenting with chronic pain: pain assessment and measurement, impairment definition, and disability assessment. Each of these three areas is addressed with different therapeutic goals, and therapy of each has different outcomes. Treatment is more likely to succeed if it is targeted toward goals in each of these three categories.

INITIAL IMPRESSION

When the patient first walks into the clinical setting or gets up from a chair, the therapist forms an initial impression. The physical therapist is uniquely able to judge quickly whether the patient's movement patterns, quality of movement, timing, and sequencing are consistent with the stated complaints. This impression is based on a judgment of the age and gender of the patient, the likely socioeconomic status, whatever the referral has stated about this patient, and immediate observations of the patient performing activities, such as standing up from a seated position, walking, and stooping down to lift objects (including judgment of the amount of weight lifted and the height of the lift). An initial impression of the patient will be the basis of the initial interview questions which begin the process of taking a history.

PATIENT INTERVIEW

The major goal of the interview is to develop a complete understanding of the properties of the patient's pain experience. Interview questions should address the nature of the physical problem and how the problem has affected the patient's life. The following sequence is suggested for determining the nature of the pain problem:

1. *Identify the pain area.* Ask the patient where the present pain is experienced. A body diagram, such as the one found in the McGill-Melzack Pain Questionnaire (see Appendix 5.2), is useful. Both the area where the initial pain was felt (e.g., at the site of original injury) and the area where the pain is now experienced should be identified. It is also useful to ask the patient to judge the intensity of the pain or pains by using a simple numeric scale (0–10) or the visual analog scale (VAS) (Chapman et al. 1985). Ask what levels on the pain scale represent the present pain at its worst and best. The speed of onset of pain should be addressed. A graph of the pain intensity over time can also be helpful. Discuss what previous interventions have helped the pain, including home remedies and alternative therapies, such as acupuncture.
2. *Explore the mechanism of injury.* Ask the patient how and when the pain started and whether the pain is acute, persistent, or a result of repetitive injury. The pain could be related to a traumatic injury or previous surgery, be insidious in onset, or arise when specific motions are repeated.
3. *Elicit the previous history of injuries.* Ask about time missed from work due to any injury.
4. *Identify activities, positions, and actions that make the pain feel worse or better.* A pain diary should help determine what work or home activities contribute to the pain and whether sitting, standing, or movement relieves or aggravates the pain. Stressors in the life of the patient that result in altered postures, increases in anxiety and irritability, and changes in muscle use patterns should be identified. Muscle imbalances are often the result of positional changes, guarding postures, and muscle disuse patterns.
5. *Determine the patient's functional limitations and disabilities.* Ask about the pain's effect on sleep patterns, ability to work or perform household tasks, and sex life. There are a number of questionnaires available to help assess disability, some of which are specific to entities such as low back pain (Oswestry Disability Index) (Appendix 5.4), and others that are intended for

use with all types of pain (Dallas Pain Questionnaire) (Appendix 5.5).

6. *Discuss the patient's activity level and exercise habits.* Ask specifically about how long the patient is able to walk, stand, or sit and the amount of weight the patient can lift and carry. Ask the patient to describe a typical day.
7. *Identify the patient's interests in recreational activities and hobbies,* and whether pain interferes with the pursuit of these. Also ask about individuals with whom the patient lives and how they are responding to the patient's pain.
8. *Identify the work situation of the patient*, how the pain has affected that work, and whether the patient is receiving workers' compensation or is involved in litigation.

Medication use should also be discussed with the patient. Many patients take pain-control medications that influence their responses and ability to participate in physical therapy programs. A brief description of medications and their impact on physical therapy treatment programs is included in Chapter 3.

Tables 5.2 through 5.4 are hypothetical cases that illustrate questions asked of three different types of chronic pain patients during the therapist's interview and their responses. The therapist's interpretation of their responses is also included.

The patient interview should accomplish three main goals. First, the therapist and patient should each have a much better sense of each other and of their therapeutic relationship. Second, the therapist should be able to determine whether there are musculoskeletal concerns that are more acute or repetitive in nature and whether they can be dealt with effectively with hands-on approaches. The therapist should also rule out potential diagnoses that could mean serious disease and should be referred to a physician. Finally, the therapist may determine that the patient has chronic, persistent pain that is not amenable to physical interventions but interferes with the patient's functional capabilities, and that these functional limitations should be addressed in treatment.

PHYSICAL EXAMINATION

It is suggested that the patient interview and physical examination together offer nearly all of the necessary information required by a diagnostician to make the correct diagnosis (Kassirer and Kopelman 1991). In almost all cases, medical tests are much more costly and often more time consuming than the interview and physical examination and may yield less significant diagnostic information. The physical therapist has a large number of physical examination techniques available but needs to be selective in choosing which ones are appropriate to use with each patient. This selection process is determined by the patient's answers to the interview questions and the resulting hypotheses generated by the physical therapist. If the patient experiences reproducible back and hip pain with specific motions, the physical therapist would hypothesize that the problem is related to the musculoskeletal system and then test specific joint ranges, muscle lengths, and muscle strength. Thus, the physical examination of the patient with chronic pain may be very brief and simple or could become more involved, depending on the result of the interview process.

The following list describes the role and components of impairment testing and functional testing.

Impairment testing should help rule out certain diseases and rule in conditions treatable by the physical therapist. Basic observations of vital signs, mental status, gait, posture, and asymmetries should always be done.

Functional testing is often the most important part of the examination. It is best to supplement a patient's report of activities he or she can or cannot perform with actual observation of patient's performances of transfers, ambulation, negotiation of environmental barriers, and so on, rather than relying only on patient recall of such activities. Signs of pain behaviors during activities, such as limping, guarding, rubbing, or grimacing, should be watched for. These signs may alert the diagnostician to the degree of behavioral factors involved in the patient's pain experience, as opposed to the physical or mechanical causes of pain. It is during the process of observation of functional activities that a pain behavioral assessment can be performed. Most chronic pain patients have an activity intolerance problem rather than a medical problem. It is the

Table 5.2. The Patient Interview: Chronic Pain in a Patient without Chronic Pain Syndrome

Question to Patient	Examples of Possible Answers	Interpretation
When did your pain start?	In an accident 2 years ago—my car was struck from the rear.	This is a common injury.
Where is your pain?	In my neck, shoulders, and hips. I also feel numbness in both legs when I lie down.	This makes no anatomic sense. Be suspicious that this chronic pain has a major psychological component.
On a scale of 0–10, how would you rate your pain?	0/10 up to 8/10. I have episodes of no pain, and some very bad days.	It is good that he reports episodes of no pain. He may not be a chronic pain patient.
How do you describe your pain?	Aching and pulling.	—
How often do you get this pain?	I was fine until 2 weeks ago when it started again. It's been constant since then.	Is this recurrent pain or reinjury?
What makes your pain worse?	All physical activity, mostly with my arms.	This pattern could lead to avoidance of all activity.
What makes your pain better?	Heat, massage, and physical therapy.	These may be passive-role therapies.
How often have you had physical therapy treatment?	I have had three separate therapists.	He is seeking complete relief.
What treatments?	Ice, ultrasound, massage, exercise. Every time I exercised I felt better.	This is a very good sign.
Are you exercising on your own?	No, I am afraid I will hurt myself. I have five kids to look after when I get home from work.	He does not follow through on a home program and takes a passive role for pain relief. He is looking for a complete cure. He uses family and work as an excuse to avoid his responsibility for caring for himself.
What is your work?	I am a salesman. I spend 40–50 hours per week driving in my car.	This is a very inactive job.
Is your sleep interrupted?	Yes, I have trouble falling asleep.	This is probably anxiety and is very common in chronic pain patients.
Your F-6 shows that your physical functioning is severely limited, with severe pain and low vitality. Your mental health score is low enough to suspect depression. Are you depressed?	No, only because of the pain I have. Without pain, my life would be perfect. I have wonderful children, my wife loves me, my business is fine.	Be suspicious of depression.
What are you most afraid that the pain will do to you?	That it will get worse and worse and I will end up in a wheelchair. I would not be able to provide for my family.	He is catastrophizing and exaggerating what could happen.

activity intolerance that must be assessed in these cases.

DETERMINING IMPAIRMENTS

Physical therapists have traditionally focused on impairments in their evaluation and treatment of patients. Muscle function problems involving strength and endurance, flexibility, joint range of motion, muscle tone, and structural deformities are most common. The goal of an objective musculoskeletal assessment is to determine which structures reproduce the patient's pain when stressed. To accomplish this, the patient is examined for active and passive range of motion, muscle strength, endurance, and motor control. Specific tests of muscle, ligament, and nerve structures can be performed. Mechanically derived pain is altered by movement or position and is

Table 5.3. The Patient Interview: Chronic Pain in a Well-Adjusted Patient

Question to Patient	Examples of Possible Answers	Interpretation
When did your pain start?	Five years ago, but I'm not sure exactly when.	Chronic pain is lasting much longer than the expected healing period.
Where is your pain?	It is mostly in my legs	—
On a scale of 0–10, how would you rate your pain?	4/10 at best; 10/10 at worst. Sometimes it doesn't bother me at all; sometimes it interferes with the things I need to do.	She is coping well.
How do you describe your pain?	Pins and needles and shooting. It feels like ants crawling.	This sounds like peripheral neuropathy.
How often is your pain present?	Most of the time, but it fluctuates in intensity.	This is also a consistent description of peripheral neuropathy.
What makes your pain worse?	It is not consistent, but it worsens with all activity.	She functions in spite of her pain.
What makes your pain better?	Medication and keeping busy.	She is coping well and using medications and distractions appropriately.
What do you do for your pain?	Heat, ice, self-massage.	She has good coping techniques.
What can you not do now that you would like to be able to do?	Stair climbing, going shopping for 3 hours at a time.	These are attainable goals.
How is your sleep?	Sometimes I have difficulty sleeping because of my pain.	This is probably a physical problem, not depression.
Do you work?	I house clean all day once a week, then I'm too tired the next day to do anything.	She needs to be provided with pacing information.
Did you ever have a job?	Yes, I was a schoolteacher, but now I'm retired.	This is consistent with age.
Was it early retirement?	Yes.	Did her pain influence her to decision to retire? Ask!
Did you retire because of your pain?	No, I became a caretaker for my son, who died of AIDS.	Retirement was definitely not related to this pain.
How much does the pain interfere with your life?	I am more tired than usual. I cannot do as much as I would like. I can't keep up with my grandchildren.	This seems a realistic fatigue response. The impact on her life seems proportionate to the amount of pain she describes.
What can I help you with?	Help me walk better, climb stairs, and be less fatigued.	She may benefit from an ankle-foot orthosis.

AIDS = acquired immunodeficiency syndrome.

most likely intermittent or variable. Chemically derived pain relates to inflammation, in which chemical irritants that are a part of the inflammatory process cause the pain. An unstable joint can result in chronic inflammation, which is worsened by movement into certain ranges. Thus, mechanical pain can provoke chemical pain or make it worse. Appropriate stabilization of the unstable joint can reduce inflammation and pain. Inflammatory pain is worsened by movement but gradually declines, because inflammation is time limited and responsive to anti-inflammatory treatment.

Biomechanical assessments can also help the physical therapist determine the patient's physical impairments. Leg-length differences, pronated feet, ligamentous laxity, and bony hypertrophy are examples of impairments to assess in cases in which the history suggests that any of these factors may be involved in the patient's symptomatology. Janda (1990) evaluated cases of chronic pain using electromyography and developed a theoretical frame-

Table 5.4. The Patient Interview: Chronic Pain Syndrome Patient

Question to Patient	Examples of Possible Answers	Interpretation
When did your pain start?	My pain started approximately 3 years ago, when I had an accident at work.	This is chronic pain. Healing of tissues is finished.
Where is your pain?	In my back and down both legs.	This pattern of pain is plausible and warrants further questioning.
On a scale of 0–10, how would you rate your pain?	10 out of 10.	A maximal pain rating is suspicious for chronic pain syndrome.
What makes your pain worse?	Everything I do makes it worse.	He is catastrophizing. With deconditioning and secondary joint pathologies, his pain response to all activities seems likely.
What makes your pain better?	Medication and lying down make it better.	He has a passive lifestyle, is displaying avoidance behavior, and is dependent on medication.
How many hours do you lie down?	21 out of 24.	He is deconditioned and severely disabled.
How is your sleep?	I cannot sleep; I am too tense.	He is anxious and irritable. His waking up at night may be due to depression.
What can you now not do because of your pain that you used to do? General activities: bending, lifting, stooping, carrying, sitting, standing.	I used to walk 20 minutes every day. Now I can't do anything. I never bend, lift, stoop, carry, sit, stand, or walk. My sitting tolerance is 10 minutes. I can walk 5 minutes. I can stand for 6 minutes.	He has fear avoidance, fear of pain, and fear of reinjury. His sitting tolerance could be misinterpretation of tolerance. His answers could be litigation driven and could be based on his low expectation for function.
What activities do you do outside of work?	I used to go bowling and socialize every weekend. Now I do not bowl, I never go out, and I watch TV.	This activity tolerance could be depression or fear avoidance based on low self-esteem and low self-efficacy.
Can you climb stairs?	No, I sleep on the sofa. I never have sex.	He demonstrates fear avoidance.
Can you grocery shop? Can you perform housework?	I never used to need any help. Now I can't shop, cook, or clean. I get help from my mother or someone else.	His dependency on his family may be meeting his unmet dependency needs. There may be disturbed role functioning.
Do you live alone?	Yes.	—
Who does chores for you?	Now my ex-wife or mother comes over to do everything.	The patient's family may contribute to his illness behavior.
Do you work?	No.	He does not perceive a need to work.
Did you like the last job you had?	My job was too demanding. I hated my boss.	Apparent job dissatisfaction is a common problem contributing to disability.
How long were you working at this job?	6 months.	He does not have a stable work pattern.
Are you now receiving workers' compensation?	No, but I have a lawyer.	There are likely to be employer conflicts. This predicts a poor outcome in rehabilitation.
Are you thinking of going back to your job?	No, I am applying for disability benefits.	This answer demonstrates passive dependence and probable secondary gains.
Are you planning to go back to work at any time?	I will go back to work when my pain is gone.	This is pain-contingent behavior and is not realistic.

Question to Patient	Examples of Possible Answers	Interpretation
It sounds like the pain that you have has had a great impact on your life.	[Patient bursts into tears.] Yes, I am worthless; I cry all the time. I can't live like this. I hate my life; if only something could be done for my pain.	Depression is very common in chronic pain patients. It is helped a lot by medications. Make use of psychiatric expertise for assistance. Check his MPI scores for dysfunctional profile and MMPI for depression scores.
Do you have a psychiatric diagnosis?	No.	Depression can run in families. If never diagnosed in the patient, find out about the family.
What would you do a year from now if you had no pain?	All my problems would be solved. I'd be just fine.	The patient has unrealistic expectations for treatment. Pain is the scapegoat for all of the patient's problems.

MMPI = Minnesota Multiphasic Personality Inventory; MPI = Multidimensional Pain Inventory.

work that describes the most frequently encountered muscle imbalances that contribute to pain. He describes a characteristic muscle pattern in which postural tonic muscles have a tendency to shorten, tighten, and become hyperactive. Phasic muscles, however, tend to weaken and become hypoactive. Both tonic and phasic muscle adaptations clearly lead to an even greater degree of impairment with muscle imbalances, postural deformities, potential for additional nociception, and damage. To evaluate impairments, palpation for muscle spasm and tightness, hypotonia, weakness, and trigger points may be substituted for electromyography. Janda provides an example of the evaluation of a patient with cervical pain. With the patient standing, the positions of both scapulae and the interscapular space are observed. Tightness will pull one scapula closer to the thoracic spinous process, and weakness will flatten the space and make it appear hollow. Tightness in the upper trapezius presents as a more prominent muscle belly, with a straightening of the neck to shoulder line. A tight pectoralis major leads to rounded, protracted shoulders. In the forward head posture, the deep neck flexors are usually weak, whereas the sternocleidomastoids are tight and frequently acquire trigger points. Weakness is rarely discovered using manual muscle testing for these muscles. It is more instructive to observe movement patterns for coordination, timing, and the sequence of activation of muscles during simple weight-bearing activities. Weak postural muscles, such as erector spinae, will likely be activated inappropriately during certain movement patterns, such as a sit-up. Instead of a reflex inhibition, these muscles are hyperactive during abdominal contractions, and sit-ups can actually worsen back pain in patients for this reason (Janda 1990). Alternative measures of muscle strength can include a maximum isometric lift test or a 10 repetition maximum (10 RM) (DeLorme) strength test. These are objective measures and relate more closely to functional limitations of patients. Range-of-motion measures with a standard goniometer and fingertip-to-floor distance tests are helpful in measuring flexibility (DiFabio et al. 1995). Evaluation of musculoskeletal problems includes observation of range of motion, muscle symmetry, body posture, and movement symmetry, as well as arm- and leg-length discrepancies; manual muscle testing; identification of muscle trigger points by the "jump sign"; and examination for signs of scoliosis or other curvatures. Variations in strength between proximal and distal muscle groups should be checked. Stepping up and down steps or squatting and rising help in determining functional strength of hip extensors and knee extensors. Toe and heel rises help determine functional strength of lower leg muscles. Balance is necessarily a part of this evaluation. A neurologic examination may be necessary, including evaluation of neuro-ophthalmologic function, coordination, and motor performance. Disturbances of muscle tone, bulk, and symmetry and the presence of spasticity, rigidity, and tremor should also be evaluated. Sensory testing, including vision and hearing, light touch, pain, vibration, and deep tendon reflex testing, should be performed to assess neurologic integrity. In addition, impairments such as autonomic disturbances can be tested using evaluations of skin temperature, color, surface trophic changes, presence of edema, sweat or absence of sweat, hypersensitivity to touch, and allodynia (pain response to any light touch stimulation). Perceptual and cognitive deficits should be noted.

Impairments associated with neuropathic pain involve loss of sensory input and motor control. Sensory testing for light touch, vibration sense, temperature, hypersensitivity to touch, and allodynia is useful. Cranial nerve testing is only slightly more complex and may be indicated for patients with headache or head trauma. Motor control testing clearly involves both muscle strength, endurance, and movement pattern assessment. Standard tests of coordination include the Romberg test, rapid alternating movements, and finger-to-nose tests. Neuropathic pain is often described as *shooting*, *lancinating*, *electric*, or *lightning-like*.

Sympathetically maintained pain is a special form of neuropathic pain. In addition to allodynia and hyperalgesia, signs of autonomic dysfunction, such as skin discoloration, altered temperature, edema, hair loss, and shiny skin surface, are common. Some patients have a body part that is red, hot, shiny, and swollen. Others have a white (or mottled), cold, shiny, and hairless body part. Edema is variable. Over time, the patient loses muscle, and atrophy becomes apparent. Deformities of feet and hands occur, with shortened tendons, hollow spaces where muscle bellies belong, and deformed joints. Osteopenia shows up on x-ray, and fractures may occur. Dysfunction is extreme, as patients protect their painful part and stop using it altogether. Disability and handicap commonly occur at later stages.

Secondary conditions occur as a result of a primary condition that disables a person (Pope and Tarlov 1991). The primary condition can be a pathology, an impairment, a functional limitation, or a different disability. Secondary impairments occur in the presence of a primary condition and can lead to additional disability. In chronic pain patients, common secondary conditions include depression, deconditioning, and loss of social role (inability to work). Secondary conditions can also include new sources of pain derived from muscle weakness that lead to altered movement patterns; shortened, weakened structures; and tight, overactive muscles. Secondary impairments are very common and will become worse if primary impairments are not identified and corrected. Neither primary nor secondary impairments necessarily lead to disability, however. There are examples of polio and rheumatoid arthritis patients who have major impairments in muscle weakness and painful joints but can function in spite of their pain by substitution of muscle groups. They may even be able to lead lives that include full-time employment, sports activities, and a relatively high quality of living. Patients with these conditions often develop more and more secondary conditions, however. In poliomyelitis, years of compensating for polio-wasted muscles cause the remaining muscle mass to be characterized by peripheral reinnervation by collateral sprouts from adjacent axons and muscle fiber hypertrophy (Grimby and Thoren Jonsson 1994). Eventually, these motor units succumb to the stresses of aging and their long-term loads, resulting in new impairments, such as the development of joint instability, muscle weakness, joint and muscle pain, loss of function, and disability.

Usually, patients with chronic pain do not compensate well and avoid activities that result in pain. Indeed, fear of pain can frequently lead to fear of activity and a net decline in the number of functional activities a patient can perform. This leads to a very common secondary impairment of deconditioning. *Deconditioning* is defined as a loss of aerobic capacity or physical work capacity (Astrand and Rodahl 1986). To assess this impairment, it is possible to be very precise and obtain a measurement of the maximum oxygen consumption ($\dot{V}O_2$ max) in patients using analysis of expired oxygen. Many chronic pain patients cannot perform at their own low maximal level, however. To overcome this problem, there are a number of tests whose measurements correlate well with $\dot{V}O_2$ max. One is a submaximal bicycle ergometer test (Astrand and Rodahl 1986). The 6-minute walk test is also a useful measure for prediction of $\dot{V}O_2$ max (Cooper 1968), although its usefulness for chronic low back pain patients may be questionable. Treadmill walking tests using specific protocols have been identified in the literature. Certain patients tolerate walking better than biking or tolerate a set speed on a treadmill better than being asked to set their own speed. Thus, the choice of test should be determined by the patient to be tested as much as by practicality issues or the therapist's preferences.

PAIN MEASUREMENTS

Many tools exist for the measurement of the sensory and emotional aspects of pain intensity. In the patient with chronic pain, however, it is best to keep such measurements short and simple so that pain is de-emphasized. An algorithm for helping the clinician select an appropriate pain measurement instrument is available (Figure 5.1). Often, patients are asked to rate their pain using a scale. The following numeric rating scale (NRS) also includes a verbal descriptor scale:

1 None
2 Mild
3 Moderate
4 Severe
5 Unbearable

Melzack's Present Pain Intensity Scale on the MPQ is also useful:

0 No pain
1 Mild
2 Discomforting
3 Distressing
4 Horrible
5 Excruciating

Many clinicians simply ask for a number on a scale of 1–10, with 1 representing no pain and 10 the worst pain imaginable. This approach can also be used with a percentage scale or a scale of 1–100.

The VAS was first developed to measure subjective phenomena, such as mood states (Maxwell 1978). It may be used as a pain intensity scale and consists of a horizontal or vertical line exactly 10 cm long with anchors at either end:

No pain	Pain as bad as it could possibly be

The patient is asked to place a mark through the line at the point that best describes how much pain is experienced at a certain point. The measurement is taken as the distance in millimeters from the zero end to the mark made by the patient. The mark is the patient's pain rating and can be read as a number or a percent.

Measures that include the affective or emotional dimension of the pain experience generally include both the sensory dimension (pain intensity) and a subjective or reactive component. The Johnson Two-Component Scale is such a scale:

Pain sensation scale

0 ________________________________ 10

No sensations	Medium	Maximum sensations

Pain distress scale

0 ________________________________ 10

None	Slight	Significant
	Moderate	Extreme

The MPQ is a multidimensional approach to measurement of pain (see Appendix 5.2). The MPQ includes a body diagram on which the patient draws the location and sensory aspects of pain, using symbols or colors to differentiate aspects of pain. It also includes Melzack's Present Pain Intensity Scale (illustrated earlier in this section) and a section dedicated to differentiating the qualities of pain. This part consists of 20 different word lists used to measure the sensory, affective, evaluative, and other dimensions of pain. Patients are instructed to select only one word from any list and only those that apply to their pain experience. The final parts of the MPQ address the pattern of pain and factors that relieve and aggravate the pain. The patient's choice of words on the Present Pain Intensity Scale are related to the pattern. This complex questionnaire has been used with many different pain populations and has been shown to have excellent reliability and predictive validity because it discriminates among groups of patients and different pain syndromes. It permits assessment of physiologic characteristics in the realms of sensory, affective, and cognitive experiences of pain and addresses the complexities of chronic pain (Turk et al. 1985).

A pain scale specific to a geriatric population has been developed (Ferrell et al. 2000). It was deemed appropriate to develop such an age-appropriate tool because of the importance of the effect of pain on functional status and the significance of functional

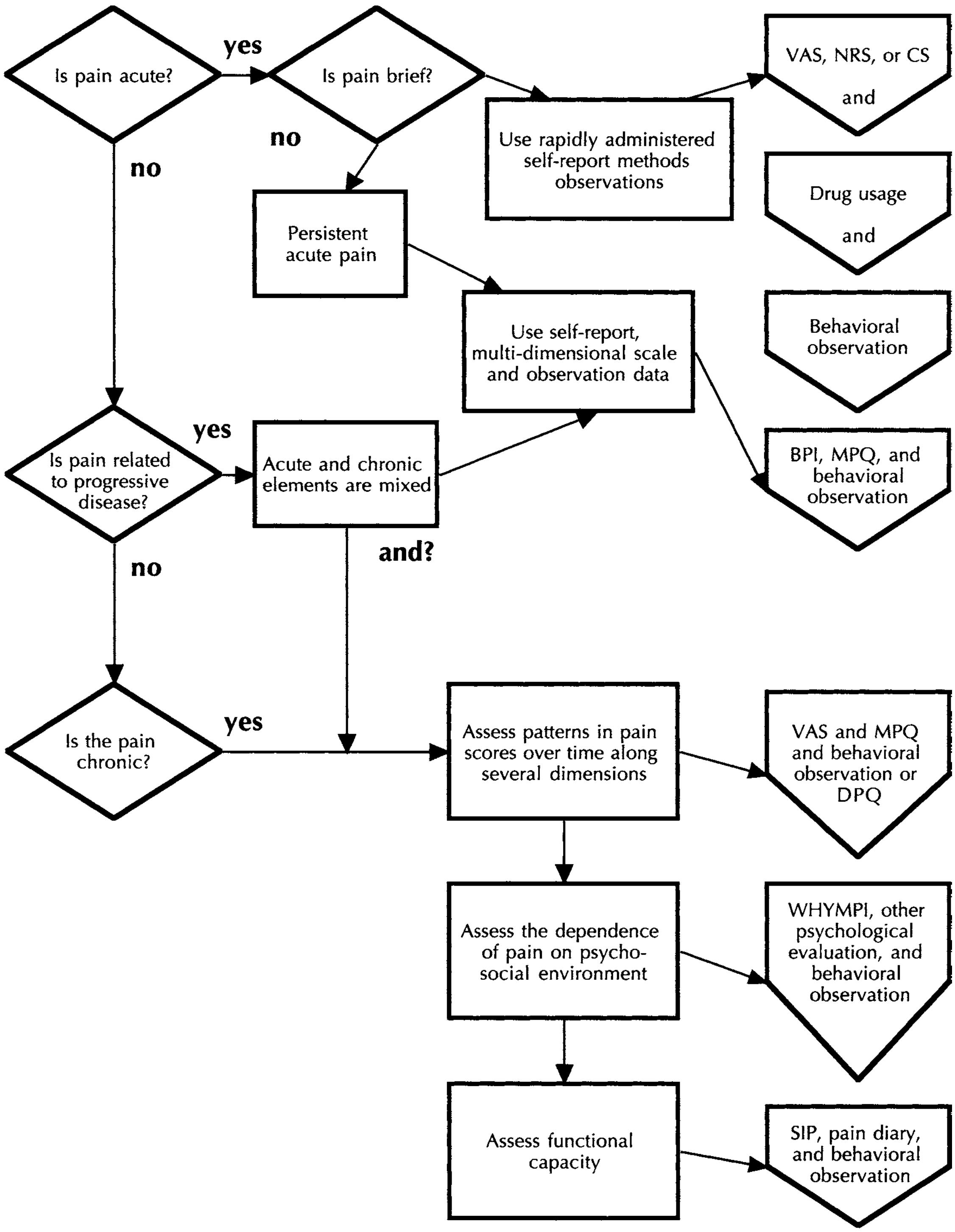

Figure 5.1. Algorithm for selection of pain measurement instruments. (BPI = brief pain inventory; CS = category scale; DPQ = Dartmouth Pain Questionnaire; MPQ = McGill Pain Questionnaire; NRS = Numeric Rating Scale; SIP = Sickness Impact Profile; VAS = Visual Analog Scale; WHYMPI = West Haven–Yale Multidimensional Pain Inventory.) (Modified from J Bonica. The Management of Pain [2nd ed]. Philadelphia: Lea & Febiger, 1990;592.)

status to the elderly. Other aspects of the geriatric pain scale include mood and quality-of-life questions, as these are also related to the pain experience. Two questions are placed on an intensity scale for pain, and all of the rest are yes or no answers relating to function, the pattern of pain, to mood (Appendix 5.6).

PHYSICAL PERFORMANCE MEASURES

Pain has a major impact on function. Therefore, functional assessment has been regarded as a major component of pain measurement and is often uniquely assigned to the physical and occupational therapist. One common approach used in rehabilitation settings is the patient self-report of functional limitations. Patient perception is valuable as a component in pain assessment but is often subject to a "mismatch" between the patient's beliefs (as in fear avoidance) and actual ability to perform specific tasks. Thus, both subjective and objective measures of functional performance have been developed for use with patients who have chronic pain. Klapow et al. suggest that the ideal assessment of clinical outcome uses both self-report instruments in conjunction with objective measures (1993). Examples of instruments that may be useful in the realm of self-report of functional limitations include the Oswestry Disability Index (see Appendix 5.4), which contains questions on disability, function, and impairments; the Roland-Morris Disability Questionnaire (Appendix 5.7); and the Sickness Impact Profile of Bergner et al. (1981). These instruments provide information about self-care, mobility, household tasks, and some work-related activities.

The ability to observe patients during their actual performance of tasks requires careful protocols for each task and impartial observers for such observations to be both reliable and valid. For practicality, only a sampling of possible behaviors can be undertaken. Specific physical performance tests have been developed for rheumatoid arthritis (Pincus et al. 1991), and for chronic low back pain patients (Waddell et al. 1992), as well as for other patient populations. For the general population of chronic pain patients, physical performance measures are being developed for outcome assessment of chronic pain management programs.

One approach is more global and involves aerobic capacity testing and dynamometry. The Astrand-Rhyming bicycle ergometer test (Astrand and Rhyming 1954) is one such test of aerobic fitness that involves an extrapolation from submaximal responses to predicted maximal performance, using a nomogram derived from healthy subjects. It has never been validated for use in chronic pain patients, who may have distorted responses to submaximal exercise due to unusual movement patterns. In a study of 50 chronic low back pain subjects, predicted $\dot{V}O_2$ max could not be established at all in 17% of patients owing to inability of subjects to achieve a heart rate of 120 beats per minute (Wittink 2000). Also, in this study, the nomogram method was shown to underestimate the value of $\dot{V}O_2$ max by 26% of 91% of the sample, especially in women.

Similar results were found using a modified Bruce Treadmill test and a 6-minute walk test, neither of which was considered to be a valid predictor of maximal aerobic capacity in chronic low back pain patients. Maximal strength testing using isokinetic dynamometry provides objective data of subjects' ability to generate torque with a variety of muscle groups. This method is shown to be highly reliable but relates poorly to actual function either as a predictor of physical performance or as a valid indicator of functional level (Mayer et al 1985).

The quest for more direct measures of function in chronic pain patients has been pursued by Harding et al. (1994) and Simmonds et al. (1998). Rather than observing patients during their everyday functional activities for many hours, a more practical approach is to sample specific important and common activities in such a way that they are relevant to the real world but are controlled in their performance so that they may be repeated. Harding et al. found the following tests to be reliable: the 5-minute–walk test, the stand-ups–for–1-minute test, the 1-minute stair climb, an arm endurance test that had moderate test-retest reliability, the hand grip test, and a peak expiratory flow test that also had only moderate reliability owing to the variance in responses. All of these tests are well described (Harding et al. 1994) and are most likely familiar to the therapist wishing to use them, except perhaps the arm endurance test, which involved the patient's holding both arms horizontally out to the side and turning small circles. The time is taken, during which the fingers remain above a line at the elbow when the arm is dependent. Harding et al. (1994) suggest that different chronic pain populations may require a different selection of these tests. It may improve reliability of testing if testers are trained in the administration of these tests.

Simmonds and her group (1998) concentrated on physical performance tests for patients with low back pain and correlated performance measures with self-report of disability (Roland-Morris Disability Questionnaire). The weakest correlation was between self-report of disability and a 50-ft walk at a self-preferred speed. The strongest correlations were between a 5-minute walk test (maximum speed); ($r = 0.60$) and also a loaded-reach test ($r = 0.57$). As a final recommended test battery for measures of performance in patients with low back pain because of strong properties of the measurements, the following is included:

- Timed 50-ft walk at maximum speed.
- Five-minute walk test (more of an endurance test).
- A loaded reach test: Subject stands next to a wall, where a ruler is mounted at shoulder height. Holding a weight not exceeding 5% of body weight or 4.5 kg in the hand, the subject reaches forward along the ruler. Maximum distance reached is recorded while the feet are maintained flat on the floor.
- Five repetitions of sit-to-stand using two trials and taking an average of the time.
- Ten repetitions of repeated trunk flexion using neutral standing as the starting position, and the time it takes to forward flex and return to upright is recorded.
- The Sorensen fatigue test (Biering-Sorensen 1984).

These eight tasks showed excellent intra- and inter-tester reliability and discriminative validity between healthy patients and patients with low back pain, and they are highly practical and acceptable for clinical use. They may be used as a correlate to a self-report measure to evaluate patients with low back pain in their ability to function (Simmonds et al. 1998).

DISABILITY ASSESSMENT

Assessment of disability becomes the most important aspect of the evaluation once the patient's status as a chronic pain patient has been established. According to the data on disability from the 1983–1985 National Health Interview Surveys, the two leading causes of disability in the United States are orthopedic impairments and arthritis (National Institute on Disability and Rehabilitation Research 1988). Both conditions often lead to chronic pain. The relationship between chronic pain and disability depends on activity intolerance and failure to return to work (Hazard et al. 1994). Waddell et al. (1993), provided a correlation coefficient of $r = 0.34$ for the relationship between pain and disability.

Because chronic pain becomes the major focus of the patient, pain becomes the single explanation for many problems the patient may be having and allows the patient to avoid dealing with these problems. Disability assessment is one of the most important parts of the assessment of the patient with chronic pain.

The simplest approach to disability assessment is to determine the functional activities that cannot be performed and those that can be performed in spite of increasing or continuing pain. The therapist can create a list of relevant functional activities or choose a scale, such as those developed for low back and neck pain. A pain scale or VAS associated with each activity on the list can then yield specific data about functional limitations due to pain. Work-related disability assessment should list job-specific tasks.

The Americans with Disabilities Act (American Medical Association 1993) supports the notion that disabled people should be accommodated to make possible their return to work. Most accommodations are defined in terms of physical specifications; however, in patients with chronic pain, the decision to return to work after a period of disablement is complex. There are complex interactions between pain-related disability, litigation, and treatment (Aronoff 1996, Brena and Chapman 1984, Ellard 1970, McGill 1968, Seres and Newman 1983). Often, psychosocial and socioeconomic factors are more important than organic findings of pathology or impairment. Waddell et al. (1993) report that the best predictor of the likelihood of returning to a job is an injured worker's beliefs about whether pain would be worsened or made better by the return to work. Catchlove and Cohen (1982) found that workers who are expected to return to work after a rehabilitation program are more likely to do so. These workers also used fewer health care resources and were more likely to remain at work than people who were not told that they were expected to work after rehabilitation. From this, it seems important to include as a part of a pain rehabilitation program the clear expectation for returning to work, which becomes part of the therapy.

The components of assessment and treatment of disability in chronic pain patients are presented as an algorithm in Figure 5.1. Assessment involves more than determination of an individual patient's impairments or a functional capacity evaluation, because it should take into consideration the requirements of the job (job skills assessment) and a determination of the individual's risk for injury if he or she attempts to perform the job. It also contains an analysis of the potential ways to modify the job to make it less risky for the individual patient. Treatment, then, is based on patient treatment and job modifications. Risks for injury and impairments are not always physical. Assessment should involve an evaluation of the psychological environment, which could include the employer's expectations and willingness to make accommodations for the patient's return, and the patient's attitudes toward the employer, especially the immediate supervisor. The physical evaluation should include a static posture evaluation, a dynamic evaluation of the worker's movements during the accomplishment of job tasks, including the time it takes, proper body mechanics, variety of movements, and presence of a suitable comfortable environment. Often, work simulation can be used to determine the ergonomic properties of a job. Then, heights for lifting, reaching, and climbing and the weights of objects can be measured to determine forces required by the worker. These components can then be used to suggest modifications in movements, environmental conditions, altering equipment, or changing procedures for a particular task. Patients can use splints, filter masks, stools, or other supports to help reduce the risk for reinjury. In general, patients who return to work have a more successful rehabilitation from their chronic pain conditions, and the physical therapist has an important influence on the process of disability prevention.

CONCLUSION

Physical therapists have been taught to evaluate impairments and probably feel most comfortable in this realm. In many patients with chronic pain, however, there is little relationship between diagnostic findings and the degree of disability identified. It is for this reason that the schema of pathology leading to impairments, disability, and handicap are important to apply in this group of patients. The complexity of the performance restrictions found during functional testing must be emphasized and remembered during evaluation of chronic pain patients. The therapist's ability to integrate findings on many different levels of evaluation becomes important.

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Appendix 5.1.

Waddell and Main Back Questionnaire

WADDELL AND MAIN BACK QUESTIONNAIRE

NAME ______________________ PHONE ______________________

DATE ____________ TIME ____________ SUBJECT CODE ____________

ADMINISTRATION # ______________________ ORDER ______________________

	YES	NO
1. Do you require help or avoid heavy lifting (i.e., 30–40 lb, a heavy suitcase, or a 3- to 4-year-old child)?	____	____
2. Have you limited your sitting to less than 30 minutes?		
3. Have you limited traveling in a bus or car to less than 30 minutes?	____	____
4. Have you limited standing in one place to less than 30 minutes?	____	____
5. Do you limit walking to less than 30 minutes?	____	____
6. Is your sleep disturbed regularly (i.e., more than 2–3 times per week)?	____	____
7. Do you regularly miss or curtail social activities (excluding sports)?	____	____
8. Has your sexual activity diminished in frequency?	____	____
9. Do you regularly require help with footwear (i.e., tights, socks, or tying laces)?	____	____

Restriction has to be since the onset of and because of low back pain. The common or usual effect is assessed, discounting occasional limitations or special efforts.

Reprinted from A Delitto. Are measures of function and disability important in low back care? Phys Ther 1994;74:460, with permission of the American Physical Therapy Association.

Appendix 5.2.

McGill-Melzack Pain Assessment Questionnaire

Cover sheet:

Patient's name: ______________________________ Age: ______

Hospital No.: ______________

Clinical category (e.g., cardiac, neurologic, etc.): ____________________

Diagnosis: ______________________________

____

____

Analgesic (if already administered):

1. Type: ______________
2. Dosage: ______________
3. Time given in relation to this test: ______________

Patient's intelligence: Circle number that represents best estimate:

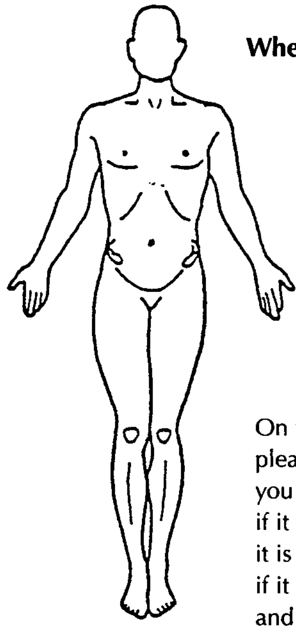
1 (low)   2   3   4   5 (high)

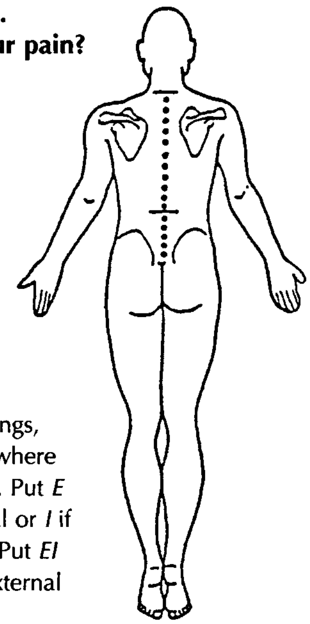
This questionnaire has been designed to tell us more about your pain. Four major questions we ask are:

1. Where is your pain?
2. What does it feel like?
3. How does it change with time?
4. How strong is it?

It is important that you tell us how your pain feels now. Please follow the instructions at the beginning of each part.

Part 1.
Where is your pain?





On the drawings, please mark where you feel pain. Put *E* if it is external or *I* if it is internal. Put *EI* if it is both external and internal.

Part 2. What does your pain feel like?

Some of the words below should describe your present pain. Circle only those words that best describe it. Use only a *single word* in each appropriate category—the one that applies best. Leave out any category that is not suitable.

1	2	3	4	5
Flickering	Jumping	Pricking	Sharp	Pinching
Quivering	Flashing	Boring	Cutting	Pressing
Pulsing	Shooting	Drilling	Lacerating	Gnawing
Throbbing		Stabbing		Cramping
Beating		Lancinating		Crushing
6	7	8	9	10
Tugging	Hot	Tingling	Dull	Tender
Pulling	Burning	Itchy	Sore	Taut
Wrenching	Scalding	Smarting	Hurting	Rasping
	Searing	Stinging	Aching	Splitting
			Heavy	
11	12	13	14	15
Tiring	Sickening	Fearful	Punishing	Wretched
Exhausting	Suffocating	Frightful	Grueling	Blinding
		Terrifying	Cruel	
			Vicious	
			Killing	
16	17	18	19	20
Annoying	Spreading	Tight	Cool	Nagging
Troublesome	Radiating	Numb	Cold	Nauseating
Miserable	Penetrating	Drawing	Freezing	Agonizing
Intense	Piercing	Squeezing		Dreadful
Unbearable		Tearing		Torturing

Part 3. How does your pain change with time?

1. Which word or words would you use to describe the pattern of your pain?

1	2	3
Continuous	Rhythmic	Brief
Steady	Periodic	Momentary
Constant	Intermittent	Transient

2. What kind of things relieve your pain?

____

____

____

____

3. What kind of things increase your pain?

____

____

____

____

Part 4. How strong is your pain?

People agree that the following five words represent pain of increasing intensity. They are:

1	2	3	4	5
Mild	Discomforting	Distressing	Horrible	Excruciating

To answer each question below, write the number of the most appropriate word in the space beside the question.

1. Which word describes your pain right now? __________
2. Which word describes it at its worst? __________
3. Which word describes it when it is the least? __________
4. Which word describes the worst toothache you ever had? __________
5. Which word describes the worst headache you ever had? __________
6. Which word describes the worst stomachache you ever had? __________

Appendix 5.3.

Fear-Avoidance Beliefs Questionnaire

Here are some of the things that other patients have told us about their pain. For each statement, please circle any number from 0 to 6 to say how much physical activities, such as bending, lifting, walking, or driving, affect or would affect *your* back pain.

		Completely disagree			**Unsure**			**Completely agree**
1.	My pain was caused by physical activity.	0	1	2	3	4	5	6
2.	Physical activity makes my pain worse.	0	1	2	3	4	5	6
3.	Physical activity might harm my back.	0	1	2	3	4	5	6
4.	I should not do physical activities that (might) make my pain worse.	0	1	2	3	4	5	6
5.	I cannot do physical activity that (might) make my pain worse.	0	1	2	3	4	5	6

The following statements are about how your normal work affects or would affect your back pain.

		Completely disagree			**Unsure**			**Completely agree**
6.	My pain was caused by my work or by an accident at work.	0	1	2	3	4	5	6
7.	My work aggravated my pain.	0	1	2	3	4	5	6
8.	I have a claim for compensation for my pain.	0	1	2	3	4	5	6
9.	My work is too heavy for me.	0	1	2	3	4	5	6
10.	My work makes or would make my pain worse.	0	1	2	3	4	5	6
11.	My work might harm my back.	0	1	2	3	4	5	6
12.	I should not do my normal work with my present pain.	0	1	2	3	4	5	6
13.	I cannot do my normal work with my present pain.	0	1	2	3	4	5	6
14.	I cannot do my normal work until my pain is treated.	0	1	2	3	4	5	6
15.	I do not think that I will be back to my normal work within 3 months.	0	1	2	3	4	5	6
16.	I do not think that I will ever be able to go back to that work.	0	1	2	3	4	5	6

Scoring
Scale 1: fear-avoidance beliefs about work—items 6, 7, 9, 10, 11, 12, 15.
Scale 2: fear-avoidance beliefs about physical activity—items 2–5.

Modified from G Waddell, M Newton, I Henderson, et al. A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance in chronic low back pain and disability. Pain 1993;52:157–168.

Appendix 5.4.

Oswestry Low Back Pain Disability Index

NAME ____________________ PHONE ____________________

DATE ____________ TIME ____________ SUBJECT CODE ____________

ADMINISTRATION # ____________________ ORDER ____________________

Please read:

This questionnaire has been designed to give the doctor information as to how your back pain has affected your ability to manage in everyday life. Please answer every section, and mark in each section only the one box which applies to you. We realize you may consider that two of the statements in any one section relate to you, but please just mark the box which most closely describes your problem.

Section 1 - Pain Intensity

- □ I can tolerate the pain I have without having to use pain killers.
- □ The pain is bad but I manage without taking pain killers.
- □ Pain killers give complete relief from pain.
- □ Pain killers give moderate relief from pain.
- □ Pain killers give very little relief from pain.
- □ Pain killers have no effect on the pain and I do not use them.

Section 2 - Personal Care (washing, dressing, etc.)

- □ I can look after myself normally without causing extra pain.
- □ I can look after myself normally but it causes extra pain.
- □ It is painful to look after myself and I am slow and careful.
- □ I need some help but manage most of my personal care.
- □ I need help every day in most aspects of self care.
- □ I do not get dressed, wash with difficulty and stay in bed.

Section 3 - Lifting

- □ I can lift heavy weights without extra pain.
- □ I can lift heavy weights but it gives extra pain.
- □ Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned, e.g. on a table.
- □ I can lift only very light weights.
- □ I cannot lift or carry anything at all.

Section 4 - Walking

- □ Pain does not prevent me walking any distance.
- □ Pain prevents me walking more than 1 mile.
- □ Pain prevents me from walking more than ½ mile.
- □ Pain prevents me from walking more than ¼ mile.
- □ I can only walk using a cane or crutches.
- □ I am in bed most of the time and have to crawl to the toilet.

Section 5 - Sitting

- □ I can sit in any chair as long as I like.
- □ I can only sit in my favorite chair as long as I like.
- □ Pain prevents me sitting more than 1 hour.
- □ Pain prevents me from sitting more than ½ hour.
- □ Pain prevents me from sitting more than 10 minutes.
- □ Pain prevents me from sitting at all.

Section 6 - Standing

- □ I can stand as long as I want without extra pain.
- □ I can stand as long as I want but it gives me extra pain.
- □ Pain prevents me from standing for more than 1 hour.
- □ Pain prevents me from standing for more than 30 minutes.
- □ Pain prevents me from standing for more than 10 minutes.
- □ Pain prevents me from standing at all.

Section 7 - Sleeping

- □ Pain does not prevent me from sleeping well.
- □ I can sleep well only by using tablets.
- □ Even when I take pills, I have less than 6 hours sleep.
- □ Even when I take pills, I have less than 4 hours sleep.
- □ Even when I take pills, I have less than 2 hours sleep.
- □ Pain prevents me from sleeping at all.

Section 8 - Sex Life

- □ My sex life is normal and causes no extra pain.
- □ My sex life is normal but causes some extra pain.
- □ My sex life is nearly normal but is very painful.
- □ My sex life is severely restricted by pain.
- □ My sex life is nearly absent because of pain.
- □ Pain prevents any sex life at all.

Section 9 - Social Life

- □ My social life is normal and gives me no extra pain.
- □ My social life is normal but increases the degree of pain.
- □ Pain has no significant effect on my social life apart from limiting my more energetic interests, e.g., dancing, etc.
- □ Pain has restricted my social life and I do not go out as often.
- □ Pain has restricted my social life to my home.
- □ I have no social life because of pain.

Section 10 - Traveling

- □ I can travel anywhere without extra pain.
- □ I can travel anywhere but it gives me extra pain.
- □ Pain is bad but I manage journeys over 2 hours.
- □ Pain restricts me to journeys of less than 1 hour.
- □ Pain restricts me to short necessary journeys under 30 minutes.
- □ Pain prevents me from traveling except to the doctor or hospital.

Reprinted with permission from JCT Fairbanks, J Couper, JB Davies, et al. The Oswestry Low Back Pain Questionnaire. Physiotherapy 1980;66:271.

Appendix 5.5.

Dallas Pain Questionnaire

DALLAS PAIN QUESTIONNAIRE

Patient # ____________

Name: ______________________ Today's Date: ______________

Date of Birth: ______________ Examiner ______________

Please read carefully: This questionnaire has been designed to give your doctor information as to how your pain has affected your life. Be sure that these are your answers. Do not ask someone else to fill out the questionnaire for you. Please mark an "X" in the appropriate box that expresses your thoughts from 0 to 100% in each section.

Section I: Pain and Intensity

To what degree do you rely on pain medications or pain relieving substances for you to be comfortable?

None — Some — All the time

0% [ ][ ][ ][ ][ ][ ] 100%

Section II: Personal Care

How much does pain interfere with your personal care (getting out of bed, teeth brushing, etc)?

None (no pain) — Some — I cannot get out of bed

0% [ ][ ][ ][ ][ ][ ] 100%

Section III: Lifting

How much limitation do you notice in lifting?

None (I can lift as I did) — Some — None

0% [ ][ ][ ][ ][ ][ ] 100%

Section IV: Walking

Compared with how far you could walk before your injury or back trouble, how much does pain restrict your walking now?

I can walk the same — Almost the same — Very little — I cannot walk

0% [ ][ ][ ][ ][ ][ ] 100%

Section V: Sitting

Back pain limits my sitting in a chair to?

None, pain same as before — Some — I cannot sit at all

0% [ ][ ][ ][ ][ ][ ] 100%

Section VI: Standing

How much does your pain interfere with your tolerance to stand for long periods?

None, same as before — Some — I cannot stand

0% [ ][ ][ ][ ][ ][ ] 100%

Section VII: Sleeping

How much does pain interfere with your sleeping?

None, same as before — Some — I cannot sleep at all

0% [ ][ ][ ][ ][ ][ ] 100%

Section VIII: Social Life

How much does pain interfere with your social life (dancing, games, going out, eating with friends, etc)?

None, same as before — Some — No activities total loss

0% [ ][ ][ ][ ][ ][ ] 100%

Section IX: Traveling

How much does pain interfere with traveling in a car?

None, same as before — Some — I cannot travel

0% [ ][ ][ ][ ][ ][ ] 100%

Section X: Vocational

How much does pain interfere with your job?

None, no interference — Some — I cannot work

0% [ ][ ][ ][ ][ ][ ] 100%

Section XI: Anxiety/Mood

How much control do you feel that you have over demands made on you?

(No change) Total — Some — None

100% [ ][ ][ ][ ][ ][ ] 0%

Section XII: Emotional Control

How much control do you feel that you have over your emotions?

Total — Some — None

100% [ ][ ][ ][ ][ ][ ] 0%

Section XIII: Depression

How depressed have you been since the onset of pain?

Not depressed significantly — Overwhelmed by depression

0% [ ][ ][ ][ ][ ][ ] 100%

Section XIV: Interpersonal Relationships

How much do you think your pain had changed your relationships with others?

Not changed — Drastically changed

0% [ ][ ][ ][ ][ ][ ] 100%

Section XV: Social Support

How much support do you need from others to help you during this onset of pain (taking over chores, fixing meals, etc)?

None needed — All the time

0% [ ][ ][ ][ ][ ][ ] 100%

Section XVI: Punishing Responses

How much do you think others express irritation, frustration, or anger toward you because of your pain?

None — Some — All the time

0% [ ][ ][ ][ ][ ][ ] 100%

Modified with permission from GF Lawlis, R Cuencas, D Selby, et al. The development of the Dallas Pain Questionnaire: an assessment of the impact of spinal pain on behavior. Spine 1989;14:512.

Appendix 5.6.

Geriatric Pain Measure

Name__________________________ Medical Record #_________________ Date _____________

Please answer each question.	Answer	Score
Do you or would you have pain with vigorous activities, such as running, lifting heavy objects, or participating in strenuous sports?	No Yes	______
Do you or would you have pain with moderate activities, such as moving a heavy table, pushing a vacuum cleaner, bowling, or playing golf?	No Yes	______
Do you or would you have pain with lifting or carrying groceries?	No Yes	______
Do you or would you have pain climbing more than one flight of stairs?	No Yes	______
Do you or would you have have pain climbing only a few steps?	No Yes	______
Do you or would you have pain walking more than one block?	No Yes	______
Do you or would you have pain walking one block or less?	No Yes	______
Do you have pain with bathing or dressing?	No Yes	______
Have you cut down the amount of time you spend on work or other activities because of pain?	No Yes	______
Have you been accomplishing less than you would like to because of pain?	No Yes	______
Have you limited the kind of work or other activities you do because of pain?	No Yes	______
Does the work or activities you do require extra effort because of pain?	No Yes	______
Do you have trouble sleeping because of pain?	No Yes	______
Does pain prevent you from attending religious activities?	No Yes	______
Does pain prevent you from enjoying any other social or recreational activities (other than religious services)?	No Yes	______
Does or would pain prevent you from traveling or using standard transportation?	No Yes	______
Does pain make you feel fatigued or tired?	No Yes	______
Do you have to rely on family members or friends for help because of pain?	No Yes	______
On a scale of 0 to 10, with 0 meaning no pain and 10 meaning the worst pain you can imagine, how severe is your pain today?		______
0 1 2 3 4 5 6 7 8 9 10	____ (0–10)	______
In the last seven days, on a scale of 0 to 10, with 0 meaning no pain and 10 meaning the worst pain you can imagine, how severe has your pain been on average?		______
0 1 2 3 4 5 6 7 8 9 10	____ (0–10)	______
Do you have pain that never completely goes away?	No Yes	______
Do you have pain every day?	No Yes	______
Do you have pain several times a week?	No Yes	______
Over the last seven days, has pain caused you to feel sad or depressed?	No Yes	______

Scoring: Give one point for each *yes* response and add the numerical responses.

TOTAL SCORE (0–42):_____ Adjusted Score (Total Score × 2.38) (0–100):_____

Appendix 5.7.

Roland-Morris Disability Questionnaire

Roland-Morris Disability Questionnaire

NAME ______________________ PHONE ______________________

DATE ____________ TIME ____________ SUBJECT CODE ____________

ADMINISTRATION # ______________________ ORDER ______________________

When your back hurts, you may find it difficult to do some of the things you normally do.

This list contains some sentences that people have used to describe themselves when they have back pain. When you read them, you may find that some stand out because they describe you *today*. As you read the list, think of yourself *today*. When you read a sentence that describes you *today*, put a check beside the number of the sentence. If the sentence does not describe you, then leave the space blank and go on to the next one. Remember, only check the sentence if you are sure that it describes you *today*.

_____ 1. I stay at home most of the time because of my back.
_____ 2. I change position frequently to try and get my back comfortable.
_____ 3. I walk more slowly than usual because of my back.
_____ 4. Because of my back, I am not doing any of the jobs that I usually do around the house.
_____ 5. Because of my back, I use a handrail to get upstairs.
_____ 6. Because of my back, I lie down to rest more often.
_____ 7. Because of my back, I have to hold onto something to get out of an easy chair.
_____ 8. Because of my back, I try to get other people to do things for me.
_____ 9. I get dressed more slowly than usual because of my back.
_____ 10. I only stand up for short periods of time because of my back.
_____ 11. Because of my back, I try not to bend or kneel down.
_____ 12. I find it difficult to get out of a chair because of my back.
_____ 13. My back is painful almost all the time.
_____ 14. I find it difficult to turn over in bed because of my back.
_____ 15. My appetite is not very good because of my back pain.
_____ 16. I have trouble putting on my socks (or stockings) because of the pain in my back.
_____ 17. I only walk short distances because of my back pain.
_____ 18. I sleep less well because of my back.
_____ 19. Because of my back pain, I get dressed with help from someone else.
_____ 20. I sit down for most of the day because of my back.
_____ 21. I avoid heavy jobs around the house because of my back.
_____ 22. Because of my back pain, I am more irritable and bad tempered with people than usual.
_____ 23. Because of my back, I go upstairs more slowly than usual.
_____ 24. I stay in bed most of the time because of my back.

Adapted with permission from M Roland, R Morris. A study of the natural history of back pain. Part I. The development of a reliable and sensitive measure of disability in low-back pain. Spine 1983;8:141.

Chapter 6

Pathophysiology of Activity Intolerance

Theresa Hoskins Michel and Harriët Wittink

Activity intolerance is a major source of disability in the chronic pain patient population. The principles of deconditioning, studies that describe physical fitness in this population, and basic theory and practical considerations in exercise reconditioning are discussed in this chapter.

The measurement of aerobic fitness or aerobic power is maximal oxygen consumption ($\dot{V}O_2$ max), which is affected by cardiac output (Q) and arteriovenous oxygen difference (a – $\dot{V}O_2$). The Fick equation describes the determinants of $\dot{V}O_2$ max:

$$\dot{V}O_2 \text{ max} = Q(a - \dot{V}O_2)$$

Thus, aerobic power is determined by the performance of the cardiac muscle and efficiency of the muscular system in extracting oxygen from blood for use in generating energy. For each liter of oxygen consumed, approximately 5 kcal of energy is produced. Therefore, the higher the oxygen uptake, the higher the aerobic energy output (Astrand and Rodahl 1986). Aerobic fitness directly affects the physical activities an individual is able to perform. Most activities are described in terms of their energy cost (Astrand and Rodahl 1986).

DECONDITIONING

The term *deconditioning* refers to a condition that makes a number of pathologies more likely and places affected individuals at increased risk. In 1986, data from the Public Health Service (U.S. Department of Health and Human Services 1986) showed that scarcely more than 1 in 10 people reported performing physical activity for at least 30 minutes daily. Approximately one in five people reported activity for at least 30 minutes five or more times a week. Nearly one in four people ages 18 years or older reported no leisure-time physical activity, and among people ages 65 years and over, more than two of every five reported essentially sedentary lifestyles. The 1990 National Health Interview Survey (NHIS) (Centers for Disease Control and Prevention 2000a) showed that 63.9% of employed adults do not meet current recommendations for participation in moderate or vigorous activity. Women, older adults, persons with less than 12 years of education, or members of racial or ethnic minorities are most likely to be inactive during leisure time (Centers for Disease Control and Prevention 2000b). Approximately two-thirds of overweight adults try to lose weight by using physical activity to achieve weight reduction. However, only one-fifth met the national recommendation for physical activity (Centers for Disease Control and Prevention 2000c).

A recent review of the sources of activity intolerance in modern life suggests that epidemiologic data are available showing that physical inactivity increases the likelihood of at least 17 chronic diseases. The reviewers suggest that the National Institutes of Health and other research resources be directed toward the effective prevention of these chronic diseases through appropriate exercise interventions (Booth et al. 2000).

One of the highest risks of deconditioning is coronary artery disease. Physically inactive people have almost twice the risk of developing coronary artery disease than do those who engage in regular physical activity. Habitual activity can also help in the management of non–insulin-dependent diabetes mellitus and osteoporosis. It has been associated with lower rates of stroke (Hu et al. 2000), prevention of hypertension (Fagard 1999), improved sleep (Sherrill et al. 1998), reduced risk of colon cancer (Rissanen and Fogelholm 1999), and reduced risk of female estrogen-dependent cancers of the breast, endometrium, and ovaries (Woods 1998).

All physical activity involves muscular contractions powered by energy. The currency of energy expenditure is adenosine triphosphate (ATP). The phosphorolysis of ATP to adenosine diphosphate (ADP) and inorganic phosphate releases the energy. The amount of ATP stored in muscle at any time is small and must be resynthesized continuously if exercise continues for more than a few seconds. The synthesis of ATP requires a substrate for energy. Carbohydrate and fat act as substrates under usual conditions and in the presence of ADP, adenosine monophosphate (AMP), creatine phosphate (CP), and inorganic phosphate. Synthesis takes place by different aerobic or anaerobic enzyme pathways. Only carbohydrates (glycogen) use the anaerobic pathway for the generation of energy, whereas glycogen, fat, and protein can be used aerobically. These aerobic and anaerobic synthesis processes are summarized as follows:

Anaerobic:

$$\text{ADP} + \text{CP} \rightarrow \text{ATP} + \text{C}$$

$$\text{Glycolysis} \rightarrow \text{Pyruvate} + \text{ATP} + \text{lactate}$$

One molecule of glycogen yields 4 ATP.

Aerobic:

$$\text{Free fatty acids} + O_2 \rightarrow \text{ATP} + CO_2 + H_2O$$

$$\text{Glycolysis} + O_2 \rightarrow \text{ATP} + CO_2 + H_2O$$

$$\text{Amino acids} + O_2 \rightarrow \text{ATP} + CO_2 + H_2O$$

One molecule of free fatty acid (palmitate) yields 138 ATP or 5.8 ATP/O_2.
One molecule of glycogen yields 38 ATP or 8.5 ATP/O_2.

These outlines demonstrate that the aerobic energy yield from glycolysis is much lower than that for free fatty acids. However, glycogen is in limited supply, whereas fatty acids are the largest supplier of stored energy. A man weighing 160 pounds has 80–85% of calories (approximately 140,000 calories) stored as fat. Less than 2,000 calories are stored as carbohydrates (Fisher and Jensen 1990). The ability to use fat depends on oxygen transport capacity, because fat can be metabolized only in the muscle cell in the presence of oxygen.

The major pathways for the production of ATP are shown in Figure 6.1. By far, the most important source of ATP is the electron transport chain on the mitochondrial membrane.

At the initiation of any activity after rest or a lower energy state, there is insufficient oxygen at the muscle cell level to permit aerobic pathways to operate. The only mechanisms to support the energy requirement in this condition of relative oxygen deprivation (oxygen deficit period) are anaerobic. When CP, AMP, and ADP are exhausted in a few seconds, only anaerobic glycolysis is available. Once the delay of oxygen transport has caught up and the demand for energy can be supplied by an oxygen-dependent pathway, it is possible to generate ATP aerobically. This delay in oxygen transport is related to the time it takes for respiratory and heart rates to meet the demands of the activity. This period of oxygen deficit is approximately 3–5 minutes. After this period, a steady state of oxygen delivery can be achieved, as long as the demand for energy does not change. The *steady-state condition* is defined as the period when energy demand is met exactly by energy delivery and can be measured in terms of a steady heart and respiratory rate response. There is no accumulation of lactate in the body. Steady state can be maintained at 40% of $\dot{V}O_2$max without undue fatigue. Higher levels can be maintained by well-trained individuals. If the activity is stopped or slowed down, a period of oxygen debt ensues, during which a recovery heart rate and respiratory rate can be recorded. If activity is shifted upward so that there is an even higher level of energy demand, a new oxygen deficit period begins, and a new steady state may be achieved after a few minutes of adjustment, unless the new level is too high (higher than 60% of maximum effort).

Whenever there is an upward shift in demand, there is a delay in delivery of oxygen based on the ability of the cardiopulmonary system to respond.

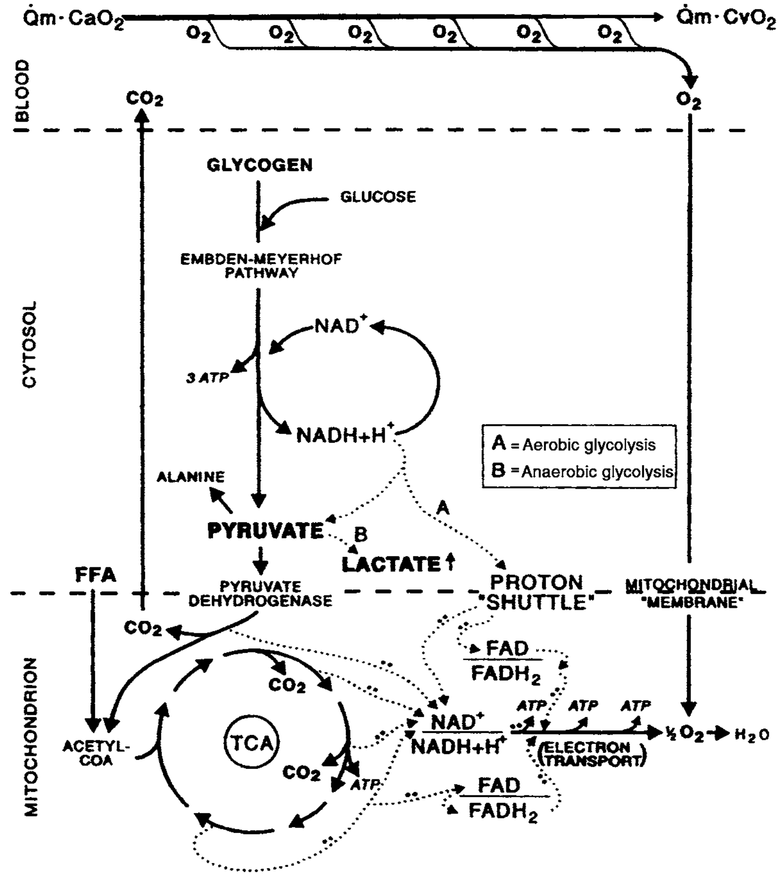


Figure 6.1. Scheme of the major biochemical pathways for production of adenosine triphosphate (ATP). The transfer of H^+ and electrons to O_2 by the electron transport chain in the mitochondrion and the "shuttle" of protons from the cytosol to the mitochondrion (pathway *A*) are the essential components of aerobic glycolysis. This allows the efficient use of carbohydrate substrate in regenerating ATP to replace that consumed by muscle contraction. Also illustrated is the important O_2 flow from the blood to the mitochondrion, without which the aerobic energy–generating mechanisms within the mitochondrion would come to a halt. At the sites of inadequate O_2 flow to mitochondria, pathway *B* serves to reoxidize NADH (reduced nicotinamide adenine dinucleotide) + H^+ to NAD^+ (oxidized form of nicotinamide adenine dinucleotide) with a net increase in lactic acid production (lactate accumulation). Lactate will increase relative to pyruvate as NADH + H^+/NAD^+ increases in the cytosol. (Acetyl-CoA = acetylcoenzyme A; CaO_2 = arterial oxygen concentration; CvO_2 = venous oxygen concentration; FAD = flavin adenine dinucleotide; $FADH_2$ = reduced flavin adenine dinucleotide; FFA = free fatty acid; $\dot{Q}m$ = muscle perfusion; TCA = tricarboxylic acid cycle.) (Reprinted with permission from K Wasserman, JE Hansen, DY Sue, et al. Principles of Exercise Testing and Interpretation [3rd ed]. Philadelphia: Lippincott Williams & Wilkins, 1999;13–14.)

This delay means there is insufficient oxygen in the muscle cell to deliver ATP aerobically, and anaerobic metabolism must supply the ATP. As oxygen becomes available, aerobic metabolism is used more. During steady state, all energy can be supplied aerobically. Even at early phases of steady-state exercise, free fatty acids are not in use. Because these are large, complicated, multicarbon chain molecules, the process of breakdown takes longer. The fragments of three carbon fatty acids are gradually made available after 15 or more minutes of steady-state exercise. Only after approximately 30 minutes of steady-state exercise is it expected that fat metabolism is preferred over carbohydrate metabolism for sustaining ATP production.

There is an intensity of exercise that, although submaximal, is too demanding to be sustained by aerobic metabolism. The delivery of ATP through

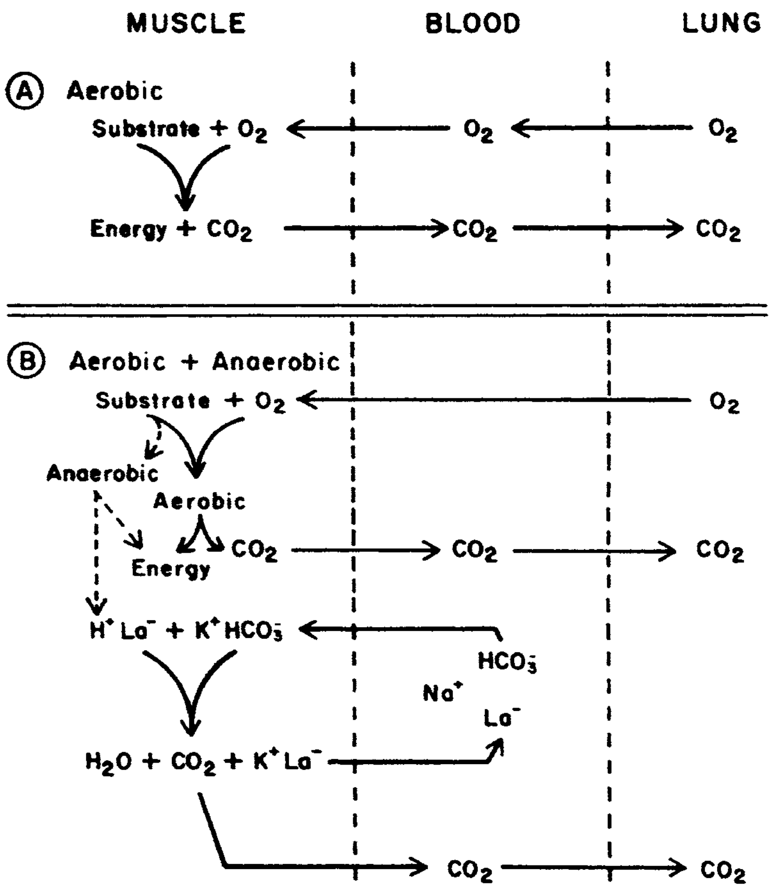


Figure 6.2. Gas exchange during aerobic **(A)** and aerobic-plus-anaerobic **(B)** exercise. The acid-base consequence of the latter is a net increase in cell lactic acid production. The buffering of the accumulating lactic acid takes place in the cell at the site of formation, predominantly by bicarbonate. The latter mechanism will increase the CO_2 production of the cell by approximately 22 ml/mEq of bicarbonate buffering of lactic acid. The increase in cell lactate and decrease in cell bicarbonate will result in chemical concentration gradients, causing lactate to be transported out of the cell and bicarbonate to be transported into the cell. (Reprinted with permission from K Wasserman, JE Hansen, DY Sue, et al. Principles of Exercise Testing and Interpretation [3rd ed]. Philadelphia: Lippincott Williams & Wilkins, 1999;13–14.)

aerobic pathways becomes inadequate at 60–70% of maximal effort, perhaps because the aerobic pathways are complicated, fairly slow, and dependent on one molecule of oxygen at the end of the respiratory chain. As the demand at this high level continues or increases, ATP continues to be delivered via aerobic metabolism. The demand is supplemented by anaerobic glycolysis, which uses up carbohydrate rather quickly and generates more ATP at the rate of 4 ATP more per molecule of glycogen. This production is added to the 38 ATP molecules still available from each glycogen molecule in the aerobic pathway.

Adding more ATP by using both pathways causes lactate to accumulate in muscle cells and in the blood stream. This relative acidosis is detected by homeostatic sensors that maintain constant pH. As the pH drops, the kidneys are signaled to retain bicarbonate to buffer the acid in the blood. This process results in the production of additional CO_2, which is added to the metabolic by-product of CO_2 in muscle cells. The quick accumulation of CO_2 results in the stimulation of the ventilatory system to rid the body of the excess CO_2. A significant increase in respiratory rate occurs, which marks the respiratory threshold. Although the level of exercise intensity can continue to increase, no long-term steady state can occur above this threshold. Fat metabolism will be too slow, and glycogen metabolism will be used above this threshold (Figure 6.2).

These changes can be marked by the respiratory quotient (RQ), which is usually measured by collecting a sample of expired air during exercise. The percentage of CO_2 is divided by the percentage of O_2 in the expired air sample. When fat or a mixture of fat and carbohydrate is being burned for energy, the RQ is less than 1, because CO_2 production is not in excess of oxygen use in aerobic metabolism. Once the anaerobic pathway is used again and lactate begins to accumulate, however, much higher concentrations of CO_2 are present in expired air owing to the burning of carbohydrates in aerobic and anaerobic pathways. RQ values become 1, and above, signaling anaerobic metabolism and a truly maximal effort. Use of carbohydrates exclusively for energy means that glycogen depletion will eventually occur. Glycogen depletion occurs in all prolonged activity; however, the higher the intensity of activity, the faster depletion occurs.

Deconditioning results in a lowering of the respiratory threshold from the normal 60–70% of maximal effort to a lower percentage. This is a relative change, even as the absolute maximal capacity is being reduced to a lower value. Thus, deconditioned individuals experience dyspnea and fatigue earlier in their aerobic exercise and have a difficult time maintaining a steady state of exercise without undue fatigue. If their deconditioned state has altered their respiratory threshold to 40% of their $\dot{V}O_2$max and they attempt to exert themselves at a level higher than 40%, they will rely on anaerobic metabolism for energy supply. This pathway requires use of the limited supply of glycogen and results in the formation of lactate.

$\dot{V}O_2$max is the aerobic capacity of the individual. This value is influenced by all of the energy delivery systems of the body and is measured by collecting expired air during a progressive exercise test. At a person's maximal level, the content of oxygen in the expired air is at a plateau, representing a lower oxygen content than that which was breathed in. This occurs because the body required the use of some of the oxygen that was taken in. Essentially, the difference in oxygen content between inspired and expired air represents the oxygen uptake of the body and, at maximum, is at a plateau value in spite of increases in workload. Table 6.1 lists normative values of $\dot{V}O_2$max. It is difficult to get deconditioned patients who also have pain to continue exercise at these high levels of workload to demonstrate the plateau in the value of oxygen. Therefore, RQ and respiratory threshold measurements are often used, and the maximal oxygen uptake is estimated by extrapolation from these submaximal levels.

Deconditioned individuals also have an inefficient oxygen delivery system that relies on the ventilatory pump, the pulmonary gas exchange system, and the cardiac pump. With inactivity, skeletal muscles, including those involved in inspiration (the diaphragm, intercostals, and accessory muscles of breathing), atrophy, lose mitochondrial enzymes, and may lose capillary blood supply to nutritive beds. As these changes occur, motor nerve conduction velocity is reduced. Thus, the ability of the ventilatory pump to respond to the stimulus for deeper and more frequent ventilations is weakened. The cardiac muscle does not atrophy but does change in its performance efficiency. With detraining, heart rates are markedly elevated at rest and show excessive response at all submaximal levels of exercise. This is owing, in part, to sympathetic stimulation, enhanced drive, and loss of stroke volume. The *stroke volume* is the volume of blood delivered by the heart with each stroke. *Cardiac output* is the stroke volume per unit of time. With a loss of volume capacity, the pump becomes smaller and must beat faster to meet the cardiac output demand. This cardiac output demand is determined by the activities being performed and their ATP (and therefore oxygen) requirements. Most activities performed in a standard way will have a predictable energy requirement. This requirement will change when muscles become inefficient owing to spasticity or weakness. It will also become higher when the patient is heavier than the standard body weight. Deconditioned, nonobese patients who do not have peripheral muscle loss, spasticity, or

Table 6.1. Cardiorespiratory Fitness Classification Measured in Maximal Oxygen Uptake (ml/kg/min)

Age (yrs)	Low	Fair	Average	Good	High
Women					
20–29	<24	24–30	31–37	38–48	49+
30–39	<20	20–27	28–33	34–44	45+
40–49	<17	17–23	24–30	31–41	42+
50–59	<15	15–20	21–27	28–37	38+
60–69	<13	13–17	18–23	24–34	35+
Men					
20–29	<25	25–33	34–42	43–52	53+
30–39	<23	23–30	31–38	39–48	49+
40–49	<20	20–26	27–35	36–44	45+
50–59	<18	18–24	25–33	34–42	43+
60–69	<16	16–22	23–30	31–41	41+

Source: Reprinted with permission from American Heart Association. Exercise Testing and Training of Apparently Healthy Individuals: A Handbook for Physicians. New York: American Heart Association, 1972.

rigidity still have an additional burden in meeting the energy demand of an activity because they are using an inefficient oxygen transport system. Deconditioned patients who also have inefficient muscle-use patterns have additional energy requirements that increase the burden to the oxygen transport system even more.

All of these factors mean that the deconditioned individual has limited oxygen available in the working tissue and less ability to use it in muscle. Therefore, carbohydrates are used for fuel, leading to formation of lactate in muscle. This accumulation decreases muscle contractility, causes muscle fatigue, and puts the individual at considerable risk for injury.

Muscle fiber types include type I and type II fibers. Type I (also called *slow-twitch* or *red*) fibers are predominantly oxidative fibers and have a low glycolytic capacity. They have a rich capillary supply and high myoglobin content, which facilitates the delivery of oxygen to muscle cells. These fibers contain numerous large mitochondria. The high oxidative capacity and low threshold for tetanization make the type I fibers well suited for prolonged tonic contractions, such as those required by postural muscles. Because of their high oxidative capacity, oxygen-delivery role, and heavy reliance on fat oxidation, these fibers are also fatigue resistant. Type II (*fast-twitch* or *white*) fibers have a high glycolytic capacity but few mitochondria and a low oxidative capacity, making them well suited for anaerobic processes.

One peripheral adaptation to inactivity in muscle tissue is loss of mitochondrial enzyme activity. This can even occur in individuals who trained intensely for 10 or more years and started with enzyme activity twice as high as untrained individuals. These individuals lose enzyme activity progressively during the first 56 days of detraining but then stabilize at levels 50% more than those obtained from sedentary control subjects (Coyle et al. 1984, 1985). Single muscle fiber analysis reveals that the persistent elevation of mitochondrial enzyme levels above control values is more marked in type II fibers than in type I fibers (Holloszy and Coyle 1984). This information is consistent with the findings on atrophy of muscles with disuse or immobilization. Type I fibers have been reported to atrophy to a greater extent than type II fibers (St. Pierre and Gardiner 1987). This observation is supported by bed rest studies, in which a proportionately higher-percentage loss of torque in the antigravity muscles was found (Gogia et al. 1988). The loss of torque may also be attributed to the reduction in reflex potentiation, suggesting an impaired ability to activate motor units during voluntary contractions (Dudley et al. 1989). Altered activity patterns have been found to result in pronounced physiologic and morphologic adaptations of the neuromuscular junction. These adaptations are dependent on the model and duration of increased or decreased use and are, in part, specific to the type of muscle fiber. Studies suggest that muscle inactivity results in a reduction in neuromuscular transmission with a concomitant increase in transmission in the neuromuscular junction area. Muscle force is also reduced during this time (Deschenes et al. 1994). Therefore, loss of muscle strength and endurance with inactivity is a function of the following factors: (1) loss of muscle mass, (2) decreased ability to use energy substrates efficiently, (3) decreased neuromuscular transmission, and (4) decreased efficiency in muscle fiber recruitment.

JOINT PATHOPHYSIOLOGY AND DECONDITIONING

The biochemical and mechanical changes arising with stress deprivation of the joint structures and their dynamic movers (the musculotendinous unit) are important to physical therapy treatment. Inactivity and bed rest cause substantial weakness and loss of tissue from all elements of the musculoskeletal system. These changes include a loss of bone, muscle, and connective tissues; a reduction in joint range of motion, muscle strength, and endurance; and a marked decline in physical fitness (Twomey 1992). Muscle responds to disuse with atrophy and loss of contractile strength and mitochondrial enzymes. Tendons and ligaments lose tensile and insertion strength, tissue elasticity, and stretch resistance.

Marked changes in fiber appearance and orientation in the joint capsule have been observed with immobilization and disuse of joints (Akeson et al. 1987). These tissues become brittle, and connective tissues become weaker and less stress resistant.

According to Wolff's law, connective tissue responds to mechanical loading the same way bone does. The more demand that is placed on connective tissue, the stronger it will become. Tendons and ligaments respond to exercise with thickening and increased tensile strength (Tipton et al. 1975). Articular cartilage demands regular mechanical loading to remain healthy. Exercise ensures the passage of synovial fluid over articular surfaces. The alternate compression and relaxation of articular cartilage that occur during movement enable the synovial fluid to be taken back into the articular cartilage as the area of pressure changes over the joint surfaces (Twomey 1992, Frank et al. 1984, Salter and Field 1960, Salter 1989). The intervertebral disk is heavily dependent on movement in the same way. Lumbar sagittal movement brings about the largest fluid exchange between the disks and the interstitial fluid surrounding the spine (Adams and Hutton 1985, 1986). Low-metabolism structures, such as tendons, ligaments, intervertebral disks, and articular cartilage, require hundreds of controlled repetitions to increase their metabolism and remodeling response (Olson and Svendsen 1992). In the absence of movement, weight bearing, and repetitions, there is no remodeling influence, no demand for strengthening of connective tissue, and no nutritive bathing by synovial fluid. Structures lose strength and nutrition, are subject to rapid tearing with minor stresses, become unhealthy, and are at high risk for damage.

In addition to these mechanical factors, there are neurophysiologic changes with inactivity. The fibrous capsules and ligaments act as joint stabilizers to guide tracking of the articulating surfaces. These fibrous structures contain proprioceptive endings that signal higher centers to compensate, using muscle response when strains are applied to the joint. The passive stabilization by ligaments is reinforced by the dynamic stabilization of muscle, and they are interlocked via the central nervous system (Figure 6.3).

RELATIONSHIP BETWEEN PAIN AND BLOOD PRESSURE

Inactivity leads to the elevation of a number of risk factors for cardiovascular diseases, which have been documented over decades by the Framingham Heart Study and other epidemiologic reports (Van Camp and Peterson 1989). One of these risk factors is hypertension. There is a relationship between hypertension and the attenuation of pain perception, which makes this particular risk factor notable in the population of chronic pain patients. Hypertensive men were assessed for experimental pain perception using electrical, thermal, and mechanical stimulation, and their responses were compared to those of normotensive men (Sheps et al. 1992). The higher the average mean arterial pressure, the higher the pain tolerance, indicating that there is a linear relationship across the full blood pressure range. Ghione (1996) postulates that this relationship is, at least in part, mediated by baroreceptor stimulation. Baroreceptor stimulation produces antinociception at both spinal and brain levels (Dworkin et al. 1994). The termination site of the baroreceptor afferents, the nucleus tractus solitarius in the caudal medulla, contains large concentrations of opioid receptors. These findings suggest an interaction between the endogenous opioid system and blood pressure regulatory systems. Decreased pain sensitivity associated with both genetic hypertension and experimental hypertension was shown to be reversible with pharmacologic opioid blockade (Zamir et al. 1980). Nonopioid mechanisms are likely involved with the blood pressure–to-pain relationship. Using a hypertensive rat model, the role of serotonergic receptors was investigated in this interaction (Hoffman 1990). These experiments involved prolonged electrical muscle stimulation of hind legs. This stimulation technique is similar to electroacupuncture and transcutaneous electrical nerve stimulation and is known to increase pain thresholds. The finding that a long analgesic response to electrical stimulation was shorter than the decrease observed in arterial blood pressure led these authors to determine the involvement of the serotonin receptor, using pharmacologic tools. They found that an intact serotonergic system was necessary to trigger analgesia after muscle stimulation but that it was not involved in maintaining analgesia over a long duration. The same 5-HT1 (5-hydroxytryptamine) receptors are also involved in the post-stimulation decrease in blood pressure.

The locus ceruleus appears to be important in both cardiovascular regulation and pain inhibition, although through nonopioid mechanisms. Descending norepinephrine pathways from the locus cer-

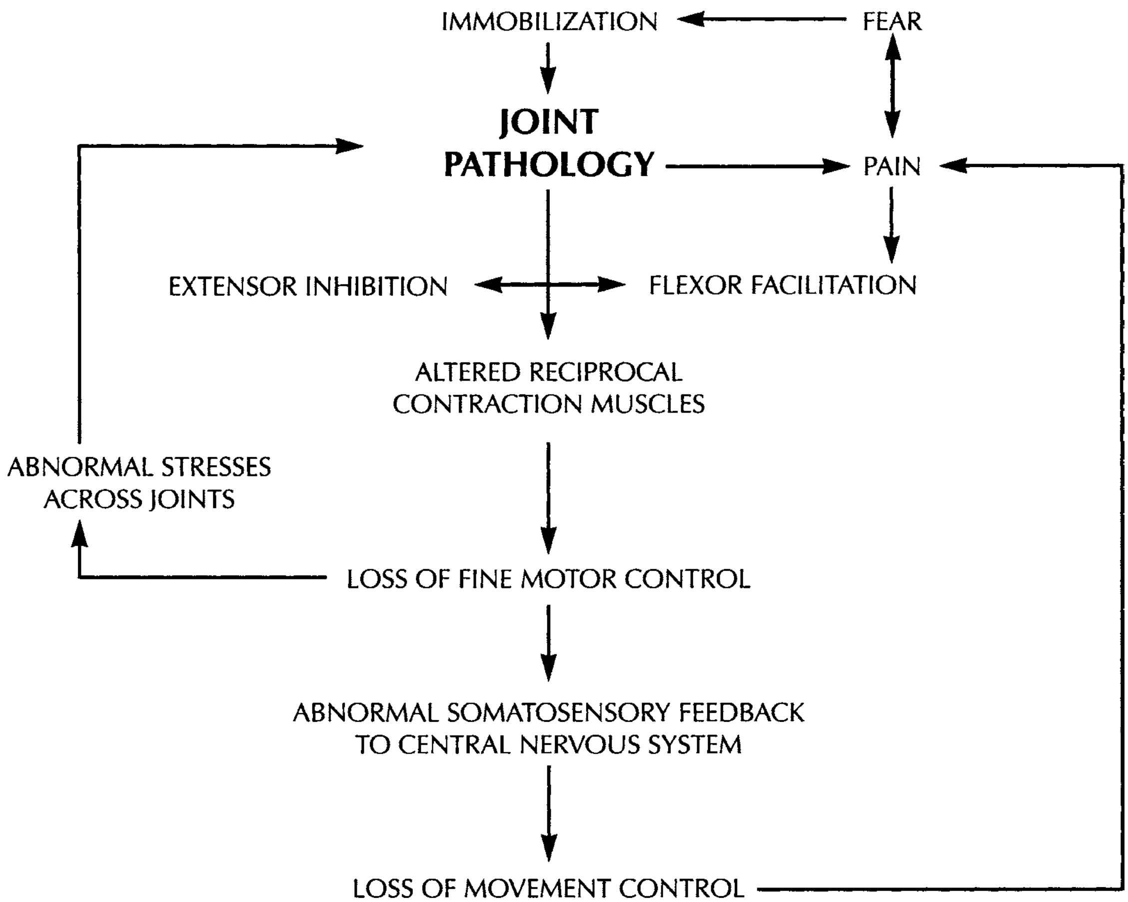


Figure 6.3. A hypothesis of the relationship of joint pathology to loss of movement control.

uleus to the spine exert antinociceptive effects, apparently through activity at $\alpha 2$ adrengeric receptors. Serotonin from the locus ceruleus and the dorsal raphe nucleus also demonstrates antinociceptive effects (Singewald and Philippu 1998).

Female subjects were used in a recent study investigating the relationship between hypertension and attenuation of pain sensitivity (al'Absi et al. 2000). The menstrual phases had a major impact on pain ratings in these women, showing that higher pain ratings were given by women in the follicular phase than in the luteal phase. Even so, the same relationship of hypoalgesia in hypertensive subjects was found. Whether this interaction is owing to the baroreflex and its link to pain perception or to a central dysregulation of the opioid mechanism, the serotonin receptors, or to the hypothalamic-pituitary-adrenocortical axis is still a matter of speculation.

It has been suggested by several authors that in patients with chronic pain, the endogenous opioid system has become altered and becomes a contributor to chronic pain (Lindblom and Tegner 1979, Maixner et al. 1997, Maixner et al. 1998, Bruehl et al. 1999). Impaired opioid function in patients with chronic pain appears to be associated with alterations in the cardiovascular pain–regulatory relationship. For example, Maixner et al. (1998) found that, in contrast to the significant inverse relationship between resting blood pressure and acute pain sensitivity in healthy persons, no such relationship was apparent in patients with temporomandibular disorders. Bruehl et al. (1998) found a progressive change in the normally adaptive blood pressure–pain relationship over the course of a prolonged chronic back pain syndrome. Whether the altered blood pressure–pain relationship in patients with chronic pain is mediated through the opioid system, a nonopioid system, or both remains to be determined.

RECONDITIONING

Aerobic exercise increases the maximal extraction of oxygen by the contracting muscles (increased difference in a – $\dot{V}O_2$). Endurance training increases the capillary density, decreases the diffusion distance from blood to muscles, and increases both the size and number of skeletal muscle mitochondria. This increased mitochondrial content is accompanied by training-induced increases in the enzyme levels involved in the oxidation of free fatty acids. Responses to endurance exercise after training include increased fatty acid oxidation, reduced carbohydrate oxidation and lactate production, and an improved endurance capacity ($\dot{V}O_2$ max). Therefore, total-body carbohydrate stores are conserved during exercise of the same absolute intensity.

Simply, endurance training promotes system efficiency by increased supply of oxygen (through increased number of capillaries, increased diameter of capillaries, and decreased diffusion distance) and increased oxygen use (through increases in size and number of mitochondria and an increase in the number of enzymes in the mitochondria).

With endurance training, the aerobic capacities of all muscle fiber types increase. The greatest increases are observed in type I fibers after continuous training and in type II fibers after interval training. The oxidative capacities of type I and II fibers become more similar after a period of endurance training. There is no evidence that type I fibers can be converted into type II or vice versa, unless the fibers are reinnervated with the alternate type of nerve, which provides trophic and stimulation input to the muscle fibers, creating the cellular changes to convert.

Anaerobic exercise generally refers to heavy-resistance, static forms of muscular contraction. The active muscle must generate very high tensions to balance a high load. When intramuscular tension exceeds the functional strength of the walls of arteries inside the muscle, there is a collapse of arterial walls, especially in the capillaries, where walls are thin and tissue nutrition takes place. When collapse occurs, there is no delivery of oxygen, and exercise can be sustained only anaerobically. Therefore, anaerobic exercise is characterized by strengthening contractions of muscle or high-load, static contractions. This is in contrast to aerobic exercise, which involves moderate-intensity, dynamic contractions of muscles and cardiopulmonary delivery of oxygen and fuel substrates.

EXERCISE AND THE AUTONOMIC NERVOUS SYSTEM

Muscle blood flow can increase up to 100-fold over resting values during intense exercise (Saltin et al. 1998). This large vasodilator capacity presents a significant challenge to blood pressure control during dynamic exercise of large muscle mass, when the blood flow needs of the exercising muscles could potentially approach maximal cardiac output (Saltin et al. 1998).

Many of the cardiovascular responses to exercise, such as increases in blood pressure, heart rate, and regional vascular resistance, are mediated by decreases in parasympathetic neural activity and increases in the sympathetic neural activity (Astrand and Rodahl 1986). These autonomic adjustments to exercise are controlled by two distinct mechanisms: one mediated within the central nervous system and the other originating from peripheral nerves. The central command that accompanies voluntary motor control produces parallel activation of somatomotor and sympathetic pathways. The peripheral mechanism is mediated by a reflex mechanism that arises from stimulation of mechanically and metabolically sensitive afferent nerve endings in the contracting skeletal muscles. This reflex mechanism (the metaboreflex) activates cardiovascular centers in the medulla, increasing efferent sympathetic outflow (Hansen et al. 2000).

The muscle metaboreflex appears to be the primary mechanism for a delayed increase in sympathetic discharge to the circulation of resting skeletal muscle during moderate to intense exercise. *Functional sympatholysis* is a local phenomenon, confined primarily to active muscle, that describes the interaction between a vasoconstrictor stimulus (from the fight-or-flight central command demanding sympathetic activation) and a local vasodilator stimulus brought about by metabolites generated by local muscle contraction. The degree of vasodilation depends on both the strength of the centrally driven vasoconstrictor stimulus and the intensity of the local muscle metabolic activity (Vatner and Pagani 1976).

Microvascular preparations have been instrumental in showing that acidosis, ischemia, hypoxia, and muscle contraction are all capable of attenuating alpha-adrenergic vasoconstriction. These studies have advanced the concept that alpha-1 and alpha-2 adrenoreceptors are distributed heterogenously within the skeletal muscle microcirculation, so that the large resistance arterioles, which regulate systemic arterial pressure, are subserved by both alpha receptor types, whereas the small nutrient arterioles, which regulate tissue perfusion, are governed predominantly by alpha-2 receptors (McGillivray-Anderson and Faber 1990). Furthermore, the alpha-2 adrenoreceptors located on the distal microvessels are much more sensitive to metabolic inhibition than are the alpha-1 adrenoreceptors located on the upstream arteries. Together, these findings have advanced the hypothesis that the relative insensitivity of the alpha-1 adrenoreceptors helps to preserve reflex control of the large arterioles to regulate systemic pressure, whereas metabolic inhibition of the alpha-2 adrenoreceptors redistributes intramuscular blood flow to optimally meet the demands of the most active muscle fibers (McGillivray-Anderson and Faber 1990).

Hansen et al. (1996) found that the threshold intensity of muscle contraction to produce functional sympatholysis (10–20% of maximum) was much lower than that required to produce activation of the muscle metaboreflex (33–45% of maximum) during handgrip exercise in humans, suggesting that the two processes are governed by different metabolic events.

The functional consequence of sympathetic discharge to the contracting skeletal muscle probably depends on the interplay of numerous physiologic factors, such as the mode, intensity, and duration of exercise; fiber type composition of the muscle; and the nature and intensity of the sympathetic stimulus (Hansen et al. 2000).

The clinical implication of these findings in patients with sympathetically maintained pain is as-yet unclear. Perhaps mechanisms such as functional sympatholysis are helpful in the amelioration of symptoms of sympathetically maintained pain through exercise. The above studies suggest that the affected limb should be actively exercised to obtain local vasodilation, which may improve the symptoms of a limb affected by sympathetically maintained pain.

Goldsmith et al. (1992) compared parasympathetic activity for 24 hours in endurance-trained and -untrained young men and found that the trained men had significantly greater parasympathetic activity in both waking and sleeping hours. As cardiac disease is often characterized by heightened sympathetic tone and attenuated parasympathetic activity, Goldsmith and his group (2000) hypothesize that exercise training restores the autonomic nervous system toward normal balance that may be associated with outcome improvements in various populations. For instance, physical activity has been shown to lower blood pressure in both overweight and lean subjects (Fagard 1999). Both a single session and repeated brief sessions of aerobic exercise have been shown to induce marked postexercise decreases in blood pressure that often last for several hours. This decrease has been linked with inhibition of sympathetic nerve activity (Thoren et al. 1990).

Significant reductions in systolic blood pressure after bouts of aerobic activity have often been associated with concomitant alterations in physiologic markers of stress. For example, the hypotensive response after exercise has been shown to exhibit a similar time course as the observed reductions in anxiety (Rachlin and Morgan 1987).

EXERCISE AND THE IMMUNE SYSTEM

A bidirectional communication between the nervous system and the immune system has been described by many authors (i.e., Woods et al. 1999, Jonsdottir et al. 1997). Evidence for an adrenergic and peptidergic innervation of specific regions of primary and secondary lymphoid organs has established the links necessary for neural modulation of immunity. Postganglionic noradrenergic fibers are widely distributed in the organs of the immune system, such as the spleen and the thymus. Large numbers of beta adrenoreceptors are found on natural killer (NK) cells (Jonsdottir et al. 1997). NK cells function as an early defense against viruses, which is the reason many exercise immunologists have been eager to study the response of these cells to exercise stress. NK cells are also the most responsive lymphocyte to exercise stress. NK cell numbers increase by 150–300% immediately after short-term (less than 60 minutes), high-intensity exercise. This postexercise increase of NK cells is transient, however. Endurance exercise may have to be intensive and prolonged (i.e., at athletic levels) before NK cell activity is chronically elevated in humans (Woods et al. 1999).

Opioid peptides, and, in particular, beta-endorphins, can modulate natural immunity, such as NK cell activity, and in most studies, the effect could be completely or partially reversed by naloxone (an opioid antagonist), indicating that an opioid receptor is involved. Accumulating evidence supports the notion that the central endogenous opioid system is part of the regulatory pathway between the central nervous system and the immune system (Jonsdottir et al. 1997). The effects of exercise on the number, functions, and characteristics of the immune system are complex and are dependent on several factors, including the cell function or characteristic being analyzed; the intensity, duration, and chronicity of exercise; the timing of measurement in relation to the exercise bout; the dose and type of immunomodulator used to stimulate the cell in vitro; and the site of cellular origin (Woods et al. 1999).

EFFECTS OF EXERCISE ON MOOD

A large body of literature exists suggesting that both aerobic and anaerobic exercise can decrease depression and anxiety and buffer stress. Because pain has repeatedly been found to be associated with psychological illness, these effects should be considered in the treatment of chronic pain patients. The incidence of depression in chronic pain populations (more than 80%) has been shown to be substantially higher than in normal or acute pain populations (Gamsa and Vikis-Freibergs 1991). Overall, the empiric evidence for a link between exercise and depression is mixed. Depressed people are unlikely to engage in physical activity. It may be that physical activity is actually indirectly associated with depression through its association with other related characteristics, such as self-efficacy, health belief system, and physical health status. The most obvious association of depression and physical activity is physical health status, as those with a physical impairment are more likely to be depressed and less likely to engage in physical activity (Camacho et al. 1991).

North et al. (1990) conducted a meta-analysis of 80 recent studies on the effects of exercise on depression. This analysis included all reported forms of depression and aerobic, strength, and endurance exercise. It concluded that both immediate and long-term exercise significantly decreased depression and that the antidepressant effects continued in follow-up measures. Subjects from most of the populations studied demonstrated decreased depression with exercise. Subjects requiring medical or psychological care for their depression demonstrated the largest increases. The data suggest that exercise was as effective an antidepressant as psychotherapy and that anaerobic exercise was as effective as aerobic exercise. Exercise was not as effective an antidepressant as exercise and psychotherapy together, suggesting that an additive effect of treatments may exist. Subjects undergoing medical rehabilitation for other conditions, such as hypertension or diabetes, demonstrated a larger decrease in depression than did other groups not receiving rehabilitation but needing psychotherapy. *The greatest decreases of depression were seen in programs of 17 weeks or longer.* A significant correlation was found between total number of exercise sessions and the amount of decrease in depression. The data suggest that the longer the exercise program and the greater the total number of exercise sessions, the greater the decrease in depression. The number of times exercise was performed per week and the length of exercise session were found to have no influence.

A second meta-analysis of 34 studies was performed (Crews and Landers 1987) in an attempt to examine moderator variables and statistically assess whether the literature supports the hypothesis that aerobically fit subjects actually experience a reduced stress response. The results of their analysis show that regardless of the type of physiologic and psychological measure used, aerobically fit subjects had a reduced psychosocial stress response. All of the studies in their review used acute, short-term stressors, meaning that these results may not necessarily apply to real-life situations in which individuals may experience more long-term, chronic levels of high stress.

Petruzzello et al. (1991) conducted a meta-analysis of the anxiety-reducing effects of exercise. Data were collected from studies reporting the effects of exercise on self-reported state (acute) or trait (chronic) anxiety and psychophysiologic correlates of anxiety (e.g., electromyography, electroencephalography, alpha waves, blood pressure, and galvanic skin response). One hundred and four studies were reviewed, and 408 effect sizes were calculated, based on a population of 3,048 subjects. Aerobic exercise was associated with lower anxiety in those subjects reporting state anxiety. Exercise did not achieve better effects than medication, relaxation, or quiet rest, however. Exercise lasting 0–20 minutes yielded significantly lower effect sizes than exercise lasting 21–30 minutes. Regular exercise was associated with a reduction of self-reported trait anxiety of more than 0.3 standard deviation units below comparison groups. The length of the exercise training program had much stronger effects when the program exceeded 9 weeks. *The strongest effects were seen for programs lasting more than 16 weeks*. The overall mean effect size for psychophysiologic correlates of anxiety was 0.56, indicating that exercise was associated with a change in anxiety of more than 0.5 standard deviation units below comparison groups.

In a review by Martinsen (1990), it was concluded that depressed people have normal pulmonary function but are physically sedentary and have reduced physical work capacity compared to the general population. This indicates that their reduced physical fitness level is caused by physical inactivity. He found that the results of all studies indicated the same conclusion: Aerobic exercise is more effective than no treatment and not significantly different from other forms of treatment, including psychotherapy. Exercise is associated with an antidepressive effect in patients with mild to moderate forms of nonbipolar depressive disorders. An increase in aerobic fitness does not seem to be essential for the antidepressive effect, because similar effects are obtained with nonaerobic forms of exercise.

Researchers unanimously concluded that aerobic exercise and anxiety are related in an inverse and consistent manner (LaFontaine et al. 1992). Yet, they have consistently refrained from suggesting that this relationship involves causality. They also found that studies consistently reported that aerobic exercise is effective in the treatment of mild to moderate forms of depression and anxiety. It was consistently reported that the benefits were greatest in those who were more depressed and more anxious and that an increase in cardiovascular health was not necessary for mood enhancement.

Byrne and Byrne (1993) reviewed 50 studies published between 1976 and 1989 in referred journals and concluded that 90% of the studies support both the antidepressive properties of exercise and the effect of exercise in combating anxiety. Their data suggest that improvements in aerobic capacity are not responsible for mood improvement and that a nonaerobic activity such as weight training has equally positive effects on the alleviation of depression.

The effects of aerobic and nonaerobic exercise on depression and self-concept were evaluated (Stein and Motta 1992). They used a pretest and post-test control group design with 89 undergraduate students who engaged in either the aerobic exercise of swimming, the nonaerobic exercise of weight training, or a control introductory psychology class. Cardiovascular fitness was estimated by the 12-minute Cooper swim test. Their analysis indicated that both aerobic and nonaerobic training was equally effective in significantly reducing self-reported depression when compared with the control group. The nonaerobic condition was superior to the aerobic condition for enhancing self-concept.

Lennox et al. (1990) studied the effect of exercise on normal mood by evaluating the effect of 13 weeks of aerobic exercise on the mood of 47 nondepressed men and women. Fitness was assessed by estimating $\dot{V}O_2max$ from a modified treadmill test before and after the training program. Although the subjects demonstrated significant improvements in physical fitness, they did not show a significant change in mood.

The hypothesis that participation in physical activity, rather than improved cardiovascular fitness, is the factor associated with better mental health and mood was investigated (Thirlaway and Benton 1992). The sample was comprised of 246 healthy men and women. Cardiovascular fitness ($\dot{V}O_2$ max) was estimated by a submaximal bicycle ergometer test. Physical activity level was estimated by a self-report questionnaire, and a Profile of Mood States was used to assess mood. They found that higher levels of physical activity are associated with a tendency to report a positive mood. This relationship was independent of gender and age factors, unless the individuals were unfit. Inactive but fit subjects were reported to have a poorer mood than those who were inactive and unfit. They concluded that the effect of physical activity on mental health and mood is not mediated by the level of fitness. Therefore, prescribing physical activity needs to emphasize performing physical activity rather than improving fitness.

Brown (1991) designed a study to determine whether the stress-buffering role of physical fitness could be found using relatively objective measurements of fitness and health status and whether the buffering effect of fitness was independent of measures of psychological distress. Subjects were 37 men and 73 women, all undergraduates. Fitness was estimated using a submaximal bicycle ergometer test, self-reports of physical exercise were assessed with the Physical Activity questionnaire, and life stress was measured with the Life Experiences Survey. Doctor visits for physical illnesses served as the main dependent variable in this research. Brown showed that stress was linked to increased medical visits only among subjects who scored low in fitness. Stress had virtually no negative impact on illness behavior in physically fit subjects. Self-reported exercise and physical fitness appeared to buffer the negative effects of life stress. He concluded that people who are physically fit are less vulnerable to the adverse effects of stress than are those who are less fit.

In an investigation of the effect of fitness on psychological and physiologic indices of well-being, 100 police officers were assigned nonrandomly to an aerobic or nonaerobic training group, and an additional 50 subjects were recruited to serve as a control group (Norris et al. 1990). Heart rate and blood pressure were recorded before and after the program. Fitness was assessed by a timed 1.5-mile run. The Job Stress Questionnaire, Life Situation Survey, and General Health Questionnaire were used to assess psychological stress. The aerobic group experienced the greatest reductions in resting heart rate and blood pressure and the greatest improvement in the 1.5-mile run. The nonaerobic group experienced reduction in resting heart rate and blood pressure. Their performance in the timed run did not improve. The aerobic training group registered substantially improved scores in self-reported stress, health, and well-being on all three tests, whereas the nonaerobic group improved scores on the Life Situation Survey and General Health Questionnaire but not on the Job Stress Questionnaire. The control group improved on none of the measures and scored higher on the Life Situation Survey at the second test time.

In summary, general agreement exists on a relationship between exercise and improvement of mood, although researchers tend to avoid statements of causality. From the meta-analyses, it appears that the longer patients are exercising (in number of weeks), the greater the reduction in depression and anxiety, perhaps pointing to a form of receptor adaptation with exercise. Chaouloff, who has done a great deal of research in this area, reports that it is likely that serotonin (5-HT) plays a pivotal role in the etiology of some forms of depression and anxiety. The hypothesis that training or acute exercise, or both, triggers changes in 5-HT receptors has been examined in several studies, and both positive and negative results have been reached (Chaouloff 1997).

The association between improved mood and exercise is extraordinarily important for the treatment of chronic pain and chronic pain syndrome patients. These patients often have complaints of depression and anxiety as comorbid expressions of their pain. Although treating anxiety and depression may not fit into the historic role of the physical therapist, the effects of exercise on these mood states should not be underestimated in their importance.

PHYSICAL FITNESS IN THE CHRONIC PAIN POPULATION

Mayer coined the term *deconditioning syndrome* to describe the physical changes observed in chronic low back pain patients (Mayer and Gatchel 1988). Cady et al. (1979) wrote the earliest paper that evaluated strength and fitness variables in workers with back injury. It examined five variables as they related to subsequent back injury occurrence in 1,652 firefighters during 1971–1974. The five variables were (1) endurance work (measured in watts at the end of 20 minutes of steady-state exercise with a heart rate response of 160 beats per minute [physical work capacity (PWC)160]), (2) total isometric strength of selected muscle groups, (3) total spine flexibility, (4) diastolic blood pressure during exercise at a heart rate of 160 beats per minute, and (5) heart rate 2 minutes after standardized bicycle exercise. Three groups of firefighters were identified based on their fitness levels. The high-fitness group had a PWC160 of 181 W, the middle-fitness group had a PWC160 of 147 W, and the low-fitness group's PWC160 was 115 W. Subsequent frequency of injuries and cost-per-injury claim were analyzed in relation to fitness classifications. The frequency of injuries was 10 times higher for the least fit group than for the most fit group (n = 266 in least fit group; n = 259 in most fit group). The cost per claim for the 19 injured men from the least-fit group was 13% more than for the 36 injured men from the middle-fitness group. There were too few claims made by the most-fit group for an accurate estimation of cost per claim. These data show that good physical fitness is associated with fewer injuries at work and lower costs of workers' compensation claims.

A second publication in 1985 followed the earlier paper in which the results of a fitness program and a self-insurance system for workers' compensation were reported (Cady et al. 1985). After a 3-year period, average PWC160 had increased by 16%, with the oldest group (older than 50 years of age) showing the most improvement. Higher levels of PWC160, strength, and flexibility were found to be inversely related to workers' compensation cost. Individuals with greater flexibility, higher strength values, or higher watts at PWC160 were characterized by a much lower frequency of back pain and lower total injury costs. A correlation coefficient of r = 0.50 was found between the level of PWC160 and general activity level as obtained by interview.

In 1980, a study of seven men and eight women enrolled in a multifaceted inpatient pain program, in which the effects of a gradually progressive activity program on gait and physiologic capacity were evaluated, was reported (Thomas et al. 1980). The average treatment period was 6 weeks. During this period, patients exercised twice daily and worked toward individualized target walking distances and bicycling levels. Three walking tests were used for evaluation, one each at free, fast, and slow speeds on a 60-m level concrete track. The energy cost of walking was examined with measurements of oxygen consumption per minute, oxygen consumption per meter walked, and the oxygen-pulse value calculated from oxygen consumption per minute divided by heart rate. This study reported that chronic low back pain patients, at their self-selected speed, consumed 11% more oxygen than values expected for a healthy population walking at the same velocity. After the treatment program, the mean velocity of walking at a self-selected speed went up by 19 m per minute, which brought the energy cost of walking to within 5% of a healthy population. Thus, there was a decline in energy cost per meter with training that was equivalent to an 18% increase in walking efficiency. The predicted maximal aerobic capacity after the treatment program was 21.4–48.5 ml/kg per minute for men and 25.6–45.1 ml/kg per minute for women. There was a 14% improvement in men and a 38% improvement in women. It is clear that chronic pain can cause a measurable reduction in aerobic capacity and that it may be reversed in a relatively short time with a suitable activity program. It is also important to note that these data point out the inefficient movement patterns adopted by chronic pain patients that result in inefficient walking. Patterns such as muscle guarding, limping, tightness, or weakness may account for this result. An activity program appears to benefit patients with this problem as well.

Schmidt (1985) investigated whether differences could be established between physical performance in chronic low back pain patients and a control group and whether differences between groups could be explained by increased pain. Thirty-nine subjects were in each group. The mean age for both groups was 41 years. Patients reported a mean pain duration of 104 months. All subjects performed a treadmill test at 5 km per hour on a 5% incline for 1 minute. The incline then increased by 1% at 1-minute intervals. The total time on the treadmill, RQ, and heart rate at the end of exercise were used to determine group differences. Pain was measured on a visual analog scale (VAS) before and after the test. There was a significant difference in performance between groups. The chronic low back pain patients spent much less time on the treadmill (a mean of 10 minutes, 40 seconds vs. 14 minutes, 42 seconds), had a lower peak heart rate at the end (a mean of 159 vs. 170), and a lower RQ (a mean of 0.98 vs. 1.04). Pain before the test in the chronic low back pain group was rated at an average of 45 and increased to an average of 53 at the end of the test. Schmidt concluded that the poorer physical performance of the chronic low back pain group could not necessarily be attributed to an increase of pain during the test, because their VAS scores increased only slightly. He stated that chronic low back pain patients are poorer at discriminating between their chronic pain and muscular pain arising from an intensive exercise involving infrequently used muscles. The mean difference of 8 mm on the VAS was slight but may be clinically meaningful to chronic low back pain patients.

McQuade et al. (1988) described the association between physical fitness, pain, depression, physical dysfunction, and psychological dysfunction in a sample of 96 chronic low back pain patients. All measures were taken at the same time. Pain was measured using the McGill Pain Questionnaire and the VAS to determine an average pain value during the previous week. The average hourly level of pain over the week was measured using an activity diary. Physical and psychosocial disability were measured with the Sickness Impact Profile. Depression was assessed with the Center for Epidemiologic Studies Depression Scale. Physical work capacity was measured by calculating a workload to heart rate ratio and then standardizing this to a heart rate of 150 on a bicycle ergometer (PWC150). Oxygen consumption was estimated from the heart rate and oxygen consumption relationship at submaximal workloads.

For 50 men and 49 women, the mean estimated $\dot{V}O_2$ max was 20.5 ml/kg per minute. This value is comparable to an expected value for an elderly unfit 70-year-old subject with no pain. There was a modest association between aerobic capacity and self-reported activity levels. Those with fewer physical limitations had a higher activity level and a higher aerobic capacity. There was no relationship between pain and physical fitness and a negative relationship between fitness and psychosocial dysfunction.

The benefits of a 3-week functional restoration program over a 1-year observation period in 59 people disabled with chronic low back pain were reported in 1989 (Hazard et al. 1989). Thirty-eight men and 19 women with a mean age of 37 years who were disabled for an average of 19 months without evidence of surgically correctable disease participated in the program. The program ran for 53 hours per week and included physical therapy (stretching, strengthening, and reconditioning), occupational therapy (work hardening), psychological treatment, and behavioral counseling. Pain was assessed using a VAS, and functional status was measured by the Oswestry Questionnaire. Aerobic capacity was assessed by a cycling endurance test, in which work demands were increased by 100 kilopond meters (kpm) per minute at 2-minute intervals until patient intolerance or a target heart rate of 85% of predicted maximal heart rate (220 – age) was reached.

Working patients differed significantly in age from nonworking patients. This could be a confounding factor in the reported differences. Working men had an initial cycling endurance of 90 kpm per minute and an improved postprogram endurance of 196 kpm per minute. Working women began at 36 kpm per minute and ended at 80 kpm per minute. Nonworking men began with 53 kpm per minute and ended at 106 kpm per minute. Nonworking women had an initial endurance of 49 kpm per minute and a postprogram endurance of 90 kpm per minute. After 1 year postprogram, working men had values of 129 kpm per minute, working women 55 kpm per minute, nonworking men 78 kpm per minute, and nonworking women 80 kpm per minute. All groups lost cycling endurance during the year after the program but did not regress to pretreatment levels. This suggests that the exercise program was not adhered to vigorously by these subjects. Hazard et al. also suggested that graduates of the program were not distinguishable from unemployed counterparts when they did return to work, except by their cycling endurance and Oswestry scores, but that these two values could not explain why some patients returned to work and others did not. They all showed similar scores on trunk isokinetic flexion and extension, lifting capacity, pain, and depression regardless of whether they were working.

After a second year of postprogram follow-up, Hazard et al. (1991) reported that subjects who did return to work 1 year after treatment had greater cycling capacity, as well as lower Minnesota Multiphasic Personality Inventory schizophrenia scores, higher Wechsler Adult Intelligence Scale-Revised scores, and lower levels of cigarette smoking. Initial and discharge cycling endurances were the best physical score predictors of employment status 1 year after treatment, but cycling endurances did not correlate with program completion. Initial pain intensity scores were higher for program graduates than for program dropouts.

In the largest study of this kind to date, 3,020 employees at the Boeing plant in the Seattle area were enrolled in an investigation of the role of cardiovascular risk factors and fitness in industrial back pain complaints (Battie et al. 1989). The subjects ranged in age from 21 to 67 years, with a mean age of 36.2 years. Men comprised 78% of the study participants. A cardiovascular risk questionnaire was administered, which screened for high blood pressure and history of heart disease. Subjects with these risks (*n* = 399) were eliminated. All of the remaining subjects were tested submaximally on a treadmill to determine predicted maximal aerobic capacity. Test endpoints were 80% of predicted maximal heart rate or physical discomfort. $\dot{V}O_2$ max estimates were obtained on 2,434 subjects who were then followed for more than 3 years to track subsequent back problems.

Both men and women, 28.5% and 28.3%, respectively, reported a history of back problems for which they had sought some medical help. Only in men was there a relationship between back pain and a high risk for cardiovascular disease. The $\dot{V}O_2$ max values did not differ significantly between subjects with or without back problems when controlling for gender and age. This finding conflicts with the earlier study of Cady et al. (1979), who suggest that fitness may not affect the risk of having low back pain but may affect the response to the problem and recovery. A closer examination of the first 26 subjects to develop chronic, disabling back pain in the Boeing study group revealed a significantly lower fitness level compared with unaffected age- and gender-matched subjects. This finding suggests that people who are less fit do not recover as well from back injury or chronic pain as do patients with higher levels of fitness.

In 1991, a report was published that compared aerobic training in three different intervention groups (inpatient, outpatient, and control groups) (Hurri et al. 1991). The 245 participants were all blue-collar workers aged 35–54 years who were randomly assigned to the three groups. Treatment consisted of physical exercise, relaxation exercise, and massage. Testing was performed with a bicycle ergometer, beginning with a 25-W load and increased by 25 W every fourth minute until the subject reported maximum effort. Pain was rated on an index that was the sum of pain VAS ratings for morning, after a workday, and evening. Subjects also rated their disability during the preceding month in 15 different situations. Results showed no differences in aerobic capacity between these three groups before or after treatment, and therefore analyses were carried out on the whole sample as one group. $\dot{V}O_2$ max values were within the range of normal reference values but somewhat low for age. These values also did not correlate significantly with the pain or short- or long-term changes in the pain or disability index. This study seems to suggest that blue-collar workers are only slightly deconditioned compared to other chronic pain patients and that exercise, relaxation, and massage are not able to make a difference in aerobic capacity, pain, or disability measures over the period of treatment.

A study that investigated the effects of an exercise program enrolled 111 industrial employees who were on sick leave owing to back pain (Kellett et al. 1991). An exercise program was instituted during working hours, with an additional exercise session at least once per week outside working hours, for 1.5 years. Before initiation of the exercise program, a baseline period of 1.5 years was used to establish the number of days of sick leave owing to back pain and the number of episodes of back pain occurring. Then the group was divided into an exercise group (*n* = 59) and a control group (*n* = 53), with comparable mean ages.

The exercise program included a warm-up, gentle stretching exercise, alternate strengthening and aerobic conditioning exercises, and 10-minute lectures about traditional theories regarding back pain. Each exercise session lasted 30 minutes and was followed by 10 minutes of relaxation. Attendance averaged 77% at each session. For the pre- and post-test of physical fitness, the participants rode a bicycle ergometer at an intensity that provoked a steady-state heart rate of at least 120 beats per minute. Both the exercise and control group subjects performed this test. The mean preprogram estimated aerobic capacity for the exercise group was 43.28 ml/kg per minute and 44.36 ml/kg per minute for the control group. These preprogram differences were not significant. The exercise group experienced a 36% dropout rate, whereas the control group had a 9% dropout rate.

At the end of the program, the exercise group had a 51.2% decrease in sick days due to back pain, whereas the control group had a 65% increase. There was no significant difference between the groups in the number of back pain episodes reported. Aerobic capacity was not significantly different postprogram in the exercise group; however, it had dropped significantly in the control group. Thus, the reduction in sick days in the exercise group could not be attributed to an increase in fitness. Enrollment in the exercise program did have a significant impact on subjective improvement of back pain, however.

In 1992, a study reported on the differences in mobility, strength, and fitness between an operant conditioning approach and a traditional approach to treating subacute low back pain (Lindstrom et al. 1992). Physical fitness was estimated using a bicycle ergometer, on which the baseline load of 50 W was increased stepwise by 50 W every 6 minutes until a steady-state heart rate of 130 beats per minute was achieved. The VAS was used to rate pain, which was not different between the two groups before treatment. The estimated $\dot{V}O_2max$ for the operant conditioning group before and after treatment was 20.7 ml/kg per minute and 28.2 ml/kg per minute, respectively. The mean number of appointments with the physical therapist was 10.7. After 1 year, the operant conditioning group had an estimated $\dot{V}O_2max$ of 33 ml/kg per minute compared with the control group mean (18.6 ml/kg per minute). Patients in the operant conditioning group returned to work 5 weeks earlier than the patients in the control group. After 2 years, the average duration of sick time taken owing to low back pain was 12.1 weeks in the operant conditioning group and 19.6 weeks in the traditional care group. Thus, this study supports the idea that more physically fit patients recover from back injury better and return to work sooner.

Aerobic power in 46 chronic pain patients was assessed before and after a residential multidisciplinary treatment program (Davis et al. 1992). Twenty-seven men and 19 women were tested for physical fitness on a bicycle ergometer using increments of 20 W per minute for women and 30 W per minute for men. The average age of these subjects was 38.4 years, and the predominant complaint was low back pain. The mean duration of pain was 41.2 months (range of 7–216 months), and the mean number of surgical procedures per patient was 1.1. The mean pretreatment aerobic capacity for the group was 16.2 ml/kg per minute. The mean group RQ on the bicycle ergometer test was 1.05. After treatment, the mean group aerobic capacity was 19.1 ml/kg per minute with an RQ of 1.11. Thus, the patients were able to achieve a higher exercise effort on their post-treatment exercise test and moved from the sedentary category to the sedentary-light or light activity level of functioning. This change was due to a physical conditioning effect, an ability to desensitize to the symptoms accompanying physical exertion, or both.

A study evaluating the effects of aerobic exercise after lumbar microdiskectomy was reported in 1994 (Brennan et al. 1994). Thirteen men and six women from one neurosurgical practice (mean age, 35.8 years) participated in the aerobic exercise program, whereas 11 men and 6 women from a second neurosurgical practice (mean age, 32.6 years) did not. Initial testing was done 4 weeks after surgery. Patients were asked to rate their pain on a VAS and to complete the Activity Pattern Indicator Questionnaire. Treadmill testing using the Balke protocol was done, and oxygen consumption was measured. The treatment program lasted for 12 weeks, during which exercise was performed five times per week at 70–80% of maximal heart rate. The nontraining group performed stretching and strengthening exercise. $\dot{V}O_2max$ values for the training group were 30.3 ml/kg per minute pretreatment and 38.1 ml/kg per minute post treatment. For the nontraining group, these values were 29.6 ml/kg per minute pretreatment and 32.3 ml/kg per minute post treatment. These differences between groups were statistically significant. No differences were found between groups for VAS and Activity Pattern Indicator scores, even after the training period. It is clear that after surgery, both groups are in a very low fitness category

Table 6.2. Borg Scale for Ratings of Perceived Exertion

6	
7	Very, very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	
20	Very, very hard

Source: Reprinted with permission from G Borg. Borg's Perceived Exertion and Pain Scales. Champaign, IL: Human Kinetics, 1998.

(fifth percentile). After the treatment period, the training group improved to a fair level of fitness (thirty-fifth percentile), and the nontraining group remained in a low fitness rating (tenth percentile).

These studies all found that chronic pain patients fall into the very low fitness or sedentary category, with the highest values found in working blue-collar subjects, and the lowest found at 16.2 ml/kg per minute by Davis et al. (1992). The subjects' capacity to improve with aerobic conditioning is clearly demonstrated. Improvement in aerobic capacity has an impact on their ability to return to work sooner and results in an apparently quicker recovery from back injury. These data provide a convincing argument that chronic pain patients can and should engage in aerobic training during their rehabilitation.

Nielens and Plaghki (1994) evaluated the fitness index and exertion perception index observed by a bicycle ergometer test in 42 patients with chronic pain and 34 controls. They used a graded, submaximal, multistaged protocol, increasing workload by 25-W increments to reach a minimum heart rate of 140 beats per minute. They found that only male patients had a reduced exercise capacity and that exertion perception appeared normal in patients with chronic pain. Seventy-two percent of the women and 33% of the men had a positive trend toward pain enhancement during testing.

Wittink et al. (2000) used the modified treadmill test in a sample of 50 patients with chronic low back pain and measured peak oxygen consumption with indirect calorimetry. They calculated prediction equations for men and women separately to compare them statistically with established prediction equations for sedentary and active men and women (Bruce et al. 1973). They found that aerobic fitness levels of patients with chronic back pain equal those in healthy sedentary men and active women. In contrast to the findings by Nielens and Plaghki (1994), pain increase during testing was sufficient for 50% of the sample to stop their test. In a further study exploring whether patients with chronic back pain stopped testing because of pain increase or mental health scores (as determined by the Mental Health score on the Short Form-36 General Health Survey), the authors found that in approximately one-half of the sample, pain intensity increased significantly ($p = .001$) independent of mental health scores (Wittink et al. 2001).

PRACTICAL CONSIDERATIONS FOR EXERCISE AND THE CHRONIC PAIN PATIENT

One of the most useful constructs to emerge in measuring subjective response to physical exercise was presented by Borg (1970) as a scale for the rating of perception of effort. This perception quantifies the subjective sense of intensity of effort, strain, discomfort, or fatigue experienced during exercise (Robertson and Noble 1997). The original category scale (Table 6.2) has been shown to correlate to heart rate, ventilation, and oxygen consumption in healthy subjects (Gamberale 1972). Furthermore, this correlation has been shown to be affected by psychological states (anxiety, depression, and personality traits) (Morgan 1973) and by different types of physical work (dynamic, static, eccentric, concentric, and isokinetic contractions) (Skinner et al. 1973). The rating of perceived exertion (RPE) has been used in formulating an exercise prescription (Smutok et al. 1980).

A variety of central physiologic exercise responses contribute to the sense of effort, including heart rate, minute ventilation, respiratory rate, and oxygen consumption. The exercising body parts also contribute to the perception of exertion. Muscle cramps, twitches, aches, and tremors are reported, which may be influenced by the elevation of local blood lactate concentration (Gamberale 1972), the level of blood glucose (Robertson et al. 1990), and other possible local physiologic factors, such as temperature (Toner et al. 1986).

A ratio scale for RPE was also presented by Borg (1998) (Table 6.3). The major advantage of the use of this ratio scale is parametric statistical testing.

The relationship of the RPE to a subjective rating of pain intensity was explored in patients with chronic low back pain (Lin 1999). Patients with chronic back pain experience fatigue during exercise, which may often be excessive, perhaps due to aerobic deconditioning. However, they may rate their RPE based on their sensations of pain or based on their psychological state. Borg and his colleagues (1985) explored this possible relationship between RPE and leg ache and muscle pain during a progressive maximal bicycle test in healthy nonpain subjects. They reported a moderate to high correlation between RPE and pain in this group of healthy subjects ($r = 0.59–0.91$).

Thirty-four patients with chronic low back pain provided RPE and pain scores at symptom-limited maximal exercise (Lin 1999). Eighteen of these subjects stopped exercise owing to pain (Table 6.4), and 16 stopped owing to fatigue. A surprising number of patients did not stop their peak exercise owing to pain but owing to fatigue. This group achieved a higher peak $\dot{V}O_2$max and a higher percent of predicted $\dot{V}O_2$max. It is suggested that when pain increases, it dominates all sensations so that fatigue is less obvious. When pain does not increase during progressive exercise, the RPE more accurately reflects fatigue, which causes them to stop, by a rating of RPE of 18 out of 20. It is interesting to see how many patients with chronic low back pain were not limited by pain on a maximal treadmill test.

Table 6.3. Rating of Perceived Exertion

0	Nothing at all
0.5	Very, very slight
1	Very slight
2	Slight
3	Moderate
4	Somewhat severe
5	Severe
6	
7	Very severe
8	
9	Very, very severe (almost maximal)
10	Maximal

Source: Reprinted with permission from G Borg. Borg's Perceived Exertion and Pain Scales. Champaign, IL: Human Kinetics, 1998.

Table 6.4. Rating of Perceived Exertion (RPE) and Numeric Rating Scale (NRS) Scores in Chronic Low Back Pain Patients at Symptom-Limited Max Exercise: Comparison of Those Who Stopped Due to Pain (Pain Group) and Those Who Stopped Due to Fatigue (Fatigue Group)

	Pain Group (n = 18)	**Fatigue Group (n = 16)**
Initial pain (0–10 scale)	4.19 ± 2.58	4.60 ± 2.38
End pain	7.26 ± 2.25	4.93 ± 1.83
Peak rate of perceived exertion	17.22 ± 1.77	18.00 ± 1.93

It is concluded that a pain rating is important, and that an RPE added in to monitor changes in symptoms during exercise in patients with chronic low back pain gives important additional information, as there may be fundamental differences between those who stop exercise owing to pain and those who stop exercise owing to fatigue. In the latter, pain did not increase with exercise. In the former, pain increased, and patients tended to overrate their RPE based on their actual oxygen consumption measurements, suggesting the possibility that their RPE reflected more psychological distress (Lin 1999).

In addition to these two subjective ratings, vital signs should be taken during exercise in all pain patients, as those with chronic pain are equally susceptible to cardiovascular or metabolic sources of exercise intolerance as any other population. In the absence of measures of oxygen consumption, heart rate, blood pressure, and respiratory rate, responses give valuable information about the amount of energy being used and how much reserve capacity may still be available to the patient.

TYPE OF EXERCISE: AEROBIC OR ANAEROBIC

Although some work has been done to investigate the effect of exercise on pain threshold, it appears that *exercise* has been understood to mean aerobic training. Very little research exists on whether strength or aerobic exercise has greater pain threshold–raising benefits. Only one investigation could be found (Anshel and Russell 1994) on the effect of aerobic and strength conditioning on pain tolerance. They found that exercise that incorporates aerobic fitness results in greater pain tolerance than does strength training alone. Markedly increased pain tolerance for those undergoing aerobic training occurred between weeks 6 and 12 of the study. According to the authors, because an aerobic training effect usually occurs after 6 weeks, it appears that marked improvement in cardiovascular functioning is a relevant component in linking the role of aerobic work to pain tolerance.

RECONDITIONING EXERCISES

The primary goal of reconditioning exercise in chronic pain patients is to improve functional performance. A general weakening of all tissues takes place with disuse. Exercise treatment should be directed at increasing the strength of the tissues, so the body can respond to the functional demands placed on it. This can be done effectively with high-repetition, low-load exercise and motions. Low loads prevent damage to the tissues, and high repetitions have been shown to be most effective in increasing metabolism in low-metabolism structures. This kind of exercise can be achieved with small dumbbells or other weights, pulleys, or Nautilus equipment. Placing stress on the low-metabolism structures can be done indirectly by muscle contractions. For instance, increasing the fluid exchange between the disk and the interstitial fluid surrounding the spine can be achieved by having the patient maximally flex and extend the lumbar spine repetitively. The patient can also be asked to perform a latissimus pull-down exercise with high repetitions. The contraction and relaxation of the muscle will have a pumping effect on the intervertebral disk, increasing its metabolic activity. Low-load, high-repetition exercise will increase muscle endurance. This is especially beneficial for postural muscles.

As the patient becomes stronger, the load can be increased and the number of repetitions decreased to increase the patient's muscle strength. The body will respond to the demands placed on it, but the challenge must not be punishing or damaging. The physical therapist must ensure that the exercise program matches the physical capacity of the patient's body.

The body responds to the demands placed on it by using a variety of homeostatic mechanisms. In the person with chronic pain, activity intolerance secondary to pain leads to physiologic and pathologic changes in almost all organ systems, but specifically in those organ systems that are related to activity performance. Reconditioning the patient with chronic pain can restore health to many organ systems and specific tissues. This approach deals directly with pain as a symptom, changes the health status of the individual, and has a profound effect on the perception of health status (and therefore on physical performance) in individuals in pain.

The aerobic challenge should follow the general guidelines for physical fitness development. The prescription includes (1) mode of exercise (any dynamic, freely moving, freely breathing form, preferably one that is enjoyable to the patient), (2) intensity of exercise (moderate, below the respiratory threshold of fatigue and dyspnea), (3) duration of exercise (at least 30 minutes, but can be in intervals), and (4) frequency of exercise (four or five times per week unless the duration is less than 30 minutes, then at least once per day).

The quota system of exercise prescription is described in detail in Chapter 7. This system allows patients to achieve short-term goals that build up their tolerance so that they achieve the above exercise prescription. In some ways, they must be conditioned to exercise in a cardiovascular and pulmonary fitness program before they can be fully reconditioned for muscular strength and endurance. In the end, the program will recondition all systems supporting movement and functional improvement.

EXERCISE IN SPECIAL POPULATIONS

Diabetes Mellitus

In the United States, between 70 and 80 million people have insulin resistance, which converts to type 2 diabetes mellitus, or non–insulin-dependent diabetes mellitus, when insulin deficiency develops as a result of chronic insulin resistance. *Insulin resistance* refers to the state of the insulin receptors located on muscle and liver cell membranes, which can acquire resistance to insulin action due to obesity, inactivity, and genetic predisposition, although the actual mechanism of insulin resistance is still unknown (Bloomgarden 1999).

Eighty to ninety percent of insulin-mediated glucose uptake is by muscle in direct response to metabolic demand (exercise). Exquisite control of muscle glucose uptake is regulated by both brain stem signals and muscle contraction feedback and is modified by an individual's fitness level, the availability of glucose related to recent meals, and, in diabetics, the site and method of insulin administration.

Acute and habitual exercise has major influences on caloric expenditure, insulin sensitivity, basal metabolic rate, and weight loss. Acute exercise produces a rapid increase in glucose uptake in exercising muscle up to 40-fold during high intensity exertion. Moderate exercise over 40 or more minutes increases liver glucose production (gluconeogenesis) by four times resting levels. At the same time, there is a reduction in insulin release from the pancreas (Felig and Wahren 1979). Thus, during acute exercise, both intensity and duration determine the balance of glucose production to glucose breakdown for energy. For example, with heavier exercise, carbohydrate use increases, free fatty acid mobilization is suppressed, and catecholamine levels increase, but glucagon decreases. Both norepinephrine and epinephrine stimulate carbohydrate oxidation, which is seen during moderate-intensity exercise in healthy subjects; however, men have higher catecholamine responses than do women, who have evidence of a greater degree of lipolysis (fatty acid use) (Bloomgarden 1999).

Exercise training has been shown to improve glucose tolerance, probably through increasing peripheral insulin sensitivity. In rats, training augments microsomal translocation of Glut-4, which is a form of glutamine that, when stimulated by insulin, migrates to the cell membrane for transport of glucose into the cell (Etgen et al. 1997). Six months of three-times-per-week treadmill training in diabetic women reduced the glucose tolerance test glycemic response and insulin concentrations compared to Nautilus-trained postmenopausal women (van Dam et al. 1988) Aerobic training, rather than anaerobic strength building, improves insulin-mediated glucose disposal in non–insulin-dependent diabetes, as compared to no change in glucose disposal after a calorie-restricted diet (Bogardus et al. 1984).

Individuals with type 2 diabetes can, therefore, expect a number of benefits from habitual exercise: (1) the potential for improved glycemic control, (2) prevention of the progression of metabolic abnormalities, (3) weight reduction, (4) decreased risk of atherosclerosis, and (5) protection from sudden death (Tudor-Locke et al. 2000). Avoiding exercise for even 3 days can worsen insulin sensitivity in these patients.

A suggestion for an exercise training program for female type 2 diabetics was given by Brandenburg et al. (1999). It involved a 3-month supervised program, 3 days per week, which included 5 minutes of warm-up stretches, 50 minutes of moderate-intensity exercise, and 5 minutes of cool-down activity. This program improved the aerobic capacity by 28% in the type 2 diabetic subjects as compared to 5% improvement in lean nondiabetics and 8% improvement in obese nondiabetic subjects. Thus, diabetes, not obesity, appears to be a determinant of these significant group differences.

Men with diabetes may not have as great an exercise impairment as do women with diabetes (Regensteiner et al. 1995). The mechanism for this gender difference is not well understood, but a number of studies have explored the phenomenon of gestational diabetes, which may relate to the basic hormonal-regulation differences between men and women (Carpenter 2000, Bung et al. 1991).

Lifestyle changes, including caloric restriction, weight loss, and increasing aerobic capacity, may prevent type 2 diabetes. The Malmo study (Eriksson and Lindgarde 1991) showed that 28% of patients progressed to type 2 diabetes, compared to 10% who exercised and restricted their caloric intake. This is true for more advanced hyperglycemia as well, in which 65% progressed to type 2 diabetes, compared to 45% who exercised and dieted (Pan et al. 1997).

Modifications to mode of exercise training and intensity may be necessary for patients who have complications of diabetes. One such complication is autonomic neuropathy, which alters the expected heart rate response to exercise. Heart rate monitoring is important but may not be relevant to the relative intensity that a given exercise load presents to such a patient with autonomic dysfunction. The Borg RPE scale can be used as an alternative. Blood pressure regulation may also be affected by autonomic neuropathy. A normal resting blood pressure may suddenly become dangerously hypertensive during a low-to-moderate exercise session. Optimal control of this form of hypertension is still not clear.

Peripheral neuropathy can be painful and often leads to foot problems. Exercise may need to be modified to allow for non–weight bearing, or protected weight bearing. Upper-body exercise and aquatic exercise may be useful alternatives (Albright et al. 2000).

Obesity

One-third of the U.S. population over the age of 20 years is obese, and the prevalence is expected to increase by 10% by 2010. A body mass index over 30 kg/m^2 (weight over height squared) is associated with a 10- to 20-fold increase in diabetes prevalence. Ninety percent of type 2 diabetic patients are obese. Therefore, obesity is a significant societal problem and is associated with high costs of medical care. These costs decrease with weight loss. Exercise and diet are the most effective means to achieve weight reduction (Bloomgarden 1999).

Hypertension

Exercise training can play an important role in the reduction of high blood pressure. The two possible mechanisms for this benefit are through the reduction in peripheral resistance and through a decrease in cardiac output. In studies of spontaneously hypertensive rats, endurance training was seen to decrease muscle sympathetic nerve activity (Winder et al. 1982) and attenuate cardiac sympathetic tone (Gava et al. 1995). Krieger et al. (1999) reported that low-intensity exercise training directly affected sympathetic activity to the heart but did not alter vagal tone, which effectively normalized the increased sympathetic tone. This group of workers emphasizes that it is low-intensity, not high-intensity, exercise that decreases blood pressure in hypertension, and that the training effect of a decreased resting heart rate and cardiac output play an important role in promoting blood pressure reduction. They suggest that through exercise training, there is a recovery of baroreceptor sensitivity which controls heart rate and blood pressure, and which derives from the normalization of cardiac adrenergic tone.

In humans, the following recommendations have been made regarding exercise for hypertension: (1) People with mild hypertension should carry out 50–60 minutes of moderate dynamic exercise of lower extremities, such as walking or cycling; (2) in people who take pharmacologic therapy for hypertension (especially those not taking β-blockers), exercise should be prescribed; and (3) there is no direct evidence that regular exercise will prevent hypertension, but it will effect a decrease in blood pressure post exercise and reduce the risks of coronary artery disease (Cleroux et al. 1999).

The training prescription to achieve the antihypertensive effect suggests that dynamic modes, rather than progressive resistance exercises, are recommended, although a recent meta-analysis of resistance exercises reports that there is a small reduction in both resting systolic and diastolic blood pressure (Kelley and Kelley 2000). Furthermore, the exercise training program is shown to be effective by weeks 4 and 5 (Filipovsky et al. 1991). Three sessions per week makes 75% of the difference that daily exercise makes on hypertension (Nelson et al. 1986) at an intensity of 50% of $\dot{V}O_2$ max. Sessions ranged from 30 to 90 minutes, with the usual session lasting 45 minutes. However, training, which lasted longer than 45 minutes, had the most dramatic decreases in systolic and diastolic blood pressure. It is therefore recommended that sessions last from 50 to 60 minutes in duration (Cleroux et al. 1999).

The majority of studies (88%) using a moderate exercise intensity of 45–60% of $\dot{V}O_2$ max showed significant decreases in systolic or diastolic blood pressure, whereas only 9% of studies using vigorous or strenuous exercise intensities (64–80% of $\dot{V}O_2$ max) showed significant decreases. Therefore, the recommendation of 50% of $\dot{V}O_2$ max as a training intensity is made (Cleroux et al. 1999). Improvements in blood pressure at rest do not actually depend on changes in $\dot{V}O_2$ max (Rogers et al. 1996).

Age does not play any role in the benefits of exercise on hypertension. The decrease in blood pressure after training is comparable in women and in men. Black, Japanese, and white subjects also have comparable results. Therefore, it is recommended that exercise training be applied to all individuals with hypertension, regardless of age, gender, or race; and to those with more severe pharmacologically managed hypertension, as well as mild hypertension; and for prevention in normotensive individuals.

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Chapter 7

Pain Rehabilitation: Physical Therapy Treatment

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> First of all, I would define medicine as the complete removal of the distress of the sick, the alleviation of the more violent diseases, and the refusal to undertake to cure cases in which the disease has already won the mastery, knowing that everything is not possible to medicine.
>
> —*The Science of Medicine*, Hippocratic Writings (Chadwick et al. 1983, 140)

All treatment plans should be based on an understanding of the physical and psychopathophysiologic changes associated with pain and should include treatment that limits the dysfunctional impact of chronic pain by changing the patient's behaviors and appraisal of pain (Dworkin et al. 1992).

Physical therapy treatment of patients with chronic pain includes the following goals:

- Reduction of the impact of pain by achieving a change in the patient's beliefs about pain
- Improvement in the patient's knowledge of independent pain management
- Resolution of treatable impairments
- Improved functional (work) capacity
- Decreased disability

Commonly used physical therapy approaches for patients with chronic pain include operant conditioning, cognitive-behavioral approaches, and functional restoration (Table 7.1).

OPERANT CONDITIONING

The operant conditioning approach to the management of chronic pain was first described by Wilbur Fordyce, a behavioral psychologist, and colleagues at the University of Washington's Department of Rehabilitation in the late 1960s and early 1970s (Fordyce et al. 1968, 1973). This program involved a 4- to 8-week inpatient period designed to gradually increase the patient's activity level and to decrease or end medication, crutch, cane, and brace use. Operant conditioning is based on the assumption that, although pain may initially result from some underlying organic pathologic condition, environmental reinforcement can modify and further maintain various aspects of pain behavior. For instance, a patient with an acute injury may grimace in pain and need a cane to be able to walk. The spouse, who has not paid much attention to the patient lately, is now considerate and forthcoming. Home duties are taken over by the spouse and the children, the patient gets breakfast in bed, and everyone is nice to him or her. The physical therapist tells the patient to "stop when it hurts" and to take time off work to recuperate. The patient thus learns that pain behaviors, such as grimacing, limping, and using a cane, have positive consequences. When the positive consequences outweigh the negative consequences of pain behaviors, the patient is likely to persist in this behavior, because there is too much to lose (attention, spare time, and avoidance of dreaded work or social duties) to revert to the premorbid status.

The term ***operant conditioning*** refers to the modification or elimination of pain behavior (e.g., lying down, avoiding physical and social activities) instead of attempting to "cure" pain (Fordyce et al. 1968). This method addresses excess dis-

Table 7.1. Key Definitions

Term	Definition
Operant conditioning	Behavior of the patient modified by the environment
Cognitive-behavioral therapy	Beliefs of the patient result in behavior modified by environment
Functional restoration	Return to work and "sports medicine approach" to rehabilitation with cognitive-behavioral therapy

ability and expressions of suffering (Fordyce et al. 1985) and substitutes rewards for healthy behavior (e.g., productive activity directed toward achievement of goals) for traditional expressions of sympathy and concern. The goal of this approach is to ignore pain behavior, so it is not reinforced, whereas the desired behavior is reinforced with compliments and attention (Greenhoot and Sternbach 1977). Operant conditioning includes having patients set their own functional goals and rewarding the accomplishment of each goal (positive feedback) and ignoring pain behaviors such as grimacing, rubbing, sighing, and moaning (no feedback). Because patients are not being rewarded for expressing their pain, the pain behaviors gradually disappear.

Physical therapy treatment in the cognitive-behavioral program uses exercises that take into account the nature and site of the pain problem and general physical status considerations. Fordyce et al. (1981) wrote the following:

> The exercises also perform the function of identifying the starting point or baseline of each patient in regard to exercise tolerance. The operant treatment program emphasizes increasing exercise and activity level. Early exercises are termed baseline sessions. For each baseline session and for each exercise, the instructions are given in a working-to-tolerance mode. Specifically, the patient is instructed by the therapist as follows: "Do as many as you can until pain, weakness, or fatigue cause you to stop."

Quotas are set for each exercise. Each quota should be less than the average baseline number of repetitions. This ensures that the patient can meet the first quota so that he or she receives positive feedback for achieving a goal. Quotas are then increased at a predetermined rate, regardless of how the patient feels. This separates fear of pain from activity and allows the patient to relearn healthy behaviors.

Case Example

The patient is a 39-year-old woman who injured her back in a motor vehicle accident 14 months ago. After the accident, she was unable to bear weight on her left leg and was told by her physician to "stay off her leg." She complied with this advice, did not bear weight on the leg for 1 year, and used bilateral crutches. She is referred with a diagnosis of possible reflex sympathetic dystrophy. The patient is encouraged to start bearing weight on her left leg. When she is able to bear enough weight on her left leg to hold her standing balance without leaning on her crutches, the next goal is use of only a cane within 2 weeks. Thus, this patient must increase her time ambulating with one crutch from 0 hours to 5 hours in 15 days. Increasing her ambulation time with one crutch by 20 minutes per day allows her to achieve this goal.

Impairment: Pain.

Functional limitation: Inability to bear weight on left leg, abnormal gait.

Disability: Decreased performance in activities of daily living (ADLs) and instrumental ADLs.

Assessment, diagnosis, and prognosis: The patient is a 39-year-old woman who presents with inability to bear weight on the left leg owing to pain. The patient will benefit from a quota-based exercise program in weaning the patient off her bilateral crutches to ambulating with a cane in 2 weeks by increasing her time ambulating with one crutch by 20 minutes (more) each day as home work exercise.

COGNITIVE-BEHAVIORAL THERAPY

Turk et al. (1983) put forth a model of *cognitive-behavioral theory*. According to the cognitive-behavioral model, patients' beliefs and coping behaviors play central roles in their adjustment to chronic pain. Measures of pain beliefs and functioning are shown to have significant associations (Jensen et al. 1999) and to be related to important outcomes in longitudinal research. For instance, catastrophizing thoughts (e.g., "My pain will get worse and worse, and I will end up in a wheelchair because of it; I will lose my income, my wife will divorce me, and I will be homeless.") in response to pain predicted depression 6 months later (Keefe et al. 1989). Changes in patients' beliefs are associated with changes in activity levels (Flor et al. 1993), depression, and pain (Lipchik et al. 1993). Changes in beliefs that pain signifies harm are associated with changes in depressive symptoms and physical functioning (Jensen et al. 1994). *Harm beliefs* (the belief that hurt necessarily indicates damage and that activity therefore should be avoided) are closely linked to measures of physical functioning and pain behavior (Jensen et al. 1999).

Kerns et al. (2000) showed that individuals who hold strong beliefs that their condition is purely physical, requiring medical attention exclusively, are not successfully engaged in a treatment approach that emphasizes personal responsibility and self-management skill acquisition. Conversely, individuals who endorse beliefs suggesting they are contemplating self-management as an alternative to medical interventions are more likely to participate in psychological treatment.

Cognitive-behavioral therapy refers to guiding patients to identify and change those beliefs that may be ineffective or even maladaptive and to adopt strategies, beliefs, and behaviors that are thought to lead to decreased pain and disability.

FUNCTIONAL RESTORATION

The term *functional restoration* was coined by Thomas G. Mayer and Robert Gatchel (1985) and was designed for patients with spinal pain. This approach integrates a functional rehabilitation emphasis (the focus is on function, not pain) with a multimodal pain management program that uses a comprehensive cognitive-behavioral treatment orientation to help patients better cope with and manage their pain, which is temporarily increased while undergoing the "sports medicine" approach to back care (Mayer et al. 1986). The philosophy of the functional restoration approach is that almost all patients experiencing chronic low back pain can be returned to a productive lifestyle (i.e., work). The primary goal for each patient is restoring high levels of function (rather than eliminating pain) and reducing reliance on health care providers (Mayer and Gatchel 1988).

The central assumption in this treatment approach is that the major physical deficit in chronic low back patients is the *deconditioning syndrome* caused by prolonged disuse of spinal joints and muscles. Physical therapy treatment consists of aggressive individualized physical reconditioning based on the objective quantification (i.e., isokinetic testing) of physical functioning.

In this program, no hands-on techniques are used, and modalities such as heat, ice, and transcutaneous electrical nerve stimulation (TENS) are discouraged. Patients are weaned from their braces, canes, and crutches, as well as from their (class II, or opioid) pain medications. The goal is return to work, and a great deal of emphasis is placed on work simulation and vocational counseling.

The program consists of four phases. In phase I, the preprogram phase, the patient is instructed in a generic stretching program at home to normalize range of motion (ROM). Phase II involves the most contact with and supervision of the patient. During an intensive 3-week program, there are 150 contact hours, with 50% of that time spent in training and 50% in counseling. The physical therapy part of the comprehensive program focuses on the patient's strength, endurance, and aerobic capacity.

Mayer and Gatchel (1988) emphasized that physical therapists should rely increasingly on objective, functional-capacity assessment technology for mobility, strength, and endurance tests. Exercises progress based on these tests, with the goal of attainment of normative values for strength and endurance. Therefore, the patient's progress is based on the outcome of his or her objective testing, regardless of his or her pain.

Phase III is a follow-up phase of variable frequency and duration. Patients are responsible for maintaining a home exercise program, using an exercise facility, or both. Phase IV tracks long-term outcomes.

CURRENT TREATMENT OF PATIENTS WITH CHRONIC INTRACTABLE PAIN

In the changing health care environment, the focus of physical therapy treatment has shifted from treating impairments to emphasizing the achievement of functional goals. Treatment of impairments must be linked to improved physical functioning. Patients are expected to take an active role and to learn to manage their problems independently. Education and instruction in home programs are extremely important. Today's patient is an educated consumer of health care, and it is not uncommon for patients to show up armed with information from the Internet. No longer passive recipients of health care, patients form dynamic partnerships with their health care providers to achieve treatment goals.

Treatment approaches for patients with chronic pain have long emphasized patient independence and self-management to achieve and maintain functional goals.

Since the development of the initial treatment philosophies for patients with chronic pain described earlier, progress has been made in understanding tissue behavior, motor planning and execution, exercise specificity, and pain mechanisms. Guarding and limping may not be just pain behaviors, but rather a reflection of abnormal sensory feedback resulting in abnormal motor output (Graven-Nielsen et al. 1997, Arendt-Nielsen et al. 1996). Extinguishing pain behaviors without changing patients' beliefs about their pain (see Chapter 8) likely will not lead to an optimal outcome. The relationship of high-technology equipment (isokinetic machinery) to assessment and treatment of patients' functional ability remains unclear.

Despite the abundance of literature on patients with chronic pain, the contribution to this collection by physical therapists is small. We have to rely on the information provided to us by other professionals to arrive at optimal physical therapy interventions for patients with chronic pain. The outcomes movement, although growing rapidly, is still young and unable to provide concrete guidelines for the treatment of patients with chronic pain. Evidence-based medicine, of which the Cochrane Collaboration is the gold standard, attempts to provide evidence for treatment by the systematic review of published research. Their efforts are hampered by existing poor-quality research, and almost every review concludes that "there is insufficient evidence to recommend X treatment . . . . There is a need for high-quality controlled trials to further evaluate X treatment." Van Tulder et al. (2000) performed a systematic review of 39 randomized controlled trials of exercise therapy for nonspecific chronic low back pain, excluding multidisciplinary programs. They concluded that "exercise therapy is more effective than usual care by the general practitioner and just as effective as conventional physiotherapy for chronic low back pain." Guzman et al. (1997) performed a systematic review of multidisciplinary team approaches for the treatment of chronic back pain and concluded that "multidisciplinary programs are more effective than nonsystematic treatment in the management of chronic low back pain, but the effects are probably modest." In conducting a literature search in Medline of documents from 1966 to January, 2001, using *functional restoration* and *pain* as keywords, 75 references were found. Evidence in the literature indicates that an active rehabilitation approach is effective in returning patients to work and in decreasing sick time, medication use, visits with health care providers, and numbers of surgeries. These studies have been criticized for lack of appropriate control groups, selection bias, incomplete follow-up, and inappropriate allocation of compared patients, as well as inappropriate statistical handling of dropout patients (Teasell 1996). Only two of the papers represented randomized studies (Mitchell and Carmen 1994, Bendix et al. 1998). The Cochrane Database of Systematic Reviews at this time holds a number of protocols to investigate the effectiveness of multidisciplinary approaches to chronic back pain (Guzman et al. 2001), work conditioning, work hardening and functional restoration for workers with back and neck pain (Schonstein et al. 2001), and multidisciplinary biopsychosocial rehabilitation for neck and shoulder pain among working age adults (Karjalainen et al. 2001), to name just a few.

The Evidence-Based Recommendations for Medical Management of Chronic Non-Malignant Pain (College of Physicians and Surgeons of Ontario 2000) advocate active exercise for chronic low back pain, chronic neck pain (with or without limb pain), and generalized soft tissue pain (see Table 7.12).

The standard of care of physical therapy treatment in multi- and interdisciplinary pain management programs is active, progressive, quota-based exercise, although passive modalities may be included in the treatment program. The decision about whether treatment should include passive modalities is based on assessment tools described in Chapter 5 and on the evaluation of the patient.

Ideally, treatment of patients with chronic pain is done by a team of health professionals, commonly consisting of physicians, psychologists, physical and occupational therapists, and nurses, to address the multifaceted nature of pain. The focus of physical therapy treatment should be on *helping patients regain control over their lives* by active participation in their pain therapy program and independent management of their pain.

Although it can be appropriate to treat patients with acute pain with hands-on techniques, this approach may not be appropriate for patients with chronic pain and can, in fact, be disastrous. Unlike patients with acute pain, there is little relationship between pain and physical functioning in patients with chronic pain; therefore, treating pain will not change the level of physical functioning. Furthermore, if a patient has had pain for a long time, it is unlikely that it can be "fixed." Patients with chronic pain will not deny that their ultimate hope is to be pain free; however, some patients are more realistic about this goal than others. Patients with chronic pain have often seen a variety of health care providers, all of whom have promised to cure the pain, tried, and were unsuccessful. During this process, patients become passive and increasingly dependent on, yet disillusioned with, the medical system. Making promises that cannot be kept, such as curing pain, only furthers disappointment and negatively impacts the patient.

An active partnership should be established between the patient and the physical therapist. This partnership should be based on shared goals. Patients actively seeking a cure or an explanation for their pain despite multiple negative tests are not likely to do well with a pain management program. Patients whose cultural beliefs do not include active participation in a treatment program are also unlikely to do well (see Chapter 2).

For those patients with whom shared goals can be established, the physical therapist becomes a guide, helping the patient achieve the desired goals of independent pain management: reduction of the impact of pain, improvement in the patient's knowledge of independent pain management, resolution of treatable impairments, improved functional (work) capacity, and decreased disability as measured by the attainment of measurable functional goals within a limited time frame in an environment sufficiently secure to reduce fear and promote self-confidence. The role of the physical therapist is that of motivator, challenger, and educator. The patient participates by following through with the home program and taking responsibility for pain management and achievement of functional goals.

The following aspects of treatment are central to the management of chronic pain patients:

- Education
- Functional goal setting
- Instruction in self-management of pain
- Behavior modification techniques
- Active modalities
- Passive modalities

EDUCATION

Patients are often surprisingly ill-informed about the nature of their pain, the anatomy of their affected body part(s), and the difference between acute and chronic pain. Education about the anatomy of the affected body part(s) and the pathophysiology of chronic pain will help to increase the patient's understanding of the nature of the problem, reduce anxiety, and increase his or her compliance with and participation in physical therapy treatment. Patients often complain that they believe they have not been given a diagnosis for their pain. They believe that if they had a diagnosis, their pain could be cured. The physical therapist should explain that there is no "magic bullet" capable of curing them from their pain, health care providers do not have all the answers, and diagnosing a specific type of pain (e.g., atypical facial pain, fibromyalgia, myofascial pain syndrome, complex regional pain syndrome) does not mean there is a specific cure for it. We can diagnose acquired immunodeficiency syndrome, but we cannot yet cure it. Similarly, seeing "something" on a magnetic resonance imaging (MRI) or a computed tomography scan does not mean that a patient's pain is now explained. In a study comparing MRI results of people with and without pain, radiologists were unable to distinguish the groups based on what they saw on MRI (Boden et al. 1990, 1991).

Most patients do not understand the difference between acute and chronic pain. Explaining that the central nervous system is highly adaptive and flexible and changes occur over time that cannot be reversed can be difficult. A good example to use is memory. Because of the central nervous system's adaptability and ability to code information, we can remember people and events—sometimes forever.

Explaining that pain pathways and psychological states have a physiologic interaction in the brain will help good patient comprehension of the multidimensional nature of pain, which involves physical and emotional components. This will help to facilitate the patient's acceptance of the need for an almost always necessary referral to a pain psychologist. It should also dispel the patient's notion that he or she is being referred to a psychologist because the pain is "all in my head." Patients need to know it is common to become depressed because of chronic pain and that they are not "losing their minds." It is also common for patients to be angry (see Chapter 8).

Occasionally, patients suggest that, for some reason, treatment to cure their pain is being withheld. Education about the range of treatments available for the patient's condition and pointing out that the patient has tried and not improved with these treatments should help to dispel this notion.

Patients generally report that their pain will fluctuate in intensity during the day. Naturally, they will seek a causal relationship between increased pain intensity and an activity they were doing at the time or before that, so they can avoid that activity. Usually, the activity to be avoided is an activity they may be fearful of in the first place. Often, this includes the physical therapist's exercise program. The attempt to find a causal relationship between activities and increased pain intensity can be challenged by asking what else was going on at the time of the pain increase. Stress at home, a fight with a spouse, financial worries, or even weather changes may increase pain intensity. The physical therapist should explain that the fluctuating nature of pain is why the focus of treatment is on improved functional ability and independent management of pain, rather than on pain relief. Gently encouraging patients to attempt the activity again and see if they have pain increase again may help to alleviate fear avoidance of those activities when patients discover that the same activity does not consistently increase pain intensity. Some patients, however, have movement-related pain, in which certain physical activities will exacerbate pain consistently.

Patients may complain of having "good" and "bad" days. Patients tend not to be active (underdo) on "bad" days and make up for their lack of activity (overdo) on "good" days; this results in a cycle of over- and underdoing. This is where education about *pacing* becomes important. *Pacing* is quota setting by the patient, in which the patient undertakes an activity but stops when the pain begins to increase and then takes time out to do some relaxation or physical exercises. Tracking how much activity time it takes before the pain noticeably increases helps the patient set quotas for the next time this activity is undertaken (Sternbach 1987). The duration of the activity can then slowly be increased, and many patients find that, with this approach, their tolerance to activity increases without an increase of pain.

Perhaps most important is education about pain treatment itself and the expectations of the patient and the health care providers involved. Commonality between the goals of the program and the patient's goals (and beliefs) increases patient compliance and participation, which is associated with a better treatment outcome. Shutty et al. (1990) showed that common treatment goals were strongly related to increased treatment satisfaction and, to a lesser extent, decreased ratings of disability 1 month after treatment.

Education about the effects of deconditioning helps patients understand what is happening to their bodies as they start to exercise. Patients with chronic pain should understand that their muscles have lost strength and endurance because of inactivity and that they are likely to experience soreness and fatigue with exercise for at least the first few weeks after starting an exercise program. Many patients are afraid to exercise, because they think they will do more damage to their bodies, which will lead to more pain and possibly serious complications, such as paralysis. The difference between *hurt* and *harm* should be explained. Patients must understand that increased pain with increased activity (hurt) does not equal a new injury (harm), but rather that muscle soreness and the aching of joints that have not been used for a long time are part of initiating an exercise program. Not warning patients about being sore after exercise can lead to increased fear by the patient and dropout from treatment.

Case Example

The patient is a 42-year-old nursing aide who has had low back pain radiating into her right leg for 2 years after a work-related injury. She had a diskectomy approximately 1.5 years ago that did not alleviate her pain. She has been told by her health care providers to get bed rest and limit activity. She has had two trials of physical therapy, including ultrasound, heat, joint mobilization, and neural stretching. None of these treatments decreased her pain. She is not working, and her children, ages 9 and 12 years old, take care of most of the housework and grocery shopping. The most amount of activity she does is walking from her bed to the living room and kitchen. The rest of her day she lies on the couch or in bed. She complains that all physical activities increase her back and leg pain.

Recently, she saw a new physical therapist who was unable to reproduce her pain by physical examination. Objective findings included decreased lumbar ROM in flexion and decreased hip flexion bilaterally. Lower extremity strength, reflexes, and sensation were normal. Straight-leg raising was negative for radicular pain bilaterally. Her physical therapist assigned a daily walking program and set of exercises. The next day, she woke up with increased pain in her back and leg—she was afraid she had reherniated her disk. She went to the emergency room and was told to stop the exercises, thus reinforcing the idea that activity causes harm to her back. Her physical therapist told her to stop the exercises and began treatment with hot packs and massage. Her belief that physical activity is harmful to her is now doubly reinforced. Her increased pain is most likely the result of movement of her stiff joints and deconditioned muscles and is misinterpreted as a new pain by herself, the emergency room personnel, and her physical therapist. Treatment would have been more effective if the physical therapist had told her she would be sore the next day after exercise and that she might have increased pain in her back and leg. She should have been told to manage the soreness with local heat or ice and to continue exercising despite her increased pain. This patient had avoided physical activities because she was afraid she would harm her back. Instead of being reassured by her health care providers that soreness is a natural result of moving stiff body parts and that it would decrease as she exercised more, the response of her providers to her complaint of increased pain confirmed her fear.

Impairments: Low back pain radiating into right leg, decreased lumbar spine ROM, decreased hip flexion, deconditioning owing to prolonged inactivity, and secondary impairments owing to avoidance of physical activities. Significant fear-avoidance beliefs, illness conviction, and inability to distinguish hurt from harm are significant contributors to the secondary impairments.

Functional limitations: Decreased tolerance to sitting, standing, walking, lifting, carrying, pushing, pulling, stair climbing, driving.

Disability: Patient is unable to work or perform household or parental duties.

Assessment, diagnosis, and prognosis: Patient is a 42-year-old woman with chronic low back pain who presents with disability out of proportion with objective findings. The patient's fear of harming her back is a significant contributor to her secondary impairments and lack of physical functioning. She would benefit from an interdisciplinary pain program, including physical therapy and behavioral medicine. Treatment should include education regarding chronic pain, self-management techniques to manage her pain, and an active, progressive, quota-based exercise program three times per week for 6 weeks to increase her tolerance and decrease her fear of physical activities and to decrease disability.

The components of patient education are outlined in Table 7.2.

Table 7.2. Elements of Patient Education

Difference between acute and chronic pain
Multidimensional nature of chronic pain
Pacing
Deconditioning and importance of physical activity
Hurt versus harm
Expectations of pain management

FUNCTIONAL GOAL SETTING

Function drives the treatment process. When functioning is increased, the subjective components of

Table 7.3. Elements of Functional Goal Setting

Define time frame
Meaningful to the patient
Define functional limitations (sitting, standing, walking, lifting, driving, etc.)
Define disability
Family and social disability (role as parent, spouse, socializing, ADLs, instrumental ADLs)
Work-related disability
Written contracts helpful

ADLs = activities of daily living.

pain and disability are said to decrease. Focusing on function allows the entire treatment team and patient to avoid issues that may disrupt a successful rehabilitation approach (Gatchel 1994) (Table 7.3).

Treatment begins with patients' setting their own goals, which is amazingly difficult for many patients. Greenhoot and Sternbach (1977) write the following:

> An extraordinary number of patients have literally never considered the possibility that they may have to adjust to their pain. It is as if time spent with the pain has been suspended, as if it "doesn't count" in one's life, and that when relieved, these patients expect to start again in life where they were suspended, despite the fact that many years have usually elapsed since they were pain free.

Because many patients have viewed their pain this way, goals must be practical and attainable within a reasonable time frame (6–8 weeks). The initial assessment should clarify the patient's current level of functioning. Patients with chronic pain most often report intolerance to sitting, standing, and walking, and difficulty lifting and carrying. These problems limit ability to perform housework, shop, work, and play. Goals may include sitting, standing, or walking longer (define in minutes) or being able to lift and carry more (define in pounds). Ideally, the patient's functional goals will be a restatement of his or her functional problems ("I want to return to work," "I want to be able to care for my children," or "I want to go grocery shopping"). The patient can then be asked to measure his or her subjective ability to do a specific functional task related to those goals on a visual analog scale:

Totally unable ________________________________ Completely able

Take care of my children

Some patients have no sense that they might be able to do anything at all, because they are overwhelmed by their pain and need help in determining functional goals. Patients will state, "I just want my life back," which is neither a realistic nor a functional goal. A goal may be as simple as showing up for treatment (on time). Many patients with chronic pain have much unstructured time because they no longer work, and no demands are placed on them to get out of bed, go somewhere, do a job, shop, socialize, clean house, and cook. While everyone else is productive, they drift through their days. Having to be somewhere requires getting out of bed at a certain time, showering, dressing, and traveling to the destination. Treatment, therefore, provides a structure or framework that these patients may not have had in a long time. Simply having structured time and "a place to go" may be therapeutic. This is especially true for patients with depression.

Because their lives seem to have stopped when they started to have pain, it is not uncommon to have patients be unrealistic about their goals, because they base them on the things they could do before they had chronic pain. A helpful question is, "What would you do if you did not have pain, that you are not doing now?" Occupational therapists are very skilled in functional goal setting, and joined assessment and treatment are recommended.

A patient who is unable to set functional goals even with help from the physical therapist is not likely to achieve a good outcome. It is possible that the patient has no functional goals. He or she may still seek complete pain relief or be involved in litigation that necessitates the amassing of medical bills.

Case Example

A 32-year-old man complaining of headache had insidious onset of headache 1.5 years ago. Since then, he has seen 64 different specialists in three states. The results of computed tomography scan of the head, magnetic resonance imaging of the cervical spine, and blood work were all negative. When he was told his headache was muscular in origin, he disagreed. "I know something is wrong with me, and I am not going to stop until I find someone who can find out what this is and fix it," he said.

Case Example

A 35-year-old woman is scheduled to see the physical therapist for an initial evaluation. When walking into the physical therapist's office, the patient says, "I need pain medication." When told physical therapists cannot prescribe medications, the patient says, "I don't know what I am doing here, then," and walks out.

Such patients will probably not benefit from a pain rehabilitation approach. When a patient has clearly unrealistic goals, further exploration of why the patient is seeking treatment is necessary. Some patients are happily disabled, meaning that although they function at low levels, they are not distressed and have no real desire to change their current situation. They may have applied for social security disability insurance, and improving their function is not their goal, because that may mean return to work, which they seek to avoid. These patients may just want some temporary symptomatic relief from their pain. It is up to the physical therapist to decide whether such expectations can be met.

Setting functional goals helps to direct treatment and makes it more meaningful for the patient. The successful attainment of functional goals has been associated with increased self-efficacy (Dolce et al. 1986). Increased self-efficacy has been shown to be a significant predictor of exercise adherence and compliance (McAuley and Blissmer 2000).

The ideal exercise program for a patient with chronic pain is related to the functional goals the patient has identified at the start of treatment. Specificity in training is an important factor. A stationary bicycle program may be good exercise to increase aerobic endurance, but it does not necessarily increase the lower-extremity strength needed for a specific lifting task. In this instance, squats and lunges may be a more appropriate choice. An example of detailed task analysis in prescribing exercise is presented in the section Functional Activities.

Before initiating treatment, it is helpful to set the number of treatments per week and the number of weeks of treatment. Having a definite end point increases patient compliance and gives a framework to the patient and physical therapist in which to achieve goals and a behavioral change.

Treatment contracts are extremely helpful. These include the pain behaviors to be eradicated, goals, length of treatment, and limits on the number of times the patient can cancel or not show for treatment (Appendix 7.1). If a patient is motivated, a contract helps to facilitate progress. If the patient is not motivated, displays an attitude detrimental to others in the group, systematically arrives late, repeatedly cancels, or does not show up for appointments, the contract allows the physical therapist to discharge the patient.

Table 7.4. Elements of Self-Management Techniques

Instruct in pain control modalities
TENS, heat, cold, self massage, relaxation
Instruct in quota-based home exercise program

TENS = transcutaneous electrical nerve stimulation.

SELF-MANAGEMENT TECHNIQUES

One of the more striking differences between acute and chronic illness is the extent to which the patient takes an active role in management. For example, treatment of acute renal failure requires that the patient allow the medical treatment team to perform procedures, administer medications, and care for the patient's well-being. In contrast, insulin-dependent diabetes mellitus requires the patient to learn to measure blood sugars, administer insulin, and make major changes in lifestyle, especially in diet and activity level. It would not be appropriate for an otherwise competent and physically able person with insulin-dependent diabetes mellitus to be a passive recipient of health care services to manage daily insulin needs. This expectation is applicable to the management of chronic pain, as well. Self-management is a cornerstone of pain management (Table 7.4). This is even more critical as shrinking health care resources continue to limit payment for physical therapy services. The therapist must be able to have a greater impact on the patient's function in a shorter period of time than ever before. This can be accomplished only by having the patient become an active participant in the process of rehabilitation.

Self-management techniques include the use of pain-control modalities (e.g., TENS, heat, ice, and self-massage) and a structured home exercise program. Other self-management techniques include relaxation and distraction techniques and the learning of assertive behaviors that are more commonly taught by occupational therapists (see Chapter 13).

These tools may seem simplistic and obvious; however, the process of instructing and investing the patient in their use is difficult and complex. Part of the difficulty lies in the history of unsuccessful treatment with which patients often present. At best, past physical therapy will have had no impact on the patient's pain. It is common for a patient to state in the initial interview that physical therapy worsens his or her pain. A number of factors may be responsible for past treatment shortcomings, including persistent failure of physical therapists to recognize and treat the differences between acute and chronic pain states, past treatment that did not address the emotional and cognitive aspects of chronic pain, and an inability of the patient to recognize anything less than total pain relief as success. It is the responsibility of the physical therapist treating chronic pain to work with a patient to change his or her perception of physical therapy. The tools of physical therapy must be reframed in a positive and functional light. This can be accomplished by helping the patient invest himself or herself in the treatment process. The simpler and more accessible the tools given to the patient, the more likely he or she will be compliant in the use of those tools.

The benefits of exercise are discussed in Chapter 6. Those benefits, however, can be realized only by consistent performance. Exercise in the context of the physical therapy clinic is of limited benefit without independent performance at home. Success in an exercise program can make the difference between function and failure for a patient with chronic pain. It is the responsibility of the physical therapist to ensure that the home program is structured, appropriate, and meaningful.

Many patients with chronic pain do not exercise appropriately, because they have lost the ability to self-assess and self-regulate activity. Patients have a tendency to do less when they feel more pain and fatigue and more on days when they feel reasonably well. Although this is understandable, it is detrimental to progress. It allows for continued linking of pain with function and results in a discontinuous course of many exercises performed on good days and none on a bad day, without any clear progression toward a goal. Furthermore, there is the danger that the patient will overexercise when he or she feels well, to make up for not exercising previously. Overuse or postexercise soreness often results from this pattern. Patients have difficulty choosing between the conflicting philosophies of "let pain be your guide" and "no pain, no gain." With appropriate structure, patients can learn to adequately listen to their bodies and make intelligent choices about exercise intensity. That structure should include therapist-directed quotas set at a submaximal level to ensure early success with an appropriate rate of increase built in.

Case Example

The patient is a 37-year-old former construction worker who had a work-related lifting injury 5 years ago. He has had chronic low back and lower-extremity pain, with several unsuccessful trials of physical therapy in the past. He is fearful of beginning an exercise program. He is also frustrated at his low level of physical conditioning and constantly talks about how much he was previously able to bench press when he was actively weight lifting. Working with the patient, the therapist chooses an exercise regimen consisting of a stationary bicycle program (he wants to bike with his children) and exercises to encourage self-mobilization of the pelvis and low back area (he has difficulty with any activity that involves lumbar motion). The patient is instructed in the use of the bicycle, including proper height adjustment and use of low-resistance settings. He is asked to ride the bicycle for as long as he can, until pain or fatigue limits him. He is instructed in pelvic tilt, lower trunk rotation, knee-to-chest, and bridging exercises. He is told to perform as many repetitions as he can, until pain or fatigue limits him. He is asked to do this once a day for 3 days and to keep a chart of the results. On the next physical therapy visit, the therapist reviews the following numbers:

	Day 1	Day 2	Day 3
Bicycle	3 mins	10 mins	2 mins
Pelvic tilt	5 repetitions	12 repetitions	0 repetitions
Trunk rotation	5 repetitions	8 repetitions	2 repetitions
Knee-to-chest	5 repetitions	10 repetitions	2 repetitions
Bridging	5 repetitions	7 repetitions	0 repetitions

The patient shows a pattern of poor self-regulation, with an overdo-and-underdo cyclic response. The therapist averages the three trial results and chooses to begin the patient at 60% of the average of each exercise because the trial results are so widely divergent. The following baselines are chosen for this patient's home program:

Bicycle	3 mins
Pelvic tilt	4 repetitions
Trunk rotations	3 repetitions
Knee-to-chest	4 repetitions
Bridging	3 repetitions

He is also given a structured rate of increase of one repetition or 1 minute every third day until he reaches 20 minutes on the bicycle and 12 repetitions of each exercise. At that time, the program will be revised to increase its level of difficulty. He is told to adhere to the schedule, regardless of his pain level. He is told that he may modify the way he does the exercises by going slower, using less force or ROM, or taking more frequent rest breaks; however, he must perform the program daily.

Impairment: Back and leg pain, decreased ROM lumbar spine, poor self-regulation exercise.

Functional limitation: Decreased performance in exercise program, poor pacing in physical activities.

Disability: Patient is unable to perform occupational and recreational (weight-lifting) activities.

Assessment, diagnosis, and prognosis: Patient is a 37-year-old former construction worker who presents with chronic back and leg pain and poor self-regulation of activity, resulting in cycles of overdoing (with exacerbations of pain), followed by cycles of underdoing (because of increased pain). The patient will benefit from a quota-based, active, progressive exercise program to increase his tolerance to physical activities, to return to recreational activities that include weight lifting, and to eliminate cyclic over- and underdoing, resulting in pain exacerbations. The patient will be seen three times per week for 6 weeks and have two follow-up sessions after this to monitor independent progress in home (or health club) exercise program.

Exercise must be compatible with a person's lifestyle, or compliance will be poor. The type of exercise should have meaning in a patient's life, and performing it should fit into his or her daily schedule. The therapist should work with the patient to find the types of activities the patient has enjoyed in the past or has interest in pursuing currently. It may be necessary for the therapist to help the patient modify the activity or his or her expectations about performance for the patient to feel successful.

A quota-based home exercise program allows the therapist to monitor the patient's compliance. The physical therapist can ask the patient to perform the number of exercises scheduled for that day. If the patient is unable to perform the preset number of repetitions in the clinician's office, questions can be asked about whether the patient is actually performing exercises at home. Addressing noncompliance is often a simple matter of clearing up the misconception that exercise harms the patient and providing an explanation of the importance of the home program. Patients should be told that they must adhere to the program daily, so they can achieve the goals they have set for themselves. If they have difficulty performing all exercises at once, they can split up their exercise routine into smaller sessions during the day. When patients understand these concepts and are compliant with them, they often report a great sense of achievement. Frequent positive feedback is extremely important. These patients are battling with their fear of movement and reinjury. For them, performing even five sit-ups can be a major achievement.

Case Example

The patient is a 72-year-old woman with osteoporosis and arthritis. She understands that she must exercise to help slow her bone loss, as well as to help manage her pain, but she has always been a sedentary person. Her husband plays golf 3 days a week and walks daily at 5:30 AM. He has been trying to convince her to walk with him, but she has difficulty with stiffness in the mornings. She is also afraid of hurting herself by trying to keep up with her husband. She lives in a condominium complex with a senior center. There is an indoor track, which is reserved for walking 3 afternoons per week. The therapist helps the patient plot out a structured walking program on this track. Because people of differing abilities walk there, she does not feel compelled to meet her husband's standard of appropriate exercise. She can also take advantage of the time of day when it is easiest for her to move. Walking was the activity of choice for this patient, because although she had never formally exercised, she had always lived in a city and walked a great deal.

Impairment: Joint pain and stiffness. Increased fracture risk owing to osteoporosis.

Functional limitation: Decreased ability to perform physical activities, including ADLs and instrumental ADLs.

Disability: None.

Assessment, diagnosis, and prognosis: Patient is a 72-year-old woman with osteoporosis and arthritis who presents with joint pain and stiffness. Through lifestyle modification, the patient with identified low bone density will reverse the demineralization process and achieve bone mineral density above fracture threshold. The patient will benefit from instruction in a structured independent walking program and should be seen twice—once for instruction and once for follow-up to ensure appropriate progress as measured by increased tolerance to physical activity and slowed bone loss.

BEHAVIORAL MODIFICATION TECHNIQUES

Behavioral modification techniques include operant conditioning and behavioral modification. Both operant conditioning and cognitive-behavioral therapy have been briefly discussed at the beginning of this chapter and are explained in much greater detail in Chapter 8. If it seems that this chapter places a greater emphasis on behavioral techniques than on actual physical therapy intervention, it is because, in general, little attention is given to therapist-patient interaction during physical therapy education, and a great deal of attention is given to the technical aspects of physical therapy intervention. If fact, what we say and how we react to patients with (chronic) pain is at least as important as what we do with them.

Patients with chronic pain present not only with a medical diagnosis but also with their attitudes and beliefs towards their pain and resultant behaviors, a history of (often unsuccessful) interventions, and expectations about the helpfulness of various treatments. Many patients feel helpless and hopeless in the face of their pain, believe that their ability to manage pain is poor, and expect to have increased pain if they exercise. Many patients also believe that an exercise approach to their pain is too simple a solution for their disabling pain and is likely to make them worse; they question whether they should have surgery or stronger pain medications instead. If patients believe that disability is an inevitable reaction to their pain, activity is dangerous, or pain is an acceptable excuse for neglecting responsibilities, not surprisingly, their disability is going to be maintained (Turk and Okifuji 1998). In addition to beliefs about capabilities to function despite pain, beliefs about pain, per se, appear to be important in understanding response to treatment, adherence to self-management activities, and disability. Successful rehabilitation appears to entail an important cognitive shift from believing in one's helplessness and passivity to resourcefulness, and ability to function regardless of pain (Turk et al. 1983, Flor et al. 1992).

The fear of pain and subsequent avoidance of all activities that could potentially cause pain is called *fear-avoidance belief* and has been associated with the development and maintenance of chronic pain and disability (Waddell et al. 1993, Klenerman et al. 1995), avoidance of physical activities, subsequent deconditioning, and development of guarded movements (Vlaeyen and Linton 2000, Crombez et al. 1998).

High correlations were found between fear-avoidance measures, disability, and behavioral performance (Crombez et al. 1999). *Kinesiophobia* (fear of movement) is closely related to fear-avoidance beliefs in patients with chronic pain (Crombez et al. 1999). Fear-avoidance beliefs should be challenged. For instance, a patient will say, "I can't play golf anymore, it hurts too much." Question when this person last played golf (5 years ago): "If you have not played golf in so long, then how do you know it hurts? Why don't you go hit some balls on the driving range, come back, and tell me how you did?" Conversely, if a patient complains of increased pain, and the therapist shows concern that more tissue damage may have occurred, the patient's fear avoidance will be confirmed, and the vicious cycle in which the patient is trapped is maintained.

Catastrophizing has been broadly defined as an exaggerated negative orientation toward pain stimuli and pain experience (Sullivan et al. 1995) and is associated with a heightened pain experience (Rosenstiel and Keefe 1983, Keefe et al. 1989). Catastrophizing, as measured by the Pain Catastrophizing Scale (see Chapter 19), was shown to be significantly correlated with patients' reported pain intensity, perceived disability, and employment status (Sullivan et al. 1998). The rumination factor (e.g., "I can't stop thinking about how much it hurts") of the Pain Catastrophizing Scale was the component of catastrophizing most strongly associated with disability. The observed relationship between rumination, pain, and disability suggests that interventions that assist patients in avoiding excessive focus on their pain sensations may be a viable means of reducing catastrophizing and facilitating the rehabilitation process (Sullivan et al. 1998). Attention diversion is one strategy. For example, some patients' only topic of conversation is their pain. Switching the topic of conversation to something more entertaining (to the therapist) may help to divert the patients' attention away from pain toward something more positive. Ironically, disclosure may be helpful as well. For patients who catastrophize, interventions that foster expression of pain-related worries and concerns may be more effective in reducing excessive focus on pain sensations than are interventions that foster inhibition or control of pain-related cognitions (Sullivan et al. 1998). Ask the patient to describe the worst scenario that he or she can think of as a result of pain, or what specifically he or she worries about related to the pain. Education might be helpful, as would be a referral to behavioral medicine to help the patient manage frequent ruminative thoughts.

Self-efficacy is the personal conviction that one can successfully execute a course of action to produce a desired outcome in a given situation. A person's self-efficacy beliefs determine the choice of activities the person will initiate, the amount of effort that will be expended, and how long the person will persist in the face of obstacles and aversive experiences (Turk and Okifuji 1998). The self-efficacy expectation has been shown to be a major mediator between pain intensity, disability, and depression (Arnstein et al. 1999); daily rating of pain; mood; coping and coping efficacy (Lin 1998); pain intensity and pain interference in daily life (Lefebvre et al. 1999); and therapeutic change for patients with chronic pain (Council et al. 1988).

Efficacy judgments are based on four sources of information regarding one's capabilities, listed here in descending order of importance:

- One's own past performance at similar tasks
- The performance accomplishments of others who are perceived to be similar to oneself
- Verbal persuasion by others that one is capable of performing
- Perception of one's own state of physiologic arousal, which is, in turn, partly determined by prior efficacy determination (O'Leary et al. 1988)

McAuley et al. (1993) showed that significant increases in self-efficacy occur with exposure to acute bouts of physical activity and that chronic exercise interventions result in still more dramatic effects.

Based on the above, it makes sense to start exercise at relatively easy levels and gradually increase the level of difficulty (quota-based exercise), until the desired goal is attained. It allows for the patient to succeed at the task (positive feedback) and sets the patient up for succeeding at future tasks. Exercising patients in groups allows patients to see the exercise performance of other patients with chronic pain (others seen as similar to oneself) and have the "If they can do it, so can I" response. Having patients exercise with other patients who have pain provides positive reinforcement, because patients come into contact with others who continue to function and exercise despite their pain. Patients realize that they are not the only ones who have pain and have others to talk to about their pain experiences and functional goals. They also receive feedback from the people with whom they are exercising. This feedback can be about pain behaviors that other patients recognize as dysfunctional. Patients often point out to another patient that his or her behavior or belief is unhealthy. They support each other through the exercise sessions and provide positive feedback when a patient is clearly progressing or attaining a goal. This bonding (group cohesion) between patients can be extraordinarily helpful to patients' progress and to the amount of fun patients have while participating in physical therapy sessions. In addition, patients who hold stronger beliefs about group cohesion will

- Attend more exercise sessions
- Be more likely to arrive on time
- Be less likely to drop out
- Be more resistant to disruptions in the group
- Be more likely to experience greater amounts of positive affect related to exercise
- Have improved attitudes toward exercise
- Have stronger efficacy beliefs related to exercise (Estabrooks 2000)

Frequent verbal encouragement from the physical therapist, assuring the patient that he or she is capable of performing exercises without harm, should further help in increasing self-efficacy beliefs, as will the successful application of pain self-management techniques. Any perception of increased personal control over pain will increase self efficacy, leading to less disability, it is hoped.

Do not let patients' pain scare you! Instead, work with the patient on finding solutions to the problem: "When you have a pain flare, what do you do? Is there a better way? What else could you do?"

Confronting patients with their fears by having them perform tasks they have been avoiding is thought to decrease catastrophizing and fear-avoidance behaviors. Dysfunctional beliefs should be challenged throughout the treatment process (see also Chapter 8). One way to do this is through repeated exposure to what the patient believes is a harmful task (e.g., lifting). Repeated exposure to avoided activities has been shown to be effective in reducing fear and anxiety about them (Dolce et al. 1986). In fact, it has been shown that chronic pain levels stay the same or decrease, despite significant increases in activity levels (Fordyce et al. 1981, Linton 1985, Rainville et al. 1992, Geiger et al. 1992, Dolce et al. 1986).

Emotional disturbances, such as crying and outbursts of anger, disrupt physical therapy sessions, other patients, and communication between patients and the therapist. A person who demonstrates such behavior may not retain the material that he or she is being taught. The physical therapist should tell the patient that such behavior is disruptive to the physical therapy sessions and that the psychological counseling sessions should be used to deal with anger (Sanders 1991). The patient needs to understand that his or her anger is "displaced" onto the therapist and that misdirected anger is a sign that the patient is not ready to take responsibility for pain management. The therapist should help the patient recognize that the pain was not caused by the therapist and that it is not the therapist's responsibility to stop the pain (Sanders 1991). Clarifying the goals of treatment, (re)focusing on functional goals, and reinforcing gains already made in physical therapy sessions will help to dissipate emotional disturbances.

The term *difficult* is used to describe patients with behaviors that are beyond the norm and undermine treatment. In minor cases, the difficult patient may stimulate a sense of uneasiness. In severe cases, caregivers may feel intense dislike for the patient. In some cases, caregivers are made to feel "special" because they are told they are the only ones making a difference in the patient's life, after seeing multiple caregivers who were all unsuccessful. Disparaging remarks about other present or prior care providers is a warning signal. The clinician who rushes into a case with disdain for prior management and offers alternatives that inspire the patient's effusive gratitude is likely to soon be on the receiving end of disdain.

Some demanding patients may have extremely low self-esteem. They often feel at risk for imminent shame and humiliation. Confronting them only increases the possibility for shame and humiliation and may promote further demands. While working with such patients, it is best to give them frequent and varied reminders that they deserve and will receive the best and most thoughtful care.

Setting limits is important in managing the difficult patient. Some patients may not believe they are cared about until someone responds to their outrageous behaviors. Such patients are usually frightened, impulsive, and very perceptive. Limit setting should not be used as an excuse for punishment. As soon as the potential for misbehavior is noted, patients must be advised of the consequences of violent behavior, threats, or imminent harm. Acts or threats of violence or self-injury must be met with an immediate and effective response to protect the patient and others. If a patient states to be suicidal,

Table 7.5. Possible Responses to Patient Statements

Patient Statement	Possible Response
I can do everything else; why do I have to do that?	This program has been proven effective as a whole. It has been carefully constructed to maximize gains for your entire body.
I have a cold. I cannot go to physical therapy.	If you are sick, this is a good chance to practice doing what you need to do even though you are not feeling well; many people continue to work with a cold. You need to take advantage of all the time you are here. (After determining symptoms are not indicative of a serious health problem.)
I am going to do the best I can, but I'm not sure I can handle the quotas you set.	I will not set quotas you cannot meet. This program has been specifically designed for you. The quotas will be gradually increased so that you can meet them.
I am tired. This is too much. I hurt too much to go to therapy.	After many years of experience, we find that this program is the best way to handle reconditioning. This is a very intensive program, and our experience has shown that to get the most out of the time and the money you spend here, the speed we have chosen is optimal. We want to do the best we can for you in the time that you are here.
I hurt worse than when I came. I feel more anxious.	You have been disabled and inactive for a long time; we expected that coming into the program and working as hard as you have been would increase your pain temporarily. It is a very common response and will pass as your body becomes used to the demands you are making on it.
My pain is getting worse. It's 10 out of 10, stabbing, and pinching.	What kind of things do you usually do to make the pain less noticeable? Try using the techniques you have learned to manage your pain. You can expect the pain to increase some with activities. I think it is great that you are able to do so much even though it hurts. This is good practice for the times you are out of the program and have a flare-up. Make a list of the things you can do to decrease the pain.
I don't know what to do. Please tell me what I should do.	I think this is a decision you can make for yourself. What do you think you should do? Sit down, make a list of possible solutions, pick one, and try it. You can handle this on your own. You are the one who has to live with the decision; don't give anybody else the right to decide for you.

Source: Adapted from K Egan. "What to say when . . .": a strategy for responding to patients' questions and complaints. Am Pain Soc Bull 1995;5:7.

the patient's psychologist or psychiatrist should be contacted. Another option is immediate referral to the emergency room for psychiatric evaluation of the patient's safety.

Limits may be set by patients, as well. Patients may have a history of physical abuse that precludes certain physical therapy modalities. The use of electrical stimulation may be appropriately refused by a patient who has been abused in his or her childhood with electrical shocks.

Extreme care should be taken with survivors of political torture, because many behaviors, examinations, or treatments may be threatening to them. Severe pain is a common long-term outcome of torture (Hough 1992). Some of the psychiatric patients referred to physical therapy have physical and sexual abuse histories that approximate torture. Egan (1995) developed a clinical aid to ensure consistent responses to patient questions (Table 7.5). Patients, particularly difficult ones, are often frightened and uncertain about treatment. Caregivers should assure the patient of the following:

1. The caregiver has expertise and experience in helping other people with similar problems turn their lives around.
2. The caregiver has confidence in each individual's unique strength and ability to rehabilitate himself or herself.
3. The caregiver understands the great difficulty of the patient's present situation and has a vision of a brighter, more productive future for the patient.
4. The caregiver has faith in the effectiveness of the treatment program.

Table 7.5 lists examples of reassuring answers to a patient's questions. Table 7.6 summarizes the behavioral modification techniques.

Table 7.6. Elements of Behavioral Modification Techniques

Operant conditioning:	Reward positive behaviors, ignore pain behaviors; quota-based exercise program
Cognitive-behavioral approach:	Address maladaptive patient beliefs
Increase self-efficacy through:	Patient success with exercise, group exercise treatment, and positive feedback and encouragement

ACTIVE MODALITIES: EXERCISE

> Generally speaking, all parts of the body, which have a function, if used in moderation and exercised in labors to which each is accustomed, become healthy and well-developed and age slowly; but if left unused and left idle, they become liable to disease, defective in growth, and age quickly. This is especially the case with joints and ligaments, if one does not use them.
>
> —*The Science of Medicine,* Hippocratic Writings (Chadwick et al. 1983)

Perceived personal control over pain is associated with less distress and disability (Cole 1998, Haythornthwaite et al. 1998). The sense of personal control, or *internal locus of control*, can be strengthened by actively encouraging patients to take greater responsibility for their care. Physical exercise is of great value in addressing the need of patients to have control over their pain (see Table 7.9). Creating a normal health club or gym atmosphere provides patients with a positive environment associated with health and fitness and puts patients on a partnership level with the physical therapist.

In patients with chronic intractable pain, two sources of impairment may be identified: a primary impairment, owing to documented organic pathology, and secondary impairments resulting from the physical and emotional consequences of painful experiences (e.g., inactivity and general psychophysiologic deconditioning).

Deconditioning results in decreased muscle strength and endurance, increased joint stiffness, postural strain, and loss of cardiovascular fitness, leading to activity intolerance. These impairments independently contribute to the perception of pain and inability to perform functional activities. The focus of physical therapy treatment is to improve functional ability and help the patient achieve the goals set before treatment (see Functional Goal Setting). Treatment must target function to ensure carry over from the clinic to the patient's life. The impairments that interfere with the patient's ability to function and the eradication of behaviors that contribute to them need to be addressed. Specific tools to help patients achieve their goals include behavioral management techniques (see Chapter 8) (Wittink and Cohen 1998), of which progressive quota-based exercise is central, both at a patient's home and in the clinic.

A specific program is developed for each patient, addressing that patient's specific impairments and functional needs. This can be a difficult and challenging task, as it requires knowledge of tissue behavior, anatomy, and kinesiology and arthrokinematics. As stated previously, hands-on treatment can be detrimental to patients with chronic pain, because it reinforces disability behavior and prevents the patient from taking responsibility for his or her own management of pain. It is easier to mobilize a joint than to invent an exercise that will allow the patient to self-mobilize it; however, physical therapists must advocate self-mobilization in the same way they do self-stabilization. The initial session with the patient is used to establish a home exercise program and the exercises the patient will perform in the treatment program. Baseline values are set for aerobic exercise (time on the treadmill, time on the bike, use of upper-extremity ergometer) by telling the patient to "do as much as you can." Setting high expectations (having the patient bicycle for 20 minutes the first visit) reinforces the patient's sense of not being viewed as "sick" and often results in an "I didn't think I could do that!" sense of accomplishment. The patient is progressed in a quota-based manner to aerobic exercise for 25–30 minutes at 65–80% of his or her maximal heart rate. If a patient is on medication that will limit heart rate response to exercise (e.g., alpha or beta blockers) a Borg scale rating of perceived exertion (RPE) (Borg 1982) can be used (see Chapter 6). Baseline values are set for weights and repetitions. Quotas are set at this time to increase the number of repetitions and weights per physical therapy session. Some therapists prefer to set a target for the program—for example, "at the end of the program you should be able to perform this exercise with X amount of weight and X repetitions"—and quotas are set accordingly. Some therapists prefer to use a more exercise physiology–based approach: endurance training at 20–40% of maximal strength for 3 sets of 15 repetitions or strength training at 40–60% of maximal strength, 3 sets of 8–12 repetitions, progressing weight and numbers of repetitions as the patient progresses, or both. For people to gain strength and endurance, a stimulus adequate to stress the tissues should be applied. As adaptation to a given load takes place, training intensity needs to be increased to achieve further improvement (Astrand and Rodahl 1986) (see Chapter 6). The objective of exercise is usually to stress both damaged tissue and healthy supporting tissue to foster tissue repair while avoiding further excessive loading, which can exacerbate an existing structural weakness (McGill 1998). As patients who have not been physically active for long periods of time may have weakened tissues, endurance training is probably the safest start and should precede strengthening exercise (McGill 1998).

A daily, gradual progression of exercises disconnects patient's pain from function and lets the physical therapist know that the patient is exercising within the boundaries of his or her physical abilities, without doing damage to the tissues through overuse. Remember, however, that chronic pain is not a static condition and that a number of your patients will have movement-related or incident pain. In a study on treadmill testing in patients with chronic low back pain, 50% of the patients stopped because of a significant increase of pain intensity. This increase in pain was independent of mental health scores (Wittink et al. 2001). This was a cross-sectional study, however, and it is not known what the percentage of incident pain is after physical therapy treatment.

Patients will come in and complain of having "a bad day." Asking patients to "do what they can" may result in completing the exercise program as agreed, or the patient may perform less than that. Some self-regulation of exercise intensity should be allowed. It would be inconsistent to ask a patient to be responsible for their own care, but deny them the opportunity to have input in their care. Exercise should be a positive experience. If it is not, patients are not likely to follow through with exercise after discharge or may drop out from treatment. Dropout rates from progressive exercise programs for patients with chronic pain are reported to be fairly high, and the most reported reason for dropout is increased pain (Barnes et al. 1989, Gatchel et al. 1999, Turk and Rudy 1990). Those patients who experience pain relief with exercise are the most likely to follow through and keep exercising after discharge. Recurrences of persistent pain are reported to be fewer and work absenteeism less in those patients who maintain regular exercise habits (Taimela et al. 2000). The health benefits of decreased blood pressure and cholesterol levels, weight loss, decreased insulin resistance, modulation of the immune system, improved sleep, and a positive influence on depression and anxiety with ongoing exercise are discussed in Chapter 6. As physical therapists, we have a duty to practice preventive medicine as well, and for that reason, getting our patients to enjoy regular exercise is important.

Although the program is individualized for each patient, each physical therapy session includes the same components: aerobic conditioning, muscle strength and endurance training, stretching, lifting, body mechanics and ergonomics, sufficiently alternating to prevent muscle fatigue from one specific group, and review of the home-based quota exercise program. Most patients benefit from bridging and upper, lower, and oblique abdominal; latissimus dorsi; rhomboids; quadriceps; and back extension exercises, as these exercises address muscle groups commonly used in most functional activities. Additional exercises are specific to the patient and his or her functional goals.

Patients are actively encouraged to record the amount of weight and repetitions used for each exercise at home and to take an active part in the documentation of their progress. Flow sheets are helpful for this, as they can easily show progress being made (Tables 7.7 and 7.8).

Always inform patients that the pain initially might worsen and that they are likely to be sore from exercising for at least the first week or weeks. Many patients report extreme fatigue after exercising the first several weeks. After the initial increase of pain and fatigue comes the sense of being able to carry out an exercise program, which will begin to erode the fear associated with movement.

Table 7.7. Example of an Objective Status Flow Sheet

Problem	Date/Signature	Date/Signature	Date/Signature	Date/Signature	Goal
Patient lacks an independent HEP	9 reps b.i.d. of all exercises	15 reps b.i.d.	20 reps with 5-lb weights	Goal met	25 reps b.i.d. with 5-lb weights
Poor physical tolerances	Sit 10 mins; walk ¼ mile	Sit 15 mins; walk ½ mile	Sit 30 mins; walk ½ mile	Sit 34 mins; walk 1 mile	Sit >60 mins; walk >2 miles
Unable to lift >5 lb from floor to waist	5 lb, 5 reps t.i.d.	7 lb, 5 reps t.i.d.	10 lb, 5 reps t.i.d.	15 lb, 5 reps t.i.d.	Lift >25 lb from floor to waist
Unable to control pain	Needs cues to use pain control modalities	Incorporates heat in HEP independently	Uses ice occasionally before and after physical therapy session	Goal met	Independent use of heat and ice for pain control

HEP = home exercise program; reps = repetitions.

Although the focus of treatment is on function and not on pain, an open mind must be kept when listening to patients. It is rare, but occasionally, patients do develop new signs and symptoms consistent with new pathology and acute pain. Re-evaluation and consultation with the referring physician may be appropriate.

Patients should set their own goals so that treatment can be geared toward the functional goals they wish to achieve. Such a functional activity is then broken down in parts, which become part of the treatment program. It cannot be emphasized enough that in all treatment, the focus is on restoration of function. Therefore, exercises should be performed in closed-chain and weight-bearing positions to simulate activities of daily living and the physical demands of functional tasks.

For example, lifting from floor to chest requires an ability to squat, bend at the hips, stabilize the upper body, and flex the elbows. Preparation for this activity includes performing squats with weights combined with hip flexion and resisted elbow flexion, while standing with the scapulae adducted and the back and abdominal muscles co-contracted.

Lifting overhead requires scapular stabilization, full flexion of the shoulders, and the ability to stabilize the spine and step forward. Exercises used to prepare for performing this activity include lunges; strengthening of the rhomboids and serratus anterior; strengthening of the upper, middle, and lower trapezius; and flexion of the shoulders against pulley resistance, while stabilizing the lumbar and cervical spine.

Walking requires aerobic fitness, leg and trunk muscle endurance, and trunk rotation. Trunk mus-

Table 7.8. Example of an Exercise Flow Sheet

Exercise	Date____	Date____	Date____	Date____	Date____	Date____	Date____
Pelvic tilt	5/5	5/10	5/0	6/6	6/6	6/6	7/7
Knee-chest	5/5	5/8	5/0	6/6	6/6	6/6	7/7
Trunk rotation	5/5	5/8	5/0	6/6	6/6	6/6	7/7
Abdominal curl	5/5	5/8	5/0	6/6	6/6	6/6	7/6
Straight-leg raising	5/5	5/10	5/0	6/6	6/6	6/6	7/6
Cat/camel	5/5	5/8	5/0	6/6	6/6	6/6	7/6

Note: In x/y, *x* is the quota and *y* is the actual number of the exercise performed.

cle endurance and rotation can be strengthened using alternate arm extension against pulley resistance while standing. Treadmill walking simulates functional movement and increases leg endurance and aerobic capacity. Treadmill speed can be increased until normal walking speed has been achieved. As a rule, practicing a task will improve the performance of that task because of exercise specificity (practicing lifting will not likely improve walking ability).

Most people need to perform activities that involve bending and rotation during their daily activities. Lumbar spine physiologic movement consists of flexion, sidebending, and rotation to the same side. This can be easily simulated with pulleys or handheld weights.

Movement analysis is a challenge to physical therapists. Explaining to the patient that the purpose of the exercises is to achieve functional movement patterns helps ensure greater compliance with the exercise program, which leads to greater ability to perform functional tasks. There is emerging evidence that patients with chronic pain execute tasks at slower speeds than healthy subjects (Maureen J. Simmonds, verbal communication, April 20, 2001). Although there is currently no evidence to support this, a reasonable hypothesis is that increasing the speed of movement will help normalize movement patterns.

Physical impairments that interfere with functional ability should be addressed. Because joint pathology is thought to have an inhibiting influence on its surrounding musculature (Young et al. 1987), care must be taken to restore normal strength and endurance of the musculature and to re-establish normal ROM of the joint.

NORMALIZING RANGE OF MOVEMENT

To establish normal ROM, joint hypo- and hypermobility, muscle tightness, and muscle weakness should be addressed.

Treatment of Joint Hypomobility

Active mobilization exercises play an integral role in the treatment of chronic pain patients. Self-mobilization exercises require specific starting positions or aids, such as bolsters, belts, or pulleys. For example, mobilization of the upper cervical spine can be achieved by fixating the cervical spine on a roll-up to C3 in extension. The patient is then asked to tuck in the chin. This results in improved flexion of C0–C2. Another example exercise is alternating arm extensions with pulleys while standing. The patient is asked to follow the extending arm with the eyes and head. The result is a general increase in spine rotation. This exercise also simulates the functional movement of trunk rotation with walking and reaching behind. The principles of medical exercise therapy, as described by Oddvar Holten, are helpful in self-mobilization of patients (Gustavsen and Streeck 1993). For example, if the goal of treatment is to improve thoracic extension, sidebending to the right, and rotation to the left, then the lumbar spine should be positioned in extension and left sidebending (by putting a wedge under the left buttock). Thus, when introducing left rotation to the thorax, the lumbar movement becomes nonphysiologic, resulting in lumbar fixation (Gustavsen and Streeck 1993). An anteriorly rotated ilium can be self-corrected by maximally flexing the involved side in the direction of the axilla on the same side or by performing a strong isometric hip extension contraction (DonTigny 1993). Proprioceptive neuromuscular facilitation techniques (Sullivan and Markos 1987) are based on functional movement patterns and can be incorporated easily by using pulleys or weights.

Treatment of Joint Hypermobility

Stabilization training includes retraining the musculature to control and stabilize the painful joint. Exercise promotes the necessary strength, coordination, and endurance to maintain the joint in a stable and safe position during loading, mobility, and weight-bearing activities. Stabilization training optimizes the capacity of the joint to absorb loads in all directions while it minimizes direct strain and stress on individual tissues. It eliminates repetitive microtrauma to the joint and limits progression of muscle imbalance (Sweeney et al. 1990). Stabilizing the lumbar or cervical spine has become popular as a treatment of herniated disk disease or internal disk disruptions and is discussed further in Chapters 10 and 11. In the case of a hypermobile spinal joint, physiologic movements can be used to avoid excessive movement across the hypermobile joint. For example, if the L5–S1 joint is hypermobile, the patient can be asked to exercise using pulleys with the legs spread apart, the spine extended, and weight mostly on the right leg. Sidebending to the right is associated with rotation to the left, resulting in movement in the midlumbar spine (Gustavsen and Streeck 1993).

These exercises are more difficult in the cervical spine. Care must be taken when exercising patients with cervical hypermobility with pulleys. Any movement with the upper extremities puts some force across the cervical spine. The patient must maintain cocontraction (optimal posture) at all times to avoid increased hypermobility.

Hypermobility of the sacroiliac joint is difficult to treat, as there are no muscles crossing the joint to stabilize. It may be necessary to stabilize this joint with a sacroiliac belt after making sure correct alignment is achieved with self-mobilization before having the patient engage in exercise. Commonly used exercises include resisted adductor and abductor exercises, gluteal and abdominal strengthening, and resisted internal and external hip rotation.

Stretching

Because muscle imbalance can be a precipitating factor in the development of both muscle and joint pain, it must be addressed. Janda (1986, 1988) observed that certain muscles respond to a given situation (e.g., pain, impaired afferentation by a joint) with tightness and shortening, whereas others respond with inhibition and weakness. Muscle responses seem to follow some typical rules—the development of tightness, weakness, or both may be considered a systematic and characteristic deviation in the functional quality of these muscles. The final result of this deviation is a general imbalance within the whole muscular system (Jull and Janda 1987, Janda 1986, Evjenth and Hamberg 1984). Fine muscle coordination is needed to prevent damage to a joint, especially during fast movement; thus, balanced muscle coordination may be the best protection of our osteoarticular system.

Stiff or shortened muscles are often activated in movements in which they would otherwise take no part (Evjenth and Hamberg 1984). When this occurs, a changed sequence of activation of the muscle in the movement pattern follows, spiraling the patient further into a continuous cycle of weakness, tightness, abnormal movement patterns, and pain. Treatment consists of stretching the short musculature and strengthening the weak muscles. Normal posture will be sought, resulting in normal bony alignment and normalized stresses across the joints. Because shortened muscle is thought to inhibit the antagonist, Janda (1986) and Evjenth and Hamberg (1984) recommend stretching the tight muscles before strengthening the antagonist muscles. Khalil et al. (1992) investigated the effectiveness of systematic stretching of the lumbar paravertebrals, quadratus lumborum, tensor fascia femoris, gluteals, internal rotators of the hip, abdominals, trunk rotators, and hamstrings as an add-on treatment for chronic low back pain patients. When compared with a control group that completed the same rehabilitation program without the stretching, the stretching group showed a significantly greater decrease in pain. The stretching group also showed significantly greater increases in static back extensor strength and electromyographic output of the trunk paraspinal muscles. Back ROM in flexion and extension, as well as straight-leg raising, increased significantly compared with the control group.

Mayer et al. (2000) report a significant increase of lumbar spine ROM, self-perceived pain, and disability in lumbar segmental rigidity through stretching and facet joint injections. Patients older than 65 years of age demonstrated greater improvement in bodily pain with flexibility exercises than with endurance and strengthening exercise (King et al. 2000).

Muscles are most safely and easily stretched when warmed up. Warming up can include an aerobic exercise or contraction against resistance. Because the shortened muscle inhibits its antagonist, the shortened muscle should be stretched before strengthening of the antagonist. A muscle should be stretched by applying a slow, static load for 15–20 seconds. Each muscle should be stretched 3–5 times for maximal benefit (Smith 1994). These stretches can be taught to patients as part of their independent exercise program. Table 7.9 list the elements important to an active approach to physical therapy.

Table 7.9. Elements of Active Treatment

Focus on functional activities
Train in functional movement patterns that have relevance to patient
Address impairments that interfere with physical functioning
Normalize range of motion
Normalize strength and endurance
Normalize aerobic fitness
Gradual progression exercise

PASSIVE MODALITIES

Passive modalities include the electrotherapeutic and thermal modalities, manual therapy, and soft tissue mobilization. The evaluation of the patient is critical to the decision-making process on the use of modalities. Modalities applied by the physical therapist should be recognized by the patient as passive treatment. The passive role is soothing and sympathetic and, therefore, may be appropriate for patients in acute pain or for those who have recurrent pain from reinjury. It is also appropriate for pain due to current cancer. Some modalities may be appropriate for patients with chronic intractable pain, but only if linked to function and if the patients can control these themselves (Table 7.10). Self-application of heat or ice can be therapeutic as positive reinforcement after activities or can be used to provide temporary symptomatic relief from pain. TENS application should be linked to increased functional activities. Because the use of these modalities is easy for patients to learn, it can play a role in effective treatment. The following is a discussion on passive modalities that patients can use independently.

Thermal Modalities

There are three theories regarding the mechanism of pain relief with heat application. The *vascular theory* postulates that heat application reduces pain by inducing vasodilatation, which can increase tissue blood flow up to 30 ml per 100 g of tissue (Lehmann and DeLateur 1990). The rise in blood flow effectively reduces ischemia by supplying oxygenated blood and nutrients while washing out metabolites (including those that contribute to nociception) accumulated during muscular activity.

Table 7.10. Elements of Passive Treatment

Thermal modalities: Heat and cold
Transcutaneous electrical nerve stimulation: High and low frequency
Biofeedback
Self-massage

The *counterirritation theory* is based on the gate-control mechanism originally proposed by Melzack and Wall (1982). According to this proposed mechanism, thermoreceptor afferent input can act as a gating mechanism in the dorsal horn of the spinal cord at the spinal levels of the sensory input, which blocks pain transmission to higher centers. Also, heating of a painful part can induce whole-body relaxation, which helps to inhibit painful muscle spasm or muscle tension. The means by which heating input activates a descending pain inhibitory system is not yet understood.

The third theory involves the direct influence of heat on muscle spindles and on sensory nerve conduction. When animal muscle spindles and exposed nerve endings are directly heated, a significant decrease in neuronal activity of the secondary endings and an increase in activity of primary endings and Golgi tendon organs have been measured. This produces a net inhibitory influence of the motor neuron pool, which breaks the vicious circle of pain-spasm-pain (Newton 1990).

There is little clinical justification for including heat application as part of physical therapy treatment in the clinic. In fact, the application of heat and cold as (part) of treatment was shown to be associated with poorer outcomes in patients with spinal impairments (Jette and Jette 1996). Patients may be invited to use heat or cold independently before or after a treatment session.

Cold therapy can be delivered in two basic forms: cold packs or ice massage. Cold packs are commercially available or can be made at home with crushed ice, ice cubes, or bags of frozen vegetables. Cold packs are useful for postexercise soreness, inflammation, and transient reduction of pain (symptomatic relief). In ice massage, ice is rubbed directly over the skin until numbness is felt. Ice massage delivers cold to a more pinpointed area with greater efficiency than a cold pack and may also provide more effective counterirritant therapy for pain relief. Patients are instructed in the safe use of ice massage, the warning signs of frostbite, and the four stages of normal ice massage (cold, burning, aching, and numbness). Ice massage is useful for relaxation, transient pain reduction, and treatment of local inflammation. Cold application for pain relief can achieve peripheral or central responses. Brief, intense cold most likely produces peripheral receptor adaptation (Cattell and Hoagland 1931). The counterirritation, discussed in the section Thermal Modalities, also applies to cold therapy.

The choice between using heat or cold for pain should take into account several factors. Heat decreases pain and induces relaxation. Therefore, it may have a counterproductive sedative effect if used before exercise. It increases tissue extensibility, which is advantageous when addressing stiff joints through self-mobilization and stretching. It decreases overall stiffness of musculoskeletal tissues. It may result in edema and should be used carefully if swelling is already a component of the patient's problem.

Cold decreases pain and swelling; however, it increases overall stiffness and decreases tissue extensibility. Some patients have a profound aversion to cold and experience anxiety with its use. Many patients with neuropathic pain do not tolerate cold well. This is counterproductive to most physical therapy goals. The therapist should choose a modality based on the patient's preferences and convenience for self-treatment. The emphasis is not on pain relief but on using the modality as a method of coping with pain. It should be possible for a patient to learn to safely apply a modality as a specific part of the total pain rehabilitation program.

Transcutaneous Electrical Nerve Stimulation

TENS is based on the early work of Melzack and Wall (1965), whose theory suggests that the peripheral stimulation of large-diameter cutaneous afferent nerve fibers could block pain sensation at the spinal cord through the gate-control mechanism. Based on this theory, devices were developed that allowed for stimulation of approximately 100 Hz, which was perceived by patients to be comfortable.

Stimulators have been developed that produce a more noxious stimulus of approximately 2 Hz. This is thought to stimulate the small-diameter afferent fibers, facilitating production of endogenous opiates, and producing pain relief through the descending pain-inhibiting pathway (Pomeranz 1976). Other proposed mechanisms of pain relief through TENS treatment include (1) pain relief by restoring an artificial afferent input in a deafferented area (Frampton 1994) and (2) pain relief by direct mechanical inhibition of a sensitized, abnormally firing nerve ending after injury (Wall and Gutnik 1974). TENS has been shown to produce pain relief of skin and fascia but does not seem to affect deeper structures (Ishimaru et al. 1993).

Low-frequency TENS has been shown to increase local skin blood flow (Cramp et al. 2000) and to activate μ opioid receptors in an acute inflammatory model in rats (Sluka et al. 1999). High-frequency TENS was shown to activate δ opioid receptors in an acute inflammatory model in rats (Sluka et al.1999). In morphine-tolerant rats, high-frequency TENS was shown to be more effective than low-frequency TENS in reducing hyperalgesia secondary to inflammation (Sluka et al. 2000). The authors postulated that, in patients who are morphine tolerant (i.e., have been on opioids for some time), high-frequency TENS would be more effective for pain relief.

The evidence for using TENS in patients with chronic musculoskeletal pain is controversial (College of Physicians and Surgeons of Ontario 2000), as is the evidence for its use in chronic low back pain (van Tulder et al. 1996). A more recent review concluded that both low- and high-frequency TENS reduce pain and increases ROM in patients with chronic back pain (Gadsby and Flowerdew 2000). There is also good evidence for the efficacy of TENS in pain relief over placebo in knee osteoarthritis (Osiri et al. 2001). Kumar and Marshall (1997) demonstrated the effectiveness of low-frequency TENS in the amelioration of pain and discomfort in patients associated with peripheral neuropathy. In a study sponsored by a TENS manufacturer, Chabal et al. (1998) found that long-term TENS use was associated with a significant reduction in the use of pain medication and occupational and physical therapy. TENS reduced costs for medication by 55% and up to 69% for occupational therapy and physical therapy.

Case Example

A 63-year-old man treated with cryotherapy 7 weeks ago for a grade V prostate adenosarcoma begins to experience excruciating pain in his perianal area and deep pelvic pain. He rates his pain as 10 out of 10 and is unable to sleep or perform occupational and daily living activities. He is seen by a physician specializing in pain, who prescribes him opioid pain medication, which reduces his pain to 4 out of 10. He is then referred for a TENS trial and management. Two electrodes are placed on his low sacral area and two in the S3 distribution on the inside of his thighs. The frequency is set to 150 Hz, random modulation—a clearly perceptible, but nonpainful, intensity. This is successful in reducing the pain to 1 out of 10 immediately.

Impairment: Pain.

Functional limitation: Decreased sleep, concentration, and cognition owing to pain and the side effects of opioids.

Disability: Decreased performance in occupational activities and ADLs.

Assessment, diagnosis, and prognosis: The patient is a 63-year-old man who presents with severe pain after cryotherapy used to treat his prostate cancer. The pain and the side effects of the medication he has been given for his pain have resulted in decreased ability to concentrate and fully function cognitively. This impairs his ability to sleep and perform his occupational duties, as well as his ADLs and instrumental ADLs. The patient will benefit from a TENS trial and will be seen once for instruction in TENS use and once for a follow-up visit within the ensuing month.

Three months after the initiation of TENS treatment, this patient still experiences significant pain relief owing to his TENS and is able to decrease the amount of opioids he is taking to control his pain. Because of this, he is able to resume his occupational duties full time and regain independence in his ADLs and instrumental ADLs. (Note: despite this, his insurance company refused to pay for the TENS unit rental.)

Biofeedback

Biofeedback uses electrodes to measure the background electrical activity in muscle tissue. It has been used effectively in chronic pain to help patients reduce muscle spasm and overactivity of muscles. It is most effective in cases of low back pain, headache, or neck pain that is a result of postural adjustments resulting in overuse patterns (Janda 1986, 1988). Relaxation of muscle in the paravertebral group is difficult to achieve voluntarily, especially in the upright position. Biofeedback can assist the patient's voluntary efforts by providing a clear picture of muscle use and relaxation. In the presence of chronic pain, the sensation of muscle contraction is distorted and even masked. The electromyographic output can be used as a replacement for this poor sensory feedback (Morgan 1988). In a study of chronic pain patients, the combination of relaxation training and electromyographic biofeedback was associated with reductions in pain, depression, distress, and interference in function, which were sustained over a follow-up period of 6 months (Spence et al. 1995).

Biofeedback is shown to be beneficial in the prevention of chronicity of acute sciatica (Hasenbring et al. 1999), and in the treatment of temporomandibular joint disorders (Berman and Swyers 1999) and fibromyalgia (Crider and Glaros 1999).

Massage

Whether chronic muscle tension causes chronic pain or is a by-product of it has not been determined. Massage can be an effective tool in decreasing muscle sensitivity and therefore improving function. Massage can reduce pain by increasing local circulation and by stimulating A-β fibers. Massage, however, can also exacerbate pain in patients who present with generalized pain to touch. Furlan et al. (2001) reviewed the available evidence for the efficacy of massage for nonspecific low back pain and concluded that "there is limited evidence showing that massage is less effective than manipulation immediately after the first session and moderate evidence it is less effective than TENS during the course of treatment and that three weeks after discharge there is no difference among massage and manipulation, electrical stimulation or corsets, but this evidence is limited." The evidence for use of massage in other conditions besides low back pain is not yet available.

Self-massage is an active modality for symptomatic relief of pain when it is incorporated into a patient's independent regimen. Self-massage may be administered by the use of a cane, umbrella handle, Thera Cane (a commercial device for trigger point massage [Thera Cane Co., Denver, Colorado]), or tennis balls using the body weight as counterpressure. The patient may press a tennis ball against a trigger point and apply ischemic pressure or slowly rotate the ball around the painful area. Two tennis balls in a sock are used for neck pain and headache. Ischemic compression massage applies sustained pressure to the trigger point with sufficient force and duration to inactivate it (Travell and Simons 1983). On release, the skin is blanched and then shows reactive hyperemia. To apply ischemic pressure, the muscle is first stretched to the verge of discomfort. As the discomfort tends to abate, pressure is gradually increased. If the patient tenses the muscle to protect the trigger point, the pressure is too much. This process is continued for up to 1 minute with as much as 20–30 lb of pressure.

Use modalities for self-management of pain and increased tolerance to physical activity.

TEAM APPROACH

The International Association for the Study of Pain published guidelines for desirable characteristics for pain treatment facilities (International Association for the Study of Pain 1991) (Appendix 7.2). Most physical therapy interventions for patients with chronic pain are unidisciplinary, meaning care is not integrated with other health care providers.

It is helpful to form unofficial alliances with the various care providers of the patient. Although time consuming, it is necessary, as it prevents the patient from getting conflicting information from providers, and it also prevents misunderstandings between care providers. Although it may be tempting to think that a sympathetic ear and an understanding of psychological problems will help patients with chronic pain with their psychological distress, physical therapists must work with pain psychologists for optimal treatment of these patients. Patients with chronic pain have high rates of concurrent anxiety and depression, and some may have suicidal ideation. Many have diagnosed (some undiagnosed) psychiatric illnesses or personality disorders, or both. Addressing psychological problems is not only far beyond the scope of physical therapy practice, it is also irresponsible and naive. Referral to psychologists specialized in the treatment of patients with chronic pain is discussed in Chapter 8. Similarly, communication with the referring physician about physical therapy goals of treatment will prevent the patient from splitting among health care providers and provide consistency of care. Such unofficial alliances may develop into a multidisciplinary team approach. Multidisciplinary pain management involves health care providers from several disciplines, each of whom specializes in different features of the pain experience. Fordyce (1973) wrote

> In a multidisciplinary exercise, two or more professions may make their respective contributions, but each contribution stands on its own and could emerge without the input of the other. In an interdisciplinary effort, life is not so simple. The end product requires that there be an interactive and symbiotic interplay of the contributions from different disciplines. Without that interaction, the outcome will fall short of the need. . . . The essence of the matter is that each of the participating professions needs the others to accomplish what, collectively, they have agreed are their objectives.

In the interdisciplinary management of chronic pain, the core team typically comprises a pain management physician, a psychologist, a nurse specialist, a physical and occupational therapist, a vocational counselor, and a pharmacist, although owing to poor reimbursement issues, many interdisciplinary teams have had to scale back in personnel. There is overlap between the various disciplines, predominantly between behavioral approaches to the patient by the psychologist and occupational and physical therapists. This overlap helps to reinforce the same message to the patient by the various care providers (Table 7.11).

The initial screening of the patient by a member of the core team determines which members of the team will be needed for a complete assessment of the patient. After this evaluation, the entire core team discusses the patient, and a com-

Table 7.11. Roles of the Members of the Interdisciplinary Pain Management Team

Member of Team	Role
Physician	Comprehensive assessment; review of prior records and previous treatments. Consideration of medical, block, or implantation interventions.
Psychologist	Comprehensive psychological assessment; focus on coping mechanisms and presence of psychological illness, psychiatric comorbidities, and substance abuse potential. Development of psychological interventions, including education on the use of self-management techniques, education, and cognitive behavioral therapy.
Nurse	Coordination of care, education, and medical therapy.
Physical therapist	Comprehensive assessment, with emphasis on the musculoskeletal system; assessment of strength, flexibility, and physical endurance. Assessment of functional activities and behavior. Education on active physical coping skills, management of physical rehabilitation process.
Occupational therapist	Assessment of the work site and home. Assessment of need for adaptive equipment. Setting functional goals. Education on active coping skills, assertiveness training, relaxation, and distraction techniques.
Vocational rehabilitator	Assess vocational skills and identify opportunities and strategies for return to work.
Pharmacist	Comprehensive review of past and current pharmacologic interventions, including the use of herbal and homeopathic substances. Education of patient with regard to appropriate use of pharmacologic interventions.
Psychiatrist	Diagnosis and treatment of psychiatric comorbidities. Medication management of psychiatric problems.

Source: Adapted from MA Ashburn, PS Staats. Management of chronic pain. Lancet 1999;353(9167):1865–1869.

prehensive treatment plan is developed. The care team tailors the care plan according to the individual needs of the patient, with a focus on achieving measurable treatment goals established with the patient. The plan must fit the patient's abilities and expectations. For some individuals, education and medical management suffice, whereas for others, care may need to include an inpatient pain program that requires the patient to remain at a treatment center 24 hours a day, 7 days a week, for 3–4 weeks, or an outpatient pain rehabilitation program that can vary according to the facility from 8 hours a day, 5 days a week for 2–4 weeks to 2 hours per day, 3 days a week for 6–8 weeks. Negotiating the overall treatment plan is the collective job of the team and the patient. Contingencies for possible outcomes should also be agreed on by the team and patient. Agreements should be clear and are best placed in writing. Contracts are a simple and effective means of avoiding future confusion about the plan. Written contracts offer the patient the opportunity to review and consider the information over time.

Team unity is critical to managing any patient, but especially the difficult patient. Unity is largely a function of communication and understanding the expertise of the other team members. Setting team members against each other is termed *splitting* and is a common behavior of the difficult patient. When there is substantial controversy among members of the treatment team, the team should still attempt to present a united appearance to the patient. The patient's best interest is served only if the treatment team is functional.

Frequent team meetings connect key representatives of the treatment team. Patient progress should be discussed during the meetings. If patients are not meeting their goals, are inconsistent with their attendance, or do not follow through with recommendations, the team should make recommendations for continuation of therapy or discharge. Because it might be impossible to meet with the entire team, there should be a mechanism for disseminating the plan between clinicians. Preferentially, the plan is put in writing, as doing so documents both the interdisciplinary effort of the team and provides a sequence of events during the treatment of a patient.

Table 7.12. Physical Therapy for Chronic Musculoskeletal Pain

Area of Concern	Passive Modalities	Bed Rest	Corsets and Orthotics	Manipulation	Exercise
Chronic low back pain	Inconclusive (not recommended)	Ineffective (not recommended)	Inconclusive	Contradictory	Contradictory (active exercise recommended)
Level of evidence*	Level III	Level III	Level IV	Level III	Level III
Chronic low back pain with sciatica	Ineffective (not recommended)	Effective for acute, but doubtful otherwise	Inconclusive	No systematic reviews but manipulation is contraindicated in presence of herniated disk	No systematic reviews
Level of evidence	Level III	Level III	Level IV	—	—
Chronic neck with/without limb pain	Inconclusive (not recommended)	Not recommended	Not applicable	Contradictory	Effective (active exercise recommended)
Level of evidence	Level III	Level II	—	Level III	Level III
Headache from musculoskeletal pain	No systematic reviews	No systematic reviews	Not applicable	Contradictory	No systematic reviews
Level of evidence	—	—	—	Level III	—
Generalized soft tissue pain	Inconclusive	No studies	Not applicable	Inconclusive	Effective (active exercise recommended)
Level of evidence	Level IV	—	—	Level IV	Level III

Note: For transcutaneous electrical nerve stimulation and acupuncture, there is Level III contradictory evidence for efficacy in a variety of musculoskeletal syndromes.
*Level I: Strong evidence from at least one systematic review of multiple, well-designed, randomized, controlled trials.
Level II: Strong evidence from at least one properly designed, randomized, controlled trial of appropriate size.
Level III: Evidence from well-designed trials without randomization, single group pre-post, cohort, time series, or matched case-controlled studies.
Level IV: Evidence from well-designed nonexperimental studies from more than one center or research group.
Level V: Opinions from respected authorities, based on clinical evidence, descriptive studies, or reports of expert committees.
Source: Data reprinted with permission from Evidence-Based Recommendations for Medical Management of Chronic Nonmalignant Pain. Reference Guide for Clinicians. Facilitated by the College of Physicians and Surgeons of Ontario. November 2000. A PDF (portable document format) file of the entire guide is available at http://www.cpsbc.bc.ca/physician/documents/pain.htm.

Table 7.12 summarizes physical therapy for chronic musculoskeletal pain, and Table 7.13 reviews the elements of team approach.

Table 7.13. Elements of Team Approach

Multidisciplinary approach.
Multiple providers from different disciplines contribute to care.
Interdisciplinary approach.
Multiple providers from different disciplines integrating care through frequent communication.
Treatment plan is decided on collectively.
Team unity is crucial.
Symbiotic interplay between disciplines to achieve common goal.

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RECOMMENDED WEB SITES

All Web sites listed here were last accessed on: June 14, 2001.

Pain Information

Physical therapy: http://www.achesandpainsonline.com/ http://www.ppaonline.co.uk/
Occupational therapy: http://www.pain.com/chronicpain.cfm
American Pain Society: http://www.ampainsoc.org/
International Study of Pain: http://www.iasp-pain.org/
Canadian Pain Society: http://www.medicine.dal.ca/gorgs/cps/
British and Irish Pain Society: http://www.painsociety.org/
Australian Pain Society: http://www.apsoc.org.au/sites.html
New Zealand Pain Society: http://nzps.org.nz/

Medical Information on Pain

National Institutes of Health pain and neurosensory mechanisms branch (NIDCR): http://www.nih.gov/od/museum/exhibits/pain/
Information on chronic pain in general (government issued): http://www.ninds.nih.gov/health_and_medical/disorders/chronic_pain.htm
Practice guidelines for chronic pain management for anesthesiologists: http://www.asahq.org/practice/chronic_pain/chronic_pain.html
Neuroscience information centre: http://www.brainland.com/
Functional MRI site for pain: http://www.fmrib.ox.ac.uk/pain/index.html
Drug company–sponsored site on pain problems: http://www.pain.com/

General Medical Information

National Library of Medicine, U.K.: http://www.omni.ac.uk/browse
National Library of Medicine, United States: http://www.nlm.nih.gov
General site for physical therapists (including chat): http://www.physicaltherapist.com/
Glossary on physical therapists' terms: http://www.physiotherapy.net.au/reference/glossary and http://www.kcl.ac.uk/depsta/iss/schools/bdhmn/subjsources/physioweb/otherp.html
Australian Physiotherapy Association: http://www.physiotherapy.asn.au/apacd/infosheet/d12.htm
American Physical Therapy Association: https://www.apta.org/
Canadian Physiotherapy Association: http://www.physiotherapy.ca/regrep.htm
Chartered Society of Physiotherapists: http://www.csp.org.uk/
For web sites on all physical therapy/physiotherapy associations, see http://www.mednets.com/physioass.htm
Database on physical therapy and rehabilitation research/publications: http://ptwww.cchs.usyd.edu.au/pedro

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Appendix 7.1.

Functional Restoration Treatment Agreement*

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*Developed by R Kulich, Ph.D., New England Medical Center Pain Management Program.

Appendix 7.2.

Pain Facilities Classifications*

The International Association for the Study of Pain has identified four classifications for pain facilities:

Modality-oriented clinic. This is a health care facility that offers a specific type of treatment and does not provide comprehensive assessment or management. Examples include a nerve block clinic, acupuncture clinic, or a biofeedback clinic. Such a facility may have one or more health care providers with different professional training, but because of its limited treatment options and the lack of an integrated, comprehensive approach, it does not qualify for the term *multidisciplinary.*

Pain clinic. A health care delivery facility focusing on the diagnosis and management of patients with chronic pain. A pain clinic may specialize in specific diagnoses or in pains related to a specific part of the body. A pain clinic may be large or small, but it should never be a label for an isolated solo practitioner. A single physician functioning within a complex health care institution which offers appropriate consultative and therapeutic services could qualify as a pain clinic if chronic pain patients were suitably assessed and managed. The absence of interdisciplinary assessment and management distinguishes this type of facility from a multidisciplinary pain center or clinic. Pain clinics can, and should be encouraged to, carry out research, but it is not a required characteristic of this type of facility.

Multidisciplinary pain clinic. A health care facility staffed by physicians of different specialties and other nonphysician health care providers who specialize in the diagnosis and management of patients with chronic pain. This type of facility differs from a multidisciplinary pain center only because it does not include research and teaching activities in its regular programs. A multidisciplinary pain clinic may have diagnostic and treatment facilities that are outpatient, inpatient, or both.

Multidisciplinary pain center. An organization of health care providers and basic scientists that includes research, teaching, and patient care related to acute and chronic pain. This is the largest and most complex of the pain treatment facilities and, ideally, would exist as a component of a medical school or teaching hospital. Clinical programs must be supervised by an appropriately trained and licensed clinical director. Has a wide array of physical therapists, occupational therapists, vocational counselors, social workers, and other specialized health care providers.

The many disciplines of health care providers required are a function of the varieties of patients seen and the health care resources of the community. The members of the treatment team must communicate with each other on a regular basis, both about specific patients and about overall development. Health care services in a multidisciplinary pain clinic must be integrated and based on multidisciplinary assessment and management of the patient. Inpatient and outpatient programs are offered in such a facility.

*Reprinted with permission from the International Association for the Study of Pain. Task Force Guidelines for Desirable Characteristics for Pain Treatment Facilities. Seattle: International Association for the Study of Pain, 1991.

Chapter 8

Behavioral Medicine Assessment and Treatment

Alan Witkower

Patients seen by physical therapists may have problems related to their pain or other conditions that are best addressed by behavioral medicine specialists. Examples of such patients are discussed in this chapter. These patients represent a clinical challenge for physical rehabilitation and highlight the value of obtaining a psychological consultation to clarify the complex issues surrounding persistent pain and disability. Physical therapists can benefit by becoming aware of the nature of psychological issues in patients by adopting some behavioral principles in their approaches to patients and by knowing how to integrate psychological findings into their own assessment findings to make realistic treatment decisions for complex patients.

Case Example

A 58-year-old, married woman complains of neck, shoulder, and diffuse back pain. She works as an office manager, and her two children have recently left home—one for college and another to enter the army. Her pain has been diagnosed as being related to degenerative disk disease and possible arthritis. She is not considered a candidate for any surgical intervention. She has had pain for approximately 10 years but reports that in the past 6 months her pain has increased considerably and is causing her significant distress and disability. She reports that, after work, she often returns home and goes directly to bed. She presents as extremely pain focused with displays of excessive pain behavior, such as groaning and wincing with the slightest movements. When not describing how much pain she is experiencing, the patient complains bitterly about being unappreciated by her husband. She describes her husband as insensitive to her discomfort and confides that she fears he may be losing interest in her and the marriage. At times during treatment, the patient begins to cry but generally excuses her behavior as being related to her pain or fatigue.

BEHAVIORAL ASSESSMENT

This patient is an excellent example of when a behavioral assessment should be included in rehabilitation. Behavioral assessment is generally indicated when a patient's pain is (1) causing significant impairment in normal functioning; (2) compromising relationships with family or friends; (3) contributing to emotional distress, such as anxiety or depression; (4) resulting in the patient's overuse of health care resources; (5) creating a dependence on the use of narcotic or sedative-hypnotic medications; or (6) significantly disproportionate to the physical findings (Kerns and Jacob 1992, Romano et al. 1989).

Psychological and behavioral factors can contribute to the maintenance or exacerbation of a particular pain problem. A behavioral assessment only explores possible contributions to a patient's pain experience, and there is no intent to differentiate

Table 8.1. Goals of Behavioral Assessment

Establish the patient's view of his or her pain problem.
Identify the behavioral, cognitive, affective, and environmental contributions.
Establish realistic and measurable treatment goals.
Identify the appropriate treatment interventions to achieve these goals.
Establish how the patient will collaborate in the treatment process.

organic versus psychogenic pain. This does not, however, rule out the contribution of physiologic processes to the nociceptive element of the pain (DeGood 1988). A patient who is depressed and is abusing narcotic pain medication can still be receiving noxious input from a strained muscle. Conversely, the presence of observable and positive signs of an organic basis for the nociceptive element of pain does not preclude significant behavioral and psychological factors from influencing pain and disability. A patient with an obvious herniated disk impinging on a nerve root can still present with an anxiety disorder that may be fueling the patient's excessive "doctor shopping." A view that pain arises either in the body or mind overlooks the critical role of the patient's environment on pain and disability. A patient's adversarial relationship with the insurer over a work-related injury or the patient's overly solicitous spouse may contribute more to the course and outcome of the patient's pain and suffering than emotional or physiologic variables.

Psychosocial and behavioral assessments of patients by behavioral psychologists range from brief screening interviews to in-depth psychological evaluations. In some settings, the assessment is performed in an expedient manner to determine the appropriateness of a particular treatment program (e.g., admission to an inpatient versus an outpatient pain rehabilitation program). In this case, the assessment may involve a relatively brief interview, along with a review of the patient's responses to a general pain questionnaire. After the patient has been admitted to the pain rehabilitation program, a more comprehensive psychosocial evaluation is performed. In other settings, a comprehensive psychological evaluation performed at the beginning of treatment may include (1) the completion of a battery of psychological and pain-focused instruments, (2) an extensive and structured clinical interview, and (3) psychophysiologic assessment with biofeedback instrumentation. The goals of this more comprehensive evaluation include establishing a psychiatric diagnosis and identifying psychophysiologic aspects of the pain problem and the contributions of behavioral, cognitive, environmental, and emotional factors to the pain experience (Bradley et al. 1992) (Table 8.1).

The in-depth behavioral assessment described here reflects an emphasis on a cognitive-behavioral orientation to pain, which is described later in the chapter, in the section Assessing Cognition and Coping. The goals of the behavioral assessment include (1) understanding patients' views of their pain problem and treatment expectations; (2) delineating the behavioral, cognitive, affective, and environmental influences on patients' pain problems; (3) establishing realistic and measurable treatment goals; (4) determining appropriate treatment interventions for achieving those goals; and (5) engaging patients in a collaborative treatment approach, including physical therapy, to achieve those goals (DeGood 1988, Romano et al. 1989).

Referral

It is not surprising that patients referred to a psychologist for a behavioral assessment may be resistant and suspicious of the reason for the referral. This resistance is understandable when the patient's point of view is considered. Often, the initial perception of patients referred for behavioral assessment is that they are being viewed as "crazy" and that therapists and doctors think the pain is "all in their heads." Many patients consider a behavioral assessment to be irrelevant to their pain problem, which they believe is strictly physical in nature. The patient's concern is that the referring clinician will not pursue further medical testing or intervention, despite the patient's belief that there is an undiagnosed medical disorder causing the pain. Some patients believe the referral is a statement that their pain problem cannot be "fixed" by health care professionals and that they are therefore being "dumped." For patients who are involved in compensation claims or litigation, there is often concern that the legitimacy of their pain is being questioned and that they are being viewed as malingerers. Therefore, the behavioral assessment is seen by some patients as an effort to "prove" that they do not have a legitimate pain problem (Cameron and Shepel 1986, Romano et al. 1989).

A behavioral assessment is of questionable value if the validity of the patient's responses is compromised by a hostile and defensive attitude. Patients may choose to be circumspect about their answers to questions during the assessment, or they may deny any psychological distress and present a "cheerful" picture of their problems to suggest psychological health. It is therefore extremely important for all members of the pain rehabilitation team to consider the following referral guidelines to ensure a valid outcome and a useful experience for the patient (Table 8.2):

Table 8.2. Referral Guidelines

Provide a credible rationale for the referral.
Acknowledge the legitimacy of the patient's pain and suffering.
Identify the mental health professional.
Personalize the referral.
Prepare the patient for inclusion of family and/or spouse.
Reassure the patient that the referral is part of the overall treatment plan.

1. Discuss the disrupting impact that chronic pain can have on all areas of life, including family, work, and social aspects. It may be helpful to personalize the rationale for the referral by using hypothetical examples of how others might respond to the pain problem the patient is experiencing or by discussing the range of personal problems the patient has disclosed in the course of treatment (Cameron and Shepel 1986, Romano et al. 1989). The clinician may empathize with the patient by using a statement such as "I can only imagine that if I could not play with my kids I would be very frustrated and sad." To remind the patient of the range of problems experienced, a statement such as "you have mentioned several times how discouraged you get when you can't fix things around the house or be a good partner for your wife; maybe it would help if you had an opportunity to talk with someone about how you are feeling" might be helpful.

2. The patient should be reassured that the clinician believes in the validity of his or her pain but should also be reminded that there are complex interactions between physical and psychological processes that influence pain perception, disability, and suffering. Even when a patient's pain complaints are disproportionate to the physical findings, the patient's distress and perception of pain can be acknowledged as genuine despite the lack of physical findings (Cameron and Shepel 1986, Romano et al. 1989). Again, statements such as "I know you have been told that your back does not look that bad on the tests, but I have seen patients with a bad muscle strain like yours causing a great deal of pain that left them discouraged and frustrated, also" can be reassuring to the patient.

3. Inform the patient that he or she will be seeing a psychologist. Explain that a psychologist is interested in learning about what factors affect the patient's pain and how each person reacts to pain. Emphasize that the role of the psychologist is to help the patient identify practical solutions to problems. Reassure the patient that he or she is not being referred with the intent of having a mental illness diagnosed. If possible, describe the psychologist in a personal way or as someone who has been helpful in similar situations (Cameron and Shepel 1986). Hearing a statement such as "I have referred patients to Dr. Smith before, and they tell me how helpful he has been in teaching them how to cope better with their pain" can make a difference in a patient's attitude about the referral.

4. It is also helpful to prepare patients for the involvement of significant others or family members. Patients can generally accept the rationale that information provided to the psychologist from someone close to them will enhance understanding of their pain problem.

5. Reassure patients that the referral does not mean you will be transferring the patient's care. Reminding patients of the multifaceted nature of their pain problem and emphasizing the benefit of a comprehensive approach can support the addition of the psychologist to the treatment team (e.g., "You and I have been making progress with your flexibility and endurance; now it may help you to learn how to transfer your gains to activities you enjoy with your family. Dr. Smith could help you find ways to become more active with your spouse and children").

Table 8.3. Elements of the Behavioral Assessment

Pain history
Reason for referral
Cause of pain
Circumstances surrounding onset of pain
Factors that influence exacerbations of pain
Review of all prior and current treatments and responses to treatments
Patient's active and passive coping responses to pain
Information from a pain diary
Dysfunction and distress
Comparison of pre-pain and post-pain activity levels
Responses of others to patient's pain behaviors
Marital and family relationships
Work performance and satisfaction
Compensation and litigation
Mood disorders, including depression, anxiety, and anger
Cognition and coping
Beliefs and expectations regarding diagnosis, prognosis, and treatment options
Patient's cognitive and behavioral efforts to control or tolerate the pain

Pain History

The behavioral psychologist's role is described for the physical therapist to have a good understanding of the way in which this team member can contribute to the pain patient's total care. For each member of the team, a good introduction is crucial in establishing rapport with a new patient. This rapport will influence the course and outcome of the subsequent assessment. In this introduction, the behavioral psychologist should address the role of the psychologist, the purpose of the psychological interview, and the issues to be covered in the interview. The interview may begin with a question about the patient's referral for the behavioral assessment. The patient should be asked what he or she was told about the reasons for referral and why he or she thinks the referral was made. The patient's responses to these questions will then allow the psychologist to clarify any misperceptions or allay any of the patient's concerns (Table 8.3).

A pain history should be elicited after the introduction. Inquiring early on about a patient's pain permits the psychologist to establish a rapport with a patient before proceeding into areas of psychosocial functioning that may be more difficult and sensitive for the patient to discuss (Bradley et al. 1992, Romano et al. 1989).

Chapters 1 and 5 describe the assessment of pain from a sensory perspective, focusing on the patient's description of the intensity, location, duration, frequency, and quality of pain. It is also important for the psychologist to explore how the pain began (Romano et al. 1989). If the pain began with a traumatic event, such as a motor vehicle accident or work-related injury, it is necessary for all members of the team to understand what specifically occurred and how the patient has responded to the injury or accident since it occurred. A patient who was injured in a serious motor vehicle accident and reports that he or she cannot tolerate driving distances because of pain may also have developed a phobia about being in a car. A patient who experienced a traumatic injury at work might be reluctant to return to work, in part because of a post-traumatic stress response associated with the accident.

Assessing what was occurring in the patient's life before or during the onset of pain is particularly important if the patient reports that his or her pain began spontaneously or developed during a chronic illness (Bradley et al. 1992, Turk et al. 1983). There may be environmental or psychosocial factors that contributed to the patient's awareness of discomfort or intolerance for pain that was previously manageable. An example of this situation is a patient whose increased complaints of pain and disability due to a chronic illness, such as arthritis, coincide with a separation from a close family member.

The psychologist also asks patients to describe factors (e.g., weather, activity, or the menstrual cycle) that influence the intensity and daily fluctuations of the pain. Patients are also encouraged to consider what variables contribute to decreased tolerance for pain (e.g., lack of sleep, frustration, distractions, worrying) and what events usually precede or follow exacerbations of pain (Bradley et al. 1992). For example, a patient may state that her pain always seems to increase just before her spouse returns home from work. Further questioning may show that the patient's spouse has been experiencing stress at work and has a tendency to complain about work when he arrives home. This line of inquiry elicits valuable information about the patient's pain and reinforces the idea that pain is multidimensional in nature.

The pain history also includes a review of all of the previous and current treatments for the patient's pain. Often, this will reveal important information about the patient's expectations of treatment and identify the patient's attitudes toward health care providers (DeGood 1988, Bradley et al. 1992). Patients often will relate a lengthy history of multiple practitioners who tried unsuccessfully to ameliorate the patient's pain. Therefore, the patient is feeling discouraged and is likely to be skeptical of any further "promises" to help alleviate the pain. A patient who reports that previous physical rehabilitation has "made me much worse" will obviously require a thorough re-education before further physical therapy is recommended. Some patients may state that they have had many passive modalities applied and received numerous medication trials and still did not improve. Patients may then conclude that nothing will help them, because they have not been introduced to active and self-management strategies. These patients may have become dependent in previous treatment on physical therapists and physicians and believe that they must submit to the ministrations of health care providers. Closer review of the reported unsuccessful treatments, such as medications and modalities, may also show that the patient was not fully compliant with the recommended treatment. For example, many patients prematurely discontinue an antidepressant medication trial owing to unpleasant side effects or because of the stigma attached to these medications. Other patients stop treatments because of an increase in pain and an inadequate explanation of how the treatment will benefit them. Ultimately, it is important for all team members to know in advance how a patient responded to previous treatment recommendations, so the patient's responses to any of the treatment approaches recommended can be anticipated.

It is also valuable for the pain team members to have information about the patient's coping strategies (e.g., medications, resting, watching television, hot showers) that have helped the patient with the pain (DeGood and Shutty 1992). Some patients may identify coping strategies (e.g., talking to friends, taking walks, listening to music, keeping busy) that suggest they are more amenable to a self-management or behavioral approach. Some of the patient's coping strategies (e.g., medication intake) may become targets for intervention and change; other strategies may involve behaviors that can be reinforced or increased, such as efforts to socialize and distract oneself from pain.

The interview can be supplemented with the use of a pain diary. This method provides the psychologist with more data, underscores how many variables influence pain, and provides the patient with a record of his or her responses to the pain. The pain diary was initially developed to record information on a patient's positioning during the day (i.e., sitting, reclining, standing, walking) (Fordyce 1976). It is now often modified to include additional variables, such as pain intensity, medication intake, mood, tension levels, where and with whom the time was spent, use of pain control strategies (e.g., hot pack, distraction), and sleep. Patients are generally asked to fill out the diaries three to four times a day, noting how they spent the preceding period of time on an hourly basis. The pain diary, therefore, provides direct, immediate, and repeated data in contrast to the clinical interview, which focuses on retrospective data and relies on the patient's memory. The pain diary also provides a baseline of behaviors that will be used to develop treatment goals and measure the patient's progress. Additionally, the pain diary can be used throughout the treatment program to identify problematic behavioral patterns that interfere with progress and to document areas of improvement during treatment (Karoly and Jensen 1987).

ASSESSING DYSFUNCTION AND DISTRESS

Patients expect and appreciate inquiry about their distress, because it permits them to describe how much pain they are experiencing and explain how their pain has interfered with their lives. Each team member inquires into this aspect in a slightly different way. The behavioral psychologist explores how these patients were functioning in family, social, and vocational aspects of their lives before the development of pain (Bradley et al. 1992). The comparison of a patient's pre- and post-pain activity level is critical in developing hypotheses regarding what consequences or variables could be maintaining pain behaviors and augmenting pain perception. For example, a patient may report that he or she can no longer assist with household activities, such as doing the laundry, because of pain, but the patient's spouse may report that the patient used to complain about this task before the onset of pain.

Thus, avoidance of certain unpleasant activities owing to complaints of pain may be a function of negative reinforcement rather than actual pain intolerance. Patients may report that they can still perform other physical activities that require comparable physical effort. An example is a patient who claims he cannot assist with the dishes because of pain in his back when he stands at the sink, but he may report that he is able to stand at his work bench to repair a broken fixture.

During this portion of the interview, the psychologist should also note how people in the patient's environment respond to the patient's pain behavior (Turk et al. 1983). The patient should be asked how his or her spouse (or "significant other") reacts when the patient takes medication or patient complains about increased pain. The spouse may respond with expressions of concern and an effort to make the patient more comfortable, thus reinforcing the patient's pain behavior and reducing the likelihood that the patient will engage in well behavior. A patient might report that her spouse reacts to her complaints of pain with frustration and avoidance of the patient. In this case, the patient's emotional distress will increase, and her efforts to receive validation of her pain may lead to an increase in pain behavior with health care providers. It is also possible that, for this patient, having her spouse avoid her solves a long-standing difficulty with intimacy in the marriage. Thus, her complaints will persist, despite efforts by professionals to ameliorate her pain problem.

This line of questioning may also involve discussion of the patient's marital and family relationships (Bradley et al. 1992, Romano et al. 1989). Patients will be more comfortable with questions about their relationships when they have acknowledged that the pain problem has had an impact on the quality of those relationships. In some instances, the focus on pain permits a couple to become closer and spend more time with each other. This unacknowledged benefit should be addressed before rehabilitation for pain can be effective. For another couple, a patient's pain problem can keep a dissatisfied spouse from leaving the marriage because the patient has a legitimate need for care. Treatment that improves the patient's pain may threaten to expose him or her to the greater pain of losing a spouse.

Case Example

The following story by patient PM illustrates the complexity of marital and family relationships in the context of a chronic pain problem.

> I've been in pain for over 25 years. I do not feel like a normal person. I feel like I am who my pain makes me be each particular day. I try very hard and use an awful lot of energy trying to hide my pain from people around me, especially my family. I'm so afraid if I didn't, that I wouldn't be loved. For instance, with my husband, I try to make sure my home is always kept up and laundry is done. If he wants to go out, I go, and I've tried extremely hard not to let it burden him. I've always felt very insecure in my husband's feelings for me. I can't understand why he's still with me after all these years. Why would he want someone who's always sick, in pain, or has something wrong with her? I worry about my son very much. I try to be upbeat and pretend I feel fine, but he sees right through me and actually gets angry that I'm faking how I truly feel. I know it bothers him to think of me as always being in pain, and I hate the thought that that's how he thinks of me. Sometimes we'll get into conversations, and roles will reverse. I'll feel like the child, and he'll take the parent role. He'll start scolding me that I'm not doing enough to change my situation, or I'm not eating properly, and I find it very difficult to talk to him and feel like he's being a little harsh on me.
>
> Then there's my mother, who thinks that if I just get off all the meds, I'll be perfectly fine. If I happen to work up the nerve to talk about things that are really bothering me, one of my siblings will beep in, and my mother will end our conversation. I have always taken a second seat to everyone, so I have trained myself to automatically put everyone else first, whether I'm in pain or not. I'm in pain, depressed, confused, and fatigued all the time. —PM

A patient reporting that pain has interfered with performance at work or that he or she is currently receiving workers' compensation owing to injury resulting in pain provides an opportunity for any team member to inquire about the patient's vocational and educational experiences (Mendelson 1994). It is critical to learn what incentives or disincentives influence a patient's pain complaints and impact the motivation to return to productive employment. Patients should be asked about their work history, education, and vocational skills. A patient who has had a poor work history with multiple jobs, has not completed high school, and has limited work skills will represent a significant challenge for pain and vocational rehabilitation. Another patient who has worked for a company for many years and is injured on the job may express disappointment with the company's treatment. In this case, the patient's resentment may interfere with participation in treatment directed at returning to work. Similarly, a patient who reports attendance problems, conflicts with co-workers, or discontent with work will require vocational counseling in addition to pain management strategies (Mendelson 1994).

The issue of compensation and litigation in a patient's pain experience is very complex and requires more discussion than is possible in this chapter. Several areas should be explored in a behavioral assessment, however, including (1) how the current level of compensation compares to the patient's previous income, (2) whether improvement in pain or disability threatens the patient's level of compensation or the financial outcome of the litigation, (3) whether the patient is being advised by his or her attorney or family to avoid any demonstration of improvement, and (4) whether the patient has a realistic opportunity to return to his or her former job or if he or she requires vocational counseling and training (Romano et al. 1989). It is important to understand that there is no consensus in the research on the relationship of compensation, litigation, chronic pain, and treatment (Mendelson 1994). However, assessment of these factors is critical in developing an appropriate treatment plan or determining whether treatment should be postponed until legal issues have been resolved (Table 8.4).

The most commonly used measures of functional disability used by behavioral psychologists are the Chronic Illness Problem Inventory (Kames et al. 1984), the Sickness Impact Profile (Bergner et al. 1981), and the Multidimensional Pain Inventory (Kerns et al. 1985).

The Chronic Illness Problem Inventory is a 65-item instrument that assesses physical limitations, psychosocial functioning, health care behaviors, and marital adjustment. The Chronic Illness Problem Inventory appears to be useful as a screening tool that can assist in focusing an assessment and as an outcome measure to evaluate progress during treatment. The Sickness Impact Profile is a questionnaire with 136 items and 12 categories: sleep and rest, eating, work, home management, recreation and pastimes, ambulation, mobility, body care, movement, social interaction, alertness behavior, and communication. Although the Sickness Impact Profile is lengthy, it has good psychometric properties and is a sensitive measure of change as a function of pain treatment. The Multidimensional Pain Inventory attempts to evaluate the impact of patients' pain on multiple areas of their lives. It is a 56-item assessment that is composed of three sections. The first section evaluates (1) interference of pain on social, vocational, and family functioning; (2) support from a spouse or significant other; (3) severity of pain; (4) perception of life control; and (5) negative mood. The second section evaluates the patients' perceptions of the responses of others as being solicitous, distracting, or punishing. The third section evaluates the frequency of patients' participation in household chores, outdoor work, social activities, and activities outside of home. The Multidimensional Pain Inventory describes three patterns of patient responses: *dysfunctional*, *interpersonally distressed*, and *adaptive coper*. These patient profiles are useful in determining areas of distress and dysfunction that require specific attention in treatment.

The psychologist should also determine the nature of the patients' associated emotional distress. The most frequently encountered areas of distress reported by patients with chronic pain are depression, anxiety, and anger. Additional problems include memory and concentration difficulties, post-traumatic stress disorders, and sleep disturbances.

Table 8.4. Assessment Tools

Functional disability
Chronic Illness Problem Inventory (Kames et al. 1984)
Sickness Impact Profile (Bergner et al. 1981)
Multidimensional Pain Inventory (Kerns et al. 1985)
Mood and affect disturbances
Beck Depression Inventory (Beck and Speer 1987)
State-Trait Anxiety Inventory (Spielberger 1983)
Symptom Checklist-90 (Derogatis 1983)
Cognition and coping
Pain Beliefs Questionnaire (Gottlieb 1984, 1986)
Survey of Pain Attitudes (Jensen et al. 1987)
Pain Beliefs and Perceptions Inventory (Williams and Thorn 1989)
Pain and Impairment Relationship Scales (Riley et al. 1988)
Coping Strategies Questionnaire (Rosenstiel and Keefe 1983)
Vanderbilt Pain Management Inventory (Brown and Nicassio 1987)

Case Example

A 22-year-old man who had traumatic amputation of both legs above the knees after a motorcycle accident 1 year ago has been in physical therapy for 3 months and is making very limited progress in learning to ambulate with his prostheses. He complains of phantom limb pain and diffuse back pain that limit his tolerance for weight bearing. He is prescribed a narcotic pain medication, an anti-inflammatory medication, a muscle relaxant, and an antidepressant. The patient continually complains that his physician is not providing him with enough narcotic medication to control his pain. His presentation is notable for a sad and irritable affect with frequent complaints about his previous care providers. Despite his expressed dissatisfaction with his care, he is reliable and on time to all of his appointments, regardless of weather or illness. He avoids discussing his accident but does comment that he wishes he had not survived it.

Depression is the disorder most commonly associated with chronic pain. Patients describe feeling demoralized, irritable, fatigued, isolated, discouraged, and hopeless; they also report problems with sleep, appetite, and sexual interest, and an inability to enjoy any pleasurable activity. Often, a depressed patient expresses passive suicidal wishes, such as "I sometimes hope that I will not wake up in the morning." The Beck Depression Inventory (Beck and Speer 1987) is a particularly useful instrument for assessing the presence and severity of depression. The Beck Depression Inventory is a brief (21 questions), self-administered instrument that assesses both the cognitive-affective and neurovegetative signs of depression. If a patient does present with depression, further inquiry is necessary to determine (1) if the patient has had a previous history of depressive disorder, (2) if the patient is being prescribed sedative-hypnotics or significant amounts of opioids, and (3) if the patient is using alcohol or other substances that would create a presentation similar to depression.

Anxiety is generally suspected when patients describe jitteriness; racing thoughts; difficulty falling asleep; excessive muscle tension; difficulty concentrating; and symptoms of autonomic arousal, such as palpitations, dyspnea, tachycardia, or nausea. As with depression, there are patients who report that they cannot function owing to pain when, in fact, the primary cause of the patients' avoidance of activity is a generalized anxiety disorder. In other situations, the patient may have been injured in a traumatic accident, and the resulting post-traumatic stress disorder is the major factor contributing to the patient's inability to function. The State-Trait Anxiety Inventory (Spielberger 1983) is a popular instrument for assessing both a patient's current *state* of anxiety and the patient's *trait* (or characteristic experience) of anxiety. The State-Trait Anxiety Inventory has 40 questions and can be self-administered and completed in 20 minutes.

Anger and hostility are important aspects of a patient's emotional distress in response to persistent pain. The expression of anger as hostility or defensiveness can seriously compromise the therapeutic relationship between the patient and every member of the rehabilitation team. Conversely, patients who minimize or deny anger in circumstances that would realistically elicit these feelings may be contributing to their excessive muscle tension or inappropriate use of medications to modulate this negative affect. The Symptom Checklist-90 Revised (Derogatis 1983) is a 90-item self-report checklist that measures psychological symptoms, including somatization, obsessiveness, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoia, and psychoticism. These nine subscales can be averaged and used to compute a Global Symptom Index that assesses a patient's degree of psychological distress. The Symptom Checklist-90 Revised is particularly useful as a screening tool to highlight areas of the patient's psychological functioning that require further examination. The Symptom Checklist-90 Revised takes approximately 20–30 minutes to complete. It therefore has a distinct advantage over more comprehensive psychological inventories, such as the Minnesota Multiphasic Personality Inventory, which is often too time intensive for patients with pain who have difficulty concentrating on a task.

ASSESSING COGNITION AND COPING

Patients' cognitions include beliefs, appraisals, and expectations regarding the pain diagnosis and treatment options. Their beliefs and expectations can be placed into one of three categories: (1) beliefs about the pain, (2) beliefs about the treatment, and (3) coping styles (Bradley et al. 1989, DeGood and Shutty 1992). For example, if a patient believes that referral to a psychologist suggests that her physician views her pain as being "psychological," this perception will evoke mistrust, defensiveness, and hostility. Thus, the patient may begin to exaggerate pain behavior to convince the physician that her pain is "real." If a patient is told by his physician that his back pain is a result of degenerative disk disease or a bulging disk, the patient may fear that any activity will cause more damage or disability. As a result, the patient may resist recommendations to engage in a physical therapy program, despite the risks associated with serious deconditioning. These examples demonstrate how an individual's belief about his or her pain will influence the patient's pain perception, suffering, coping effort, and disability.

Case Example

A 44-year-old man complains of low back pain. The onset of his pain followed a work-related injury, in which the patient attempted to lift a heavy object and reports that he heard a "popping noise" and then felt "something let go in my back." Several diagnostic procedures have been performed, including magnetic resonance imaging, myelography, bone scans, and an electromyography. None of these procedures has shown any spinal abnormality. He has also had consultations with an orthopedic surgeon, a neurologist, a chiropractor, and, most recently, a physiatrist. He is diagnosed with a severe sprain and strain. Despite reassurances that his injury is not serious, the patient expresses considerable fear of engaging in any activity that might further harm him. He has not progressed in previous courses of physical therapy but now states that he has no other alternatives, because he is not a surgical candidate, and his insurer refuses to cover any further diagnostic procedures. His wife accompanies him to all appointments and appears very solicitous of his needs. According to the patient, he is totally dependent on his wife for basic activities of daily living, such as showering and dressing. The patient states that he is extremely frustrated with his dependency but maintains that this state of affairs is preferable to "becoming paralyzed."

Patients routinely question why they are having pain. Therefore, it is important for team members to ask patients what they have been told about the cause of their pain and what they believe is the cause of their pain. These questions are important, because patients frequently are told that their pain is due to a relatively benign disorder, but their anxiety makes them suspicious that the pain is due to a much more serious and undiagnosed problem. A common example of this misperception is the patient who has a soft-tissue injury, causing diffuse pain that persists for several months. Because most patients are socialized to believe that pain is a symptom of an underlying disorder, it is difficult to help the patient accept the notion that pain may represent an interaction of physiology, psychology, and environmental factors (Romano et al. 1989, DeGood 1988).

It is common for patients to describe disappointment that their physician reported that there was no serious medical problem identified by the clinical examination and diagnostic testing. Patients often believe that they will receive treatment to ameliorate their pain if a specific medical problem is diagnosed. The lack of clinical findings does not reassure patients but instead impels them to seek further medical consultation. Therefore, a significant component of the psychologist's treatment is focused on assisting patients in reconceptualizing their pain problem. Many patients with chronic pain should be encouraged to see their pain as an interaction of somatic, psychological, and social factors (biopsychosocial model) rather than as a symptom of disease (medical model) (Hanson and Gerber 1990).

The psychologist's questions may also explore the patient's expectations of the consequences of pain. Many patients are prone to catastrophizing (DeGood and Shutty 1992, Turk et al. 1983).

Patients commonly believe that all rehabilitation treatment should fix their pain so that they will be able to resume life as it was before the onset of pain. They expect health care providers to have the answers and that they should merely be a passive recipient of treatment. Some patients believe that "dramatic" and invasive treatments are more likely to provide relief. Many patients would prefer surgical intervention or a series of painful nerve blocks to physical rehabilitation or lifestyle adjustment. Patients who have already been prescribed potent narcotic medications conclude that there is a serious problem if such medical intervention is warranted. Therefore, any "lesser" treatment (e.g., physical rehabilitation) will be viewed as insufficient to address their pain.

When a treatment approach is presented to a patient, there are two important beliefs that influence the patient's acceptance of the treatment. First, patients must determine whether the treatment, such as relaxation exercises, is a credible intervention that will have a positive impact on their pain perception. This is the patient's *outcome expectancy* (Bandura 1977). Second, patients must decide if they are capable of effectively using the technique for their pain. This is the patient's *self-efficacy expectancy* (Bandura 1977). Some patients may respond negatively to the suggestion that moderating their reactions to stressful events will reduce their pain, because this treatment is completely incongruous with their belief that their pain is caused by a pinched nerve.

There are numerous psychometric instruments designed to measure patients' beliefs about their pain and expectations about treatment. Questionnaires with particular clinical relevance and good psychometric properties include the Pain Beliefs Questionnaire (Gottlieb 1984, 1986), Survey of Pain Attitudes (Jensen et al. 1987, Jensen and Karoly 1989), Pain Beliefs and Perceptions Inventory (Williams and Thorn 1989), and the Pain and Impairment Relationship Scale (Riley et al. 1988). The Pain Beliefs Questionnaire is a 43-item questionnaire that assesses disability expectations, self-efficacy, depression, and the perceived threat of pain. Research with this instrument has demonstrated that patients who were considered treatment successes in a behaviorally oriented treatment program had demonstrated a reduction in dysfunctional cognitions as measured by this instrument. The Survey of Pain Attitudes is a 35-item self-report scale measuring pain control, solicitude, medical cure, disability, medication, and emotion. Pain beliefs measured by the Survey of Pain Attitudes appear to be related to patient outcome after behavioral treatment. The Pain Beliefs and Perceptions Inventory is a 16-item questionnaire that measures patient beliefs about stability of pain, self-blame, and perceptions of pain as mysterious. The Pain and Impairment Relationship Scale is composed of 15 attitudinal statements to examine the patient's association of pain with disability. Patients who strongly endorse the statements that attribute impairment to pain perception have been shown to have a greater level of disability and suffering.

Coping styles reflect how patients manage their pain, disability, and distress. Coping styles include both cognitive and behavioral efforts to control or tolerate stressful circumstances, such as pain. Cognitive coping strategies include distraction, self-reassuring statements, and reinterpretation of the pain sensation. Examples of behavioral coping strategies include resting and using medication or heat. Coping strategies can be viewed as either active or passive strategies (Bradley et al. 1989, DeGood and Shutty 1992). Catastrophizing as a coping strategy is associated with the highest levels of pain and distress and also appears to be a predictor of treatment failure if it is not improved (Keefe et al. 1989, Rosenstiel and Keefe 1983, Turk and Holzman 1986, Turner and Clancy 1986). The two most popular instruments used to assess patients' coping styles are the Coping Strategies Questionnaire and the Vanderbilt Pain Management Inventory (Brown and Nicassio 1987). The Coping Strategies Questionnaire assesses both cognitive and behavioral strategies, including diversion of attention, reinterpretation of pain sensations, coping self-statements, ignoring pain sensations, praying or hoping, catastrophizing, increasing activity level, and increasing pain behavior. The Vanderbilt Pain Management Inventory is a 19-item self-report scale that categorizes coping strategies as *passive* or *active*. Both of these instruments have been used in studies that have concluded that passive coping strategies and the use of catastrophizing self-statements appear to be associated with poorer outcome with respect to subjective pain intensity, disability, and depression.

When asking about patients' coping styles or strategies, it is also appropriate for the team members to ask them about their use of narcotic pain medication. A number of problems are associated with patient use of narcotic pain medications. There is a risk of iatrogenic complications, such as dependency, cognitive impairment, and dysphoric mood. Many patients who are taking prescribed narcotic pain medication become convinced that this treatment validates their belief that there is a serious medical problem causing their pain. Other patients convince themselves that because they have pain, they must continue taking the medication, even when the medication is no longer effective in controlling the pain. Once this topic has been raised, it is easier to inquire about the patient's use of alcohol or drugs to cope with pain. Patients are generally tolerant of questions about their past use of substances, including alcohol, illicit drugs, or other prescription medications, if this line of questioning is shown to be relevant to understanding how the patient copes with distressing physical and emotional states.

BEHAVIORAL TREATMENT

The two major approaches to the behavioral treatment of chronic pain are *operant behavioral* and *cognitive behavorial*. These approaches conceptualize chronic pain very differently from the disease model. In the disease, or medical, model, there is an assumption that the patient's suffering is a symptom of an underlying disease or injury and that resolution of the pathology will eliminate the suffering. This model places an emphasis on diagnostic studies to identify the pathology and places the responsibility for treatment on the health care professional. The behavioral model, however, sees suffering as a behavior that results from an interaction between cognitions, emotions, behavior, environmental influences, and any nociceptive stimuli. Behavioral approaches maintain that suffering can be reduced or eliminated through a combination of patient participation in treatment and training patients to modify thoughts, feelings, and behaviors, even if the nociceptive input is not eliminated (Hanson and Gerber 1990, Turk and Holzman 1986).

Operant Behavioral Model

The operant behavioral approach to chronic pain was introduced by Fordyce and colleagues (Fordyce et al. 1968a, 1968b, 1973; Fordyce 1976) to explain why many patients are disabled despite insufficient evidence of any significant nociceptive input or in excess of any physical impairment. Fordyce considered pain to be an unpleasant subjective experience communicated in some form of observable behavior, such as grimacing, complaining, taking medication, or lying down. These manifestations occur irrespective of pathology. Fordyce used operant conditioning principles to treat these pain behaviors. These principles predict that behaviors followed by a positive consequence or reinforcement will reoccur more frequently and that behaviors that are no longer followed by a reinforcing consequence will diminish in frequency of occurrence (Keefe and Lefebve 1994, Ott 1992). In the operant-conditioning paradigm, behavior that avoids or postpones an aversive or unpleasant consequence is considered *avoidance learning* (Fordyce 1990). This behavioral concept emphasizes the role of the environment in maintaining the patient's suffering and disability.

The principles of Fordyce's approach and their success in treatment are highlighted in one of Fordyce's patients. This patient avoided physical therapy and frequently complained about his pain. Fordyce turned away whenever the patient complained of pain but did pay attention to non–pain-related behaviors. This strategy eventually reduced the patient's pain complaints, and his attendance at physical therapy improved. These changes in the patient's behaviors occurred despite the patient's statement that he knew Fordyce was intentionally ignoring his complaints of pain (Fordyce 1990).

The operant behavioral approach to treatment emphasizes identifying target behaviors to be modified and then developing a strategy to increase, decrease, or eliminate those specified behaviors. The treatment involves the patient, all rehabilitation team members, the therapist, members of the patient's family, and third parties, such as an attorney or insurance case manager (Fordyce 1976, Roberts 1986).

The initial stage of operant behavioral treatment involves identifying target behaviors, such as reducing medication intake, increasing compliance with a home exercise program, increasing patient tolerance for a specific activity or exercise, improving mood, and enhancing family communication. The desired change in behavior should be observable and measurable. If medication reduction is the goal, the specific medication, frequency, and dosage must be clearly stated in the goal. The target behaviors should include pain behaviors and well behaviors.

Once the target behaviors have been identified, the patient, the psychologist, and those close to the patient begin to monitor the behaviors to establish what cues evoke the behaviors and what the consequences are for the behaviors.

Table 8.5. Elements of the Operant Behavioral Approach

Identify target behaviors to modify (e.g., decreasing pain behaviors and increasing well behaviors).
Behaviors to be changed need to be observable and measurable.
Behaviors are monitored to identify cues and consequences.
Goals are established for behavioral increases and/or decreases.
Goals must be realistic and achievable.
Patient receives feedback on progress toward goals.

With cooperation of the patient and others, goals are established for the target behaviors. The goals must be established with consensus from the patient (Ott 1992). Patients who feel coerced to perform a specific exercise or eliminate a medication will ultimately sabotage the plan. The goals should also be realistic and achievable by the patient.

Providing the patient with continual feedback on progress in modifying the selected behaviors by each member of the rehabilitation team is critical to the success of an operant behavioral approach. Feedback can be both a reinforcer as well as an early warning of possible problems with the treatment plan. The feedback can be in both verbal and written forms (e.g., charts, graphs). For some patients, the charting behavior itself motivates the patient to continue with his or her program (Keefe and Lefebve 1994, Ott 1992, Roberts 1986) (Table 8.5).

Model

The approach to chronic pain is generally attributed to Turk et al. (1983). The model emphasizes the role of the patient's cognitions and beliefs in pain perception, affective distress, and pain behaviors. There are five basic assumptions of the model (Turk and Rudy 1989):

1. Individuals are active processors of information. Patients attempt to make sense of their pain through past experiences. Therefore, the anticipated consequence of a behavior is as important as the actual consequence of behavior.
2. Thoughts can influence mood, physiology, and behavior; mood, physiology, and behavior can influence thoughts. A patient's awareness of sudden pain can trigger catastrophizing thoughts; a patient's anxious ruminations may produce disturbed sleep, resulting in a depressed mood.
3. Behavior is reciprocally determined by the individual and by the environment. This is a departure from the operant behavioral model, which emphasizes the influence of the environment on the individual.
4. Individuals can acquire more adaptive ways of thinking, feeling, and behaving.
5. Individuals need to be involved actively in the changing of their maladaptive thoughts, feelings, and behaviors. In contrast to the medical model, which reinforces the passive and compliant behavior of the patient, the model maintains that patients can be instrumental in learning and using adaptive strategies for coping with and managing pain (Turk and Rudy 1989).

Cognitive behavioral treatment has six major goals: (1) to reconceptualize the patients' views of their pain problem from being overwhelming to being manageable and optimistic; (2) to shift patients' views of themselves from being passive to being resourceful and proactive; (3) to ensure that patients learn to monitor their thoughts, feelings, and behaviors during activities to highlight the connection between these factors and their pain symptoms; (4) to teach patients the necessary skills to adaptively respond to their pain problems; (5) to encourage patients to attribute their success to their efforts at using these skills; and (6) to ensure that patients are able to anticipate and manage future pain problems (Holzman et al. 1986).

The approach is composed of four overlapping phases of treatment. These phases follow a logical course of education and training but are also flexible. Patients may progress at different rates, and at times, acute problems may occur that require the psychologist to return to an earlier phase to stabilize the patient (Turk et al. 1983, Ott 1992) (Table 8.6).

Reconceptualization

The goal of the reconceptualization phase is to educate the patient on the rationale and expectations of an approach to pain. Ideally, this process will introduce patients to the importance of their active participation in treatment and help them develop a new perspective on their pain problem. To meet the goals of this phase, it is particularly helpful to invite patients to review the information shared in the psychologist's evaluation and to use their own experiences to demonstrate the interaction between thoughts, feelings, behavior, and the pain experience. The psychologist can also discuss the gate-control theory of pain (Melzack and Wall 1965).

It is also helpful to review the triad of pain, impairment, and disability with patients. The goal of treatment is to address these three aspects of pain. Treatment will provide relief in one or more of these areas. This approach can be reassuring to the patient who may report minimal pain relief but has increased the range of motion in an extremity or has increased participation in family activities. At the conclusion of this phase, patients should have accepted that multiple factors contribute to their pain experience and that they have the ability to influence the severity of their pain and the resultant disability.

Table 8.6. Elements of the Cognitive-Behavioral Approach

Reconceptualization—providing a rationale for treatment
Role of thoughts, feelings, and behavior on the pain experience
Importance of patient-clinician collaboration in treatment
Skill acquisition—training in cognitive and behavioral coping strategies
Relaxation strategies
Attention-diversion strategies
Cognitive coping strategies
Rehearsal—integrating learned skills into everyday life
Stress inoculation
Role playing
Homework assignments
Relapse management—preparation for discharge
Identifying risks for relapse
Review of skills and outcomes
Support of self-efficacy
Follow-up

Skill Acquisition

The task of the second stage of treatment is to promote the successful use of adaptive coping strategies that the patient already possesses and to help the patient develop new coping strategies. These strategies include relaxation strategies, attention-diversion strategies, and cognitive coping strategies.

Relaxation techniques reduce excessive muscle tension, patient's attention to pain, and the emotional arousal that can amplify pain perception. They also promote a feeling of control during episodes of pain (Turk et al. 1983). For these techniques to be successful, it is extremely important to emphasize to patients that relaxation strategies are learned skills that require practice and use in the appropriate circumstances. Relaxation techniques include jacobsonian progressive muscle relaxation, autogenic relaxation, diaphragmatic breathing, and relaxation imagery.

Progressive muscle relaxation alternately tenses and then relaxes a series of muscle groups (Bernstein and Borkovec 1973, Turk and Holzman 1986, Turk et al. 1983). The purpose of having patients initially tense their muscle groups is to train them to recognize what muscle tension feels like in their body and to discriminate between tension and relaxation. Tensing muscles and then abruptly relaxing those muscles also produce a more pronounced sensation of relaxing muscles. Patients' attention is continually focused by the therapist on the sensations occurring in the muscle groups. When patients have developed confidence in identifying tension in muscles, the tensing portion of the exercise is eliminated.

Diaphragmatic breathing exercises should begin with a discussion of the anatomy of the chest and how regulating respiration and increasing the efficiency of oxygenation can induce generalized muscle relaxation and counteract the effects of autonomic arousal. Patients are shown how to slow down breathing, inflate the lungs fully, and relax the diaphragm. Patients are instructed to breathe slowly in through the nose and then to gradually exhale through the mouth. In both muscle relaxation training and diaphragmatic exercises, patients are encouraged to associate a word, phrase, or image with the sensation of relaxation while practicing the exercises. Additional components of the relaxation and breathing exercises involve asking patients to routinely scan their bodies throughout the day to determine if they are experiencing any muscle tension or signs of autonomic arousal. If they notice any areas of tension, they should use breathing or tension-reduction strategies to create a state of relaxation or reduce the symptoms of autonomic arousal (McCaffery 1979).

Attention-diversion strategies, or distraction techniques, consist of imagery that modifies patients' perception of the pain sensations and diverts their attention away from it (Hanson and Gerber 1990, Turk et al. 1983). Patients are presented with a rationale for this approach and examples of how attention diversion can assist them in coping with their pain. They are taught how attention can influence a person's perceptions either by selecting a focus of attention or by magnifying the awareness of a sensation. Generally, patients can identify at least one example of a situation in which they were not as focused on their pain. Examples offered by patients include being engrossed in watching a movie, absorbed in a book, engaged in watching a sporting event, or involved in an emotionally arousing interaction.

Imagery training includes pleasant, transformative, or contextual change imagery (Melzack and Wall 1988, Turk et al. 1983). The use of pleasant imagery is the most commonly used strategy and an approach most patients have some familiarity with before treatment. This form of imagery relies on the patients' creating a scene in their minds that is so vivid and absorbing that it is incompatible with awareness of the pain sensations. Not all images represent relaxing or pleasant associations to all patients. It is critical that patients be asked to offer personally meaningful scenes that they associate with pleasurable and calming experiences. Transformative imagery involves teaching patients how to modify the images of the pain to be less intrusive or distressful. This involves asking patients to describe what the pain feels like. If the patient describes pain in an extremity as a "burning pain," the patient is instructed to make use of imagery, such as immersing the extremity in a cool mountain stream. Imagery that changes the context of the pain requires patients to tolerate the pain sensation but to imagine that the pain is associated with a different circumstance. For example, a patient with shoulder pain could imagine that he or she has been shot in the arm while protecting hostages or that he or she is a secret agent who is wounded while escaping from government forces.

Attention-diversion strategies also include focusing patients' attention on physical surroundings, thoughts, or a scientific and detached observation of the pain sensations. A patient experiencing pain could engage in mental activity, such as planning the week's activities, performing mental arithmetic, or recalling the words to a favorite song or poem. Some patients can be successful in distancing themselves from the pain sensations by analyzing the sensation as if they were conducting a scientific experiment and were being totally objective about the sensations. Although all attention diversion strategies may not be effective for all patients all of the time, it is important for all team members to remind the patient that, by developing a repertoire of techniques, there is a greater likelihood that at least one technique will provide some degree of relief. Patients must be reminded that these techniques are skills that will become more effective if the patient is willing to consistently practice them.

Cognitive coping strategies include cognitive restructuring and social skills training (Holzman et al. 1986, Turk et al. 1983). These strategies focus on the patient's thoughts and feelings about pain. Cognitive restructuring is a specific application of the reconceptualization process described earlier in the chapter. Patients are invited to consider how their thoughts and images influence their pain experience. Cognitive restructuring enlists patients in challenging their beliefs or correcting the distortions in their thinking. The psychologist does not directly offer alternatives or tell patients what to do. Instead, a collaboration is emphasized, in which patients are helped to create their own alternative views and competing thoughts or images.

Skills training recognizes that interactions with others cause many patients to experience increased pain and distress owing to conflicts, misperceptions, and disappointments in relationships. In those situations, patients will benefit from learning assertive communication of their needs, effective expression of their feelings, and a capacity for active listening.

Rehearsal

In the rehearsal phase of treatment, patients integrate the skills acquired in the previous stage and practice these skills in their everyday lives. Several techniques of rehearsal are used in this stage, including stress inoculation, role playing, and homework.

Stress inoculation introduces patients to a plan for problem solving during episodes of increased pain. It teaches patients how to break down episodes of increased pain into several manageable stages. Patients are asked to consider the pain episode as requiring a period of preparation, an attempt to manage the sensations, an effort to cope with thoughts and feelings at critical moments, and a period of reviewing how the episode was handled. In the preparation phase, patients recognize that there are many periods when they do not experience intense pain. During this period, patients are encouraged to recognize early signs of increasing pain and to adopt a positive attitude. This stage is followed by patients' noticing an increase in the pain and confronting the pain with the relaxation and distraction techniques. There will be times, however, when the strategies do not work, and a patient becomes discouraged or begins to panic. At these critical moments, the patient must make use of coping statements, such as "I may not eliminate this pain completely, but if I persist, I know I can make myself more comfortable." Finally, after the episode resolves, the patient is expected to review how the pain episode was handled and to consider what could be done differently the next time. Patients are also told that they must credit themselves with their efforts, regardless of the relative effectiveness of the strategies.

Role playing is directed at consolidating patients' coping skills. Patients identify situations in which interactions with another person consistently elicit increased distress or pain (Turk et al. 1983). The situation is then re-enacted with the psychologist assuming the role of the patient, while the patient plays the role of the antagonist. The psychologist then attempts to model appropriate coping strategies, including assertive communication, breathing exercises, and coping self-statements. A variation on role playing is role reversal, in which the patient is asked to play the psychologist, and the psychologist assumes the role of a new patient. In this version of role playing, the patient has an opportunity to convince the psychologist that he or she can learn to manage pain. The patient may teach the psychologist how to use the various coping strategies that the patient has learned.

Homework is an essential component of all stages of treatment. Its use can be best illustrated by its role in the rehearsal stage of treatment, however. At this point in the treatment, patients are asked to engage in progressively more challenging tasks and activities in their everyday life. The homework assignments are concrete, observable, and measurable and are established in a graded fashion to parallel patients' progression (Turk and Rudy 1989). An example of homework is keeping a log of relaxation practice or medication use. As patients demonstrate greater proficiency in using coping strategies, such as imagery or assertiveness, the homework assignments become more difficult. An example of homework assigned later in treatment is for a patient to attend a meeting with a supervisor to negotiate accommodations for the patient's work schedule or site. The more realistic the assignments the patient can complete, the more self-confident he or she will feel.

Relapse Management

In this final phase of treatment, patients are asked to focus on the circumstances that might make them prone to relapse (Holzman et al. 1986, Turk et al. 1983). This discussion is not intended to suggest to patients that they are expected to fail. Rather, it helps them recognize that they will likely experience exacerbations of their pain or that events may occur that will challenge their coping resources. Once these high-risk situations are identified, patients are encouraged to envision and plan for how they will handle that particular situation.

During this final stage of treatment, patients are asked to review what they have learned and to compare how they were feeling and functioning at the beginning of treatment with how they are currently feeling and functioning. If the patient has been maintaining a pain diary, these records should be reviewed. Ultimately, the goal of this stage of treatment is to reinforce (1) that the patient has developed coping strategies that have been effective in reducing pain perception and improving functioning, (2) that the success of these strategies has been a function of the patient's efforts, and (3) that continued success depends on use of these strategies (Holzman et al. 1986). It is generally recommended that the final stage of treatment be long enough to allow patients to adjust to managing their pain independently. At the conclusion of the formal treatment program, arrangements for follow-up should also be made with patients.

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Chapter 9

Headache

Joanna R. Allan

HEADACHES

Headaches are extremely common in the industrialized world. The 1-day prevalence of headache in the general population has been estimated at 16%, whereas migraine affects 10–12% of the population annually (Bronfort et al. 2000), and tension-type headache affects more than 38% of the population annually. The financial cost to society in terms of lost work days is enormous—migraine alone costs American employers approximately $13 billion per year (Hu 1999).

The International Headache Society (IHS) classifies headaches into 13 different categories (IHS 1988). The types often treated in physical therapy are migraine (with or without aura), tension-type headache (with or without muscle involvement), and acute and chronic post-traumatic headache. Many patients assume they have migraines if they have severe headaches, but tension-type, post-traumatic, and other headaches can also be severe and disabling. In fact, patients with chronic headache are reported to have significantly lower physical functioning, role functioning, bodily pain, general health, and mental health scores than patients with migraines, as measured on the Short Form 36 (Monzon and Lainez 1998). Physical therapists treating patients with headaches should become familiar with the IHS classification system.

DIAGNOSIS

It is preferable to obtain a precise diagnosis from the patient's referring physician, but the diagnosis of headache without a specific classification is still common. A precise diagnosis helps the physical therapist to determine treatment objectives and prognosis. If the precise diagnosis is unknown, treatment results should not be adversely affected, because treatment of headache is largely based on the signs and symptoms of the patient. It will, however, be more difficult to explain the role of physical therapy treatment in the total care of the patient's headache.

Muscle pain is an important component of headaches (Lance 1993). A musculoskeletal evaluation of the head, neck, and shoulder girdle areas and a postural evaluation should be done on headache patients. Evaluation should include palpation of all soft tissue areas, particularly the muscles of the head and face (Kendall et al. 1993). Passive range of motion (ROM) testing should also involve accessory movement testing of the joints of the cervical spine. The presence of muscle guarding in passive and accessory movement should be classified as *mild*, *moderate*, or *severe*.

A brief evaluation of the temporomandibular (TMD) joint area should be included. The patient should be asked if he or she has pain when chewing hard fruits or tough meat or has habits such as clenching or grinding the teeth. Assessment of the active range of mandibular motion and palpation of

TMD joints and pterygoid, temporal, and masseter muscles should be completed.

The patient's headache may be reproduced during the evaluation. For example, palpation of both temporal muscles may reproduce a patient's temporalis muscle headache. It would be unusual to reproduce a migraine headache. A migraine headache patient is likely to experience tenderness of cervical muscles on palpation, mild loss of active ROM, and muscle guarding with passive movement, however.

COMMON HEADACHE TYPES IN PHYSICAL THERAPY

Tension-Type Headache

Tension-type headache is characterized by a bilateral, dull ache across the frontal and temporal areas (IHS 1988). The pain may radiate posteriorly, or it may start as a dull ache in the upper trapezius or cervical paraspinal areas and radiate forward. Patients often describe the headache as feeling like a tight band around the head. These headaches may occur as often as several times a week and are typically mild to moderate in intensity and last several hours (IHS 1988). They can become severe or constant when a patient is under additional psychosocial stress, is very symptom-focused, or is overusing painkillers or muscle relaxants (see section Headache Associated with Substance Abuse [Rebound Headache]).

Patients with tension-type headache with muscle involvement have tightness and tenderness of facial and pericranial muscles on palpation (Corrigan and Maitland 1983). This type of headache is generally triggered by muscle overuse. Patients often assume the overuse is due to overactivity with poor posture, such as working for long periods at a computer. Such conditions may produce upper back and neck pain that can be referred from the upper trapezius muscle to the temple and behind the eye (Evjenth and Hamberg 1984). Overuse of the facial muscles due to habits such as frowning and clenching the teeth may also contribute to these headaches. These habits typically occur in response to everyday stressors. Patients are often confused about why they have headaches, because they do not believe that they are under any undue stress. It is helpful to explain that the overuse of facial muscles is as common an occurrence as poor posture.

Physical therapy can significantly decrease the severity and frequency of these headaches by using soft tissue and joint mobilization techniques and by teaching correct posture, home stretching and strengthening exercises, the use of pain control modalities, and biomechanical and ergonomic principles. Tension-type headaches are usually chronic, so an important part of treatment is providing the patient with a comprehensive home exercise program that should become a lifelong routine.

A number of patients may respond to physical therapy treatment alone, but many do better with a combination of behavioral medicine and physical therapy. Behavioral medicine treatment typically consists of general relaxation and stress management training. If patients seen in physical therapy are not improving at the expected rate, have continued difficulty relaxing facial and pericranial muscles, or are complaining of psychosocial stressors, the physical therapist should contact the referring physician to suggest an evaluation by a psychologist or mental health counselor.

Migraine

Migraines are a genetic disorder and occur twice as often in women as in men. They are triggered by a variety of factors, including hormonal changes, diet, environment, overactivity, stress, irregular sleep patterns, and lack of exercise. They usually start at puberty and decrease in frequency, severity, and duration after menopause. Migraines are typically unilateral, although they may shift sides. They are usually experienced as a throbbing, pounding pain in one temple and behind the ipsilateral eye. They occur one to several times a month (Corrigan and Maitland 1983).

Physical therapy cannot cure migraines, but it can help a great deal by promoting regular aerobic exercise (Lockett and Campbell 1992) and alleviating secondary myofascial problems of the head and neck that can increase the frequency, intensity, and duration of migraines. The secondary muscle tenderness, increased tone, and muscle guarding in the facial, neck, and shoulder girdle muscles appear to be due to the patient's bracing the head, neck, and shoulder girdle during severe migraine pain. This pain can last for 24–48 hours (Corrigan and Maitland 1983). Migraine patients frequently have rigid posture, especially of the head, neck, and upper back.

In migraine with aura, pain is preceded by a visual aura that lasts approximately 20 minutes. The aura is characterized by zigzag lines and black spots that radiate progressively outward from the center of a homonymous field defect, called the *scintillation scotoma* (Mumenthaler 1990). Physical therapy treatments cannot change the frequency, intensity, or duration of the aura.

Headache Associated with Substance Abuse (Rebound Headache)

When patients with tension-type or migrainous headaches overuse pain medicines, their headaches can become more frequent or even constant with moderate to severe pain and no discernible headache trigger. These headaches typically do not respond to any other form of treatment until the patient has completed detoxification.

Acute or Chronic Post-Traumatic Headache

Acute or chronic post-traumatic headache is associated with head trauma, often from a motor vehicle accident. The pain is usually either frequent or constant and is often accompanied by dizziness in the acute stages. These headaches usually respond slowly to treatment. It is best if they are treated as early as possible after the trauma. Use of an interdisciplinary team, consisting of a physician, psychologist, and physical therapist, is appropriate. Successful physical therapy will only partially decrease this type of headache because it may in part be due to traumatic brain injury and not just myofascial damage.

Physical therapists can decrease these headaches by using soft tissue and joint mobilization techniques and by teaching correct posture, home stretching and strengthening exercises, the use of pain control modalities, and biomechanical and ergonomic principles. Patients often discontinue home practice because they are discouraged by their slow progress. They should be informed that much of the treatment is preventive and that without it, the headaches will worsen. These headaches improve on a weekly or monthly basis, although they improve more rapidly in the first few months after the trauma that causes them.

Cervicogenic Headache

The pain of cervicogenic headache is referred from the neck and tends to respond well to physical therapy. It is characterized by neck and occipital pain that radiates to the temporal region, frontal region, or both and is either unilateral or bilateral. Examination of the neck should reproduce the headache. This would occur from palpation of the neck and shoulder muscles, accessory movement testing of upper cervical joints (C0 through C3, possibly C4), or palpation of the C2 nerve as it passes through the suboccipital musculature. The patient should be given a preventive home program of exercise to maintain improvement.

Cluster Headaches

These headaches are more rare than other types and occur mostly in men. They occur in clusters, often at the same time in each year. The patient may then have no headaches for months at a time. They are characterized by severe, brief periods of unilateral facial pain, head pain, or both and are accompanied by unilateral parasympathetic nervous system signs, such as weeping and eye redness. They generally respond well to medical treatment such as oxygen administration, but a patient may be referred to physical therapy with secondary muscular problems of the neck or face that have occurred owing to muscle bracing against the pain of the headache.

Sinus Headache

The most common site for facial pain is located around the jaws, owing to TMD dysfunction, but patients may complain of frontal facial pain or pain located in their maxillary sinuses. Many of these patients complain of chronic sinusitis and associate it with a sinus "headache." When sinusitis has been ruled out (computerized axial tomography scan is negative, the sinuses are clear on examination), the pain may, in fact, be referred from elsewhere. A careful examination of the neck and facial muscles with palpation can reproduce this pain. Common muscles referring pain to the maxillary sinus area are the pterygoids, masseters, and sternocleidomastoids.

GOALS

Most headaches are chronic conditions. Therefore, treatment modalities may provide only temporary relief unless the patient is also instructed in a comprehensive home program involving muscle conditioning exercises and postural and ergonomic concepts. The goals of treatment for headache involve sympathetic pain relief; resolution of treatable impairments, such as decreased ROM, muscle strength, and endurance; and instruction regarding preventive measures.

1. Immediate relief of symptomatic pain. Good relief is possible with neck pain, headaches due to referred neck pain, and acute headaches. Chronic tension-type and post-traumatic headaches are only slightly diminished in intensity by pain control modalities and soft tissue techniques. The aggregate effect of these treatments can be beneficial, however. Immediate relief should be expected for the secondary neck pain of migraine.

Techniques for relief of symptomatic pain include hot and cold therapy, ultrasound, electrical stimulation, and small-amplitude joint mobilizations (Hertling and Kessler 1990). The patient should be taught the home use of hot and cold therapy and self-massage for daily symptomatic relief. Some patients find neck-relaxing exercises provide symptomatic relief.

2. Restoration of normal ROM. Many headache patients have at least a mild to moderate decrease in cervical spine and shoulder girdle active ROM often associated with forward head posture. Restriction in ROM is usually due to increased tone of suboccipital, cervical paraspinal, and upper trapezius muscles. It can progress to the point of limiting functional activities, such as driving. Limited passive and accessory movement of the cervical spine is usually associated with muscle guarding due to increased muscle tone of the small intervertebral muscles, rather than with ligamentous restrictions. Exceptions, however, are seen in post-traumatic headache, headache patients who have separate neck problems (e.g., osteoarthritis), and patients with active restriction of neck motion who are experiencing secondary joint stiffness.

Techniques that decrease muscle tone are highly effective at restoring normal ROM. Pain control modalities, soft tissue techniques, and small-amplitude joint mobilizations that reflexively relax muscles are effective. If ligament tightness is present, larger-amplitude joint mobilizations should be used (Hertling and Kessler 1990).

3. Increase in muscle strength and endurance. Patients often exhibit mildly decreased muscle strength of pericranial, paraspinal, interscapular, and upper-extremity muscles. This is usually much more pronounced in patients with post-traumatic headache. Occasionally, patients may complain of subjective weakness that is part of their pain experience and be very motivated to do resisted exercises. These patients may present with severely increased muscle tone and guarding and often experience more functional gains by learning local muscle relaxation and relaxation during movement and then progressing to relaxed neck and upper-extremity exercises. Headache patients typically present with the tendency to over-recruit, using more than the necessary muscle work for any activity. Habits such as hunching shoulders, bracing the neck, and frowning while using a computer typify this problem. Before being taught resisted exercises, they need to be taught to do gentle, active exercises.

4. Patient understanding of preventive measures. Patients should be instructed in neck and back care, postural correction, and biomechanical and ergonomic principles.

METHODS

Heat and Cold Application

The application of heat and cold is valuable for symptomatic relief of all headaches. For the applications to be fully effective, patients must be taught to use these modalities at home on a daily basis. It is also beneficial to use one of these modalities in office sessions to relax muscles or decrease pain sufficiently so that soft tissue or joint mobilization can be performed. Heat and cold are also helpful in decreasing post-treatment soreness.

Migraine patients benefit particularly from the use of ice massage or cold packs applied to the forehead or neck during severe migraine pain. Ice massage has been found to increase pain tolerance with long-term use. This massage can be used on areas other than the affected muscles, and good results have been achieved with use of the acupuncture hoku point between the thumb and index finger.

Because the use of heat not only relieves pain, but also relaxes muscle, it should be used daily when muscle tenderness and increased tone are present even if there is no symptomatic relief from pain. Tension-type headache patients benefit from the soothing, relaxing effects of moist heat applied to the affected muscles. This treatment should be applied 1–3 times daily. A warm bath, shower, or sauna may occasionally be substituted. Patients will need education regarding the effects of heat so they are motivated to continue it in the absence of pain relief.

Heat therapy can be used for 20–30 minutes and cold therapy for up to 10 minutes per application. It is advisable to wait an hour or more between applications. Contraindications for use of heat and cold include broken areas of skin and decreased skin sensitivity and circulation to an area.

Electrical Stimulation

Electrical stimulation can be useful for patients who are very symptom focused or whose muscles are reacting in an oversensitized manner to soft tissue techniques.

Soft Tissue Techniques

All soft tissue techniques should be performed gently, for short periods, and with frequent assessment, because severe headaches frequently develop suddenly and persist for long periods.

Occasionally, when massage and stretching techniques to increase ROM progress slowly because the assessing movement reproduces pain, it is helpful to decrease assessment within the session and focus on assessment of movement 12–24 hours after the session. This should be done only when previous assessment has provided a good understanding of the effects of the treatment and the patient is a good historian. Any change in treatment would then be accompanied by assessment within the session.

Massage

Because headache patients tend to overuse the muscles of their head, face, and neck, the muscles frequently become tender and oversensitive to touch and movement. Massage is a very important modality for headache patients, because it is effective at decreasing both muscle tension and tightness. It is also very effective for symptomatic relief of local tenderness. By loosening tight muscle fibers and working on trigger points, massage can effectively reduce referred pain.

It is often helpful to precede massage with the use of heat or cold to relax muscles and increase pain tolerance. Soreness due to massage can be decreased by following the massage with heat, cold, or small-amplitude joint mobilizations. If treatment soreness is significant and lasts more than 1 hour, the massage is too vigorous or the patient should be re-evaluated. In some cases of post-traumatic headache and tension-type headache, muscles have become so oversensitized to touch that several treatments of gentle electrical stimulation and joint mobilization are necessary before massage can be performed. The presence of secondary gain factors or chronic pain syndrome should also be considered in these cases.

Massage to the facial muscles, particularly the temporal muscles, can prevent, lessen, and stop muscle tension headaches involving the frontal and temporal regions and lessen the throbbing pain of a severe migraine. Signs and symptoms are common in this region because of the patient's tendency to brace, clench, or grind the jaw. The suboccipital area is also important, because muscle tightness builds up owing to the forward head position, and muscle tone is owing to bracing of the head and neck against pain and stress.

There are a wide variety of massage techniques. Facial muscles respond well to gentle, circular finger-and-thumb kneading massage. Suboccipital muscles respond to both circular and transverse finger and thumb kneading. This should be done deeply but gently. Cervical and upper trapezius muscles respond to a range of techniques. Deep thumb kneading to areas of increased tone and tenderness is particularly helpful, especially when palpation of these areas refers pain to the headache area. When muscles are oversensitized or the patient has a low pain tolerance or difficulty relaxing, slow, deep techniques are useful.

Muscle Stretching Techniques

Headache patients typically present with tight, shortened pericranial muscles. Muscle stretches are effective for suboccipital, cervical paraspinal, and upper trapezius muscles. They are particularly helpful if used with gentle hold-relax techniques to promote relaxation (Evjenth and Hamberg 1984).

Joint Mobilization Techniques

Vigorous joint mobilizations can quickly increase local pain and provoke a headache. Small-amplitude techniques performed gently and with frequent assessment are the most helpful to treat headache. Techniques to mobilize the typically hypomobile upper cervical spine include manual traction; passive cervical rotation; and unilateral pressures to C1–C2, C2–C3, and C3–C4, particularly end-of-range oscillations. It is especially beneficial to apply unilateral pressure anteriorly or posteriorly with the patient's head rotated away from the pain. Transverse and central pressures to the upper cervical spine may be of additional benefit. A large-amplitude, gentle transverse pressure to both sides of the midcervical area and gentle large-amplitude oscillations help to relax the small muscles of the upper cervical spine and reduce treatment soreness from the use of end-of-range oscillations.

Case Example

A 69-year-old man has a 15-year history of unclassifiable headaches (IHS 1988) and an additional diagnosis of cervical spine osteoarthritis. He has moderate to severe headaches in the right occipital region that wake him and last 1–2 hours, until he is able to fall asleep again. They usually occur 5 days per week. He occasionally experiences a mild, dull ache in the same area during the day and frequently experiences a mild, dull ache bilaterally in the suboccipital area. The patient has cardiac problems and wonders if this stress could be contributing to his headaches. He states that he practices stress management and relaxation and is interested only in physical therapy.

On examination, he has a 50% decrease in cervical spine ROM consistent with osteoarthritis but more limited upper cervical forward bending that reproduces his headache. Cervical backward bending reproduces his headache and neck pain. He has moderately increased muscle tone in his frontal and temporal muscles and severely increased muscle tone in his suboccipital, cervical paraspinal, and upper trapezius muscles. His right suboccipital area is tender to palpation, but this does not reproduce his headache. He is severely hypomobile on accessory joint testing of the cervical spine, with particular restrictions of forward bend at C2–C3 and C3–C4. He tends to avoid neck and upper thoracic movements by holding his back rigidly and turning at the lower thorax.

Impairment: Pain, decreased cervical spine ROM, increased muscle tension, decreased motion at the upper cervical spine intervertebral levels

Functional limitation: Interrupted sleep

Disability: None

Evaluation, diagnosis, and prognosis: Patient is a 69-year-old man who presents with headache associated with decreased cervical spine ROM with increased muscle tension and decreased mobility of the upper cervical intervertebral levels. Over a course of six treatments of soft tissue and joint mobilization of the cervical spine and instruction in a home exercise program that includes postural correction, the patient will demonstrate improved cervical spine ROM, independence in his exercise program, and improved sleep. It is anticipated that these improvements will result in a reduction in the number and severity of headaches.

He receives six treatments of massage to the frontalis, temporalis, suboccipital, and cervical paraspinal muscles. Manual traction is administered four times as end-of-range oscillations to suboccipitals and then cervical paraspinals. Joint mobilization includes central pressures to C2, C3, C4, and C5 and unilateral pressures to C2–C3 and C3–C4 on the right. Large-amplitude cervical rotation mobilization to both left and right is also performed as a treatment for limited active ROM due to cervical osteoarthritis.

He is taught a home program of postural and biomechanical correction, neck stretches, and thoracic rotation. He finds that the relaxed neck exercises lessen his headache, and he performs them when woken at night.

At the end of treatment, he has one mild nocturnal headache every 1–2 weeks, which does not prevent him from falling asleep again. His active cervical forward bending and rotation increase to 75%. Two further sessions are scheduled, but the patient decides to discontinue treatment and continue with home exercises. At 1-month follow-up, the patient's psychosocial stressors have significantly increased, and his headaches have increased to two to three times per week but are lessened or stopped by the exercise program. The patient decides to continue without further treatment, stating that his increased stress is short term and that he is very satisfied with and committed to his home exercise program.

Relaxation Techniques

Overused muscles have a higher baseline muscle tone because they are required to contract often without sufficient relaxation. They develop the tendency to contract when movement is occurring elsewhere in the body, leading to pain and fatigue. This problem can be identified by palpating the suboccipital muscles while the patient moves the arms or legs. Muscle over-recruitment can lead to tension-type and cervicogenic headaches and plays a role in the neck pain that accompanies migraines.

There are many techniques to relax muscles locally. These include soft tissue techniques, gentle manual traction, and hold-relax techniques.

Case Example

The patient is a 41-year-old woman who has had bilateral, frontal tension-type headaches with muscle involvement (IHS 1988) for 10 years. She has decreased the frequency and duration of episodes with relaxation training using biofeedback. She is referred for a physical therapy evaluation, however, because she continues to have almost constant, bilateral neck pain that is particularly severe in the suboccipital area. Her neck pain can become severe and trigger a frontal headache.

On examination, the patient has a significant forward head position and moderately increased muscle tone of the frontalis, temporalis, suboccipital, paraspinals, and upper trapezius muscles. These muscles are not tender on palpation, and her headache is not reproducible. Her active and passive ROM is within normal limits, with the exception of reduced active cervical rotation to the right that is not associated with any pain or muscle guarding.

The patient is taught postural correction, relaxed neck and postural exercises, and self-massage. The self-massage provides symptomatic relief, but the exercises tend to increase her neck pain. The patient performs the exercises with significant shoulder bracing and a rigidly held neck with an elevated chin.

Impairment: Pain, abnormal posture, and increased muscle tone in the craniofacial muscles, and faulty exercise execution

Functional limitation: None

Disability: None

Evaluation, diagnosis, and prognosis: Patient is a 41-year-old woman who presents with headache pain associated with abnormal posture and muscle tension, exacerbated by the incorrect execution of her home exercise program. Over the course of six treatments of postural correction, instruction in self-massage, and a home exercise program, the patient will demonstrate the ability to maintain corrected posture during activities of daily living (ADLs), instrumental ADLs, and home exercise, with an anticipated reduction in frequency and severity of headache pain.

She is asked to discontinue the exercises temporarily and receives four sessions of localized muscle relaxation for the trapezii, cervical paraspinal, and suboccipital muscles. She is taught to keep these muscles relaxed while exercising her arms and legs. She is also taught to perform gentle neck retraction. The patient gradually learns to locally relax her posterior neck muscles, and home exercises are reintroduced. After six treatment sessions, the patient has improved her posture, is able to relax her shoulder girdle effectively, and has decreased her overuse of the suboccipital muscles. She now has only occasional, mild neck pain that does not trigger headaches. She continues with relaxation training and feels better able to relax her neck and shoulders. She now has an average of one brief, mild headache per week.

This patient is seen for two 1-month follow-up sessions, focusing on localized relaxation because of initial difficulty maintaining improvement between sessions. She continues to improve.

SELF-MANAGEMENT

Because most headaches are chronic problems, physical therapy treatment should teach the patient to manage the condition on an ongoing basis. Patients should be instructed regarding the use of pain control modalities, a comprehensive exercise program, and postural correction. Patients should be taught the home use of hot or cold therapy and self-massage. Patients may have tried heat or cold but discontinued use because their effect was only temporary. They should be reminded that the aggregate effect is beneficial.

Self-Massage

If patients develop good massage skills, they can stop or significantly lessen a tension-type headache and provide good relief for migraine and post-traumatic headache. Patients must be taught to do self-massage in a relaxed position (e.g., reclining, with arms fully supported by cushions or pillows to promote shoulder relaxation). If necessary, they can reduce the amount of muscle work by performing the massage unilaterally and alternating sides. Patients typically maintain a forward head position and should be instructed to relax the neck and head by bringing the elbows up in a supported position. They should be taught finger massage with a gentle pressure and release, which promotes relaxation of the arms as well as the affected muscles.

Case Example

The patient is a 45-year-old woman who has had migraine without aura for many years and presents with an almost constant, dull ache in her right temporal area. She also complains of bimonthly migraines involving pain behind the left eye that radiates into the left temporal area. The dull ache varies in intensity from mild to severe, and the patient thinks that an increase in severity occasionally precedes a migraine. She can achieve slight relief by steady finger pressure onto the left temporalis, which she performs in a forward head posture with significant grimacing.

On examination, she has moderately increased muscle tone of the frontalis and cervical paraspinal muscles and severely increased muscle tone of the temporal and upper trapezius muscles. Palpation of the right temporalis reproduces her dull pain but does not trigger a headache. She has a significant forward head posture and mildly decreased ROM of cervical spine in forward bending and right rotation. Passive and accessory movements are within normal range, although suboccipital muscle guarding creates a slight hypomobility of the upper cervical spine on passive movement testing.

Impairment: Pain, increased muscle tone of the craniofacial muscles, abnormal posture, and decreased cervical spine range of motion

Functional limitation: None

Disability: None

Evaluation, diagnosis, and prognosis: Patient is a 45-year-old woman who presents with headache associated with increased tone of the craniofacial muscles, abnormal posture, and decreased cervical spine range of motion. Within six sessions of pain self-management techniques, soft tissue mobilization, postural correction, and home exercises, the patient will demonstrate the ability to maintain optimal posture during ADLs and instrumental ADLs. It is anticipated that within this period, she will experience relief of her dull, aching headache pain. She may also have fewer migraine headaches or less severe pain during these headaches.

Relief of the dull ache is achieved with therapeutic massage, but the ache recurs between sessions, despite a home program of postural correction and relaxed neck exercises, which improve her posture and increase her cervical spine active ROM to within normal range. The patient is taught self-massage to the temporal, frontal, suboccipital, and cervical paraspinal muscles. She performs a home program of application of moist heat to the forehead and neck and a 5-minute massage to the temporales and suboccipitals (twice a day) and to frontalis and cervical paraspinals (once a day). She treats her left temporal and migraine pain with a cold pack followed by self-massage to the left temporalis.

The patient reports significant improvement in the dull ache and no longer rates the pain as severe enough to record on her monthly headache chart. At 1-month follow-up, she reduces her home program to heat and massage to temporalis and suboccipital muscles (once a day), frequent posture correction, relaxed neck exercises (once a day), and treatment with cold and massage for a migraine. She states that she feels better able to lessen her migraines and that their duration and intensity have decreased.

Exercise

It is important to evaluate whether nonaerobic and aerobic exercise increases or decreases intensity, frequency, duration, or has no effect on headaches in the individual patient. When exercise relieves headache, it can be integrated into the treatment program.

Case Example

The patient is a 35-year-old man who has had chronic tension-type headache with muscle involvement for 5 years. The pain occurs daily, starting in the late morning and increasing in intensity during the day. The patient has had a trial of relaxation training and continues to practice it, even though he has found that sitting still increases his mental and physical tension. He reports that using the treadmill for 20 minutes decreases his headache slightly. He is given ROM exercises that restore a mild loss of active movement but do not change his headaches. He is instructed to increase his treadmill use. Exercising 20 minutes daily decreases the frequency, intensity, and duration of his headaches by 60%.

Relaxed Active Exercise

Relaxed active exercise promotes localized relaxation. Performance of relaxed movement can be promoted by teaching diaphragmatic breathing and instructing patients to lower their shoulders slightly during the exercise. Two exercises are outlined below. The first relaxes the neck.

1. Lower the chin slightly by looking at the knees.
2. Lower the chin toward the chest.
3. Roll the chin slowly around to one shoulder and pause.
4. Tuck the chin in slightly again and roll forward and down to return to the middle.
5. Without pausing, repeat in the other direction.

The second relaxes the shoulder girdle.

1. Roll both shoulders forward slowly 10 times and pause.
2. Repeat backward.

The number of repetitions of both exercises should depend on an assessment of the patient's muscle reactivity and pain tolerance.

Patients typically do exercises quickly in a jerky and uncoordinated manner. Precise instruction on breathing and gentle guidance through the movement should be provided. Instructing the patient to lower the shoulders during movement is helpful. The patient frequently is unaware that his or her shoulders are hunched, and it will take time to correct this habit.

If a patient cannot develop the skill of relaxed movement despite physical therapy instruction, he or she may have an inability to generally relax and could benefit from a referral to behavioral medicine for relaxation training and stress management.

Stretching

It is useful to alternate stretching exercises with relaxed active exercises to prevent muscle overrecruitment. The following exercise combines neck retraction and forward bend to correct a forward head position and stretch out tight suboccipital muscles, both of which are involved in migraine and tension-type headache.

1. Lower the chin slightly by looking at the knees.
2. Lower the chin toward the chest and hold for a slow count of five.

3. Repeat three times.

The next exercise stretches tight muscles of the shoulder girdle.

1. Interlace the fingers above the head.
2. Push the arms slightly back and up.
3. Feel a gentle stretch in the arms, shoulders, and upper back and hold for 5 seconds.
4. Lower arms, pause, and repeat three times.

It is extremely important that stretching exercises are done slowly and gently. A full set of stretches, including neck retraction, forward bend, neck rotation, neck side bend, and shoulder girdle retraction, should be performed once to twice daily.

Strengthening Exercises

Once the patient can perform exercises in a relaxed, coordinated manner, strengthening exercises can be added to the regimen. It is best to start with active exercises, using body weight as resistance, and progress to the use of rubber bands or free weights as possible. Teaching resisted head movements to strengthen pericranial muscles is useful in promoting localized relaxation.

Strengthening exercises can be alternated with stretch or relaxed active exercises to promote relaxation and prevent muscle over-recruitment. If patients wish to use equipment for resisted exercise, they need to be given good postural and ergonomic instructions and have developed the skill of relaxation during movement to prevent the triggering of headaches.

Aerobic Exercise

When aerobic exercise increases headaches, it is usually because the exercise is being performed with poor body mechanics or over-recruitment. Initially, it is important to evaluate whether the patient has the required muscle strength, ROM, balance, and coordination for the chosen activity. Jogging with a forward head position or swimming breaststroke with excessive neck extension are examples of how neck muscle tone can be increased and lead to localized or referred pain.

Migraines can decrease in frequency, intensity, and duration with regular aerobic exercise, but migraine patients typically overdo exercise. Simple instruction in pacing and body mechanics can prevent triggering of headaches. If the patient has difficulty with pacing, he or she may need a referral to behavioral medicine for general relaxation training and stress management.

Case Example

A patient with migraine with aura finds that her migraines are triggered after 5 minutes of jogging. After correction of her forward head posture and instruction on pacing, her migraines are triggered after 10 minutes and are less severe. She is advised to experiment with different types of exercise and joins an aerobic class. She finds that aerobics does not trigger her headaches. She had not enjoyed jogging but ran because she thought it was good for her. She often ran competitively against a partner. She finds the aerobic class relaxing and fun, a factor that may contribute to the cessation of exercise-triggered headaches.

Postural Correction

Headache patients usually present with a forward head posture and an elevated and protracted shoulder girdle. They may have a flattened cervical spine with a level chin position or an increased cervical lordosis with an elevated chin. This abnormal posture also plays a role in TMD pain with primary muscle disorder. Significant improvement in TMD pain through postural correction was demonstrated by Wright et al. (2000). Migraine patients often present with a flattened thoracic spine and a rigid, erect posture with spinal muscle guarding. Tension-type headache patients often present with an increased thoracic curvature.

Typically, patients correct their posture with maximum muscle effort. They need to be guided into sitting and standing with a relaxed posture so that muscle tone is not further increased. Patients also tend to forget to practice posture correction. It is helpful to ask patients to correct their posture for 1 minute once an hour, rather than to ask them to remember a correct posture at all times. Regular repetitions develop good habits at a pace that should not cause new muscle strains.

Postural correction instructions should be as simple as possible to follow. Patients should perform postural stretches, such as bilateral arm elevation. They should also be advised to take regular breaks to stretch and walk around if their occupation involves a lot of time in one position or activity. They should be instructed on the response of muscles and ligaments to prolonged positioning.

Patients need instruction regarding correct sleeping positions, particularly if they read in bed. Tension-type headaches often start in the early morning and are associated with anticipatory tension or a buildup of muscle tension from the previous day that does not dissipate with sleep.

HEADACHE MANAGEMENT PRINCIPLES

The physical therapist should remember several principles of sound headache management:

1. Assess and discuss with the patient the role of physical therapy in his or her treatment. It may be the primary treatment or a small part of a multidisciplinary approach.
2. When a multidisciplinary approach is required, communicate effectively with the other clinicians involved. Help the patient to be aware of the importance of the team approach and that individual treatments are not cures in themselves, but pieces that fit together to ensure effective, long-term headache control.
3. Monitor the patient's weekly or monthly headache diary. This diary should record frequency, duration, intensity, and possible triggers of headaches. Without daily assessment recorded on a long-term basis, improvement in headaches cannot be assessed.
4. Choose specific objective findings, such as ROM, to assess pre- and post-treatment goals. A patient can improve objectively but not subjectively or vice versa, which has implications for the team's approach.
5. Focus on long-term headache management. Most headaches are chronic problems, and patients need self-management strategies to prevent or lessen their pain problem.

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Chapter 10

Chronic Back Pain

Harriët Wittink

Studies from the Western world show that back pain is the first or second most prevalent pain complaint in the general population (Raspe 1994). Most patients will recover in a median time of approximately 7 weeks, but relapses are common, and up to 80% of patients will remain disabled to some degree, although approximately only 10–15% will be highly disabled (Bogduk 1999). The status of the patient at 2 months is an indicator of his or her status at 12 months (Bogduk 1999). For those who remain in pain and are disabled and unable to work beyond the initial months, the functional prognosis is grim. *Fewer than 50% of people who are disabled by their pain for more than 6 months ever return to work, and re-employment is almost never achieved after 2 years of disability* (Waddell 1992) (Figure 10.1).

Return-to-work rates fall to 25% after 1 year of disability and to 10% after 2 years of disability. Waddell (1996) estimates the total cost of back pain to the U.S. society to be $\$100 \times 10^9$. Approximately 85% of societal costs for low back pain are incurred by a very small percentage (5–10%) of patients who develop chronic low back pain (CLBP) (Frymoyer 1988, Spengler et al. 1986). Predictors of chronicity and return to work are less determined by physical than by psychosocial factors (Klenerman et al. 1995, Frymoyer and Cats-Baril 1987, Gallagher et al. 1989, Burton et al. 1995, Linton 2000). Risk factors for the development of CLBP include (among others) depression, low activity and high pain behavior, negative beliefs, fear of pain, job dissatisfaction, blue collar and heavy physical work, age, severe psychological stress or abuse, high levels of pain intensity during the acute phase, substance abuse, and compensation and unemployment (Sanders 2000).

Although the Quebec Task Force on Spinal Disorders (Spitzer 1987) defined *CLBP* as back pain lasting more than 7 weeks, the guidelines for acute low back pain (Bigos et al. 1994, Accident Rehabilitation and Compensation Insurance Corporation and the National Health Committee 1997, Bogduk 1999) define *CLBP* as pain lasting for more than 3 months.

ANATOMY

The abdominal muscles provide stability to the trunk. Posteriorly, the abdominal muscle group becomes contiguous with the thoracolumbar fascia, which sheathes the bundles of erector spinae muscles. The lateral abdominal muscles are therefore in a position to assist and enhance the role of the erector spinae. The superficial lamina of the thoracolumbar fascia is composed primarily of the aponeurosis of the latissimus dorsi. The gluteus maximus inserts into the external fascia of the sacrum, which connects with the thoracolumbar fascia. The paired contralateral external and internal obliques can provide a very strong rotary movement because of their long-movement arm of force. Therefore, they are more important in trunk rotation movements than the multifidus (Liemohn 1990). Snijders (1994) maintains that biomechanical studies indicate that the stability of the sacroil-

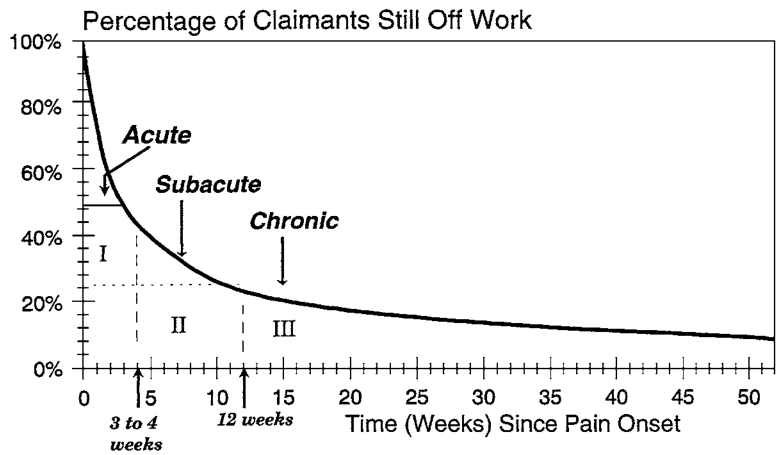

Figure 10.1. Three-phase model of back pain. (Reprinted with permission from JW Frank, MS Kerr, AS Brooker, et al. Disability resulting from occupational low back pain. Pain 1996;21:2908–2929.)

iac joint is important in treatment of low back pain. The hamstrings are capable of tensing the sacrospinal and sacrotuberal ligaments. Contraction of the gluteus maximus and the oblique abdominal muscles increases compression of the sacroiliac joint, thus providing stability.

Richardson et al. (1999) discuss the model of spinal stabilization first proposed by Panjabi (1992). This model incorporates a passive subsystem (osseous and articular structures and the spinal ligaments), an active subsystem (muscles), and a neural subsystem (muscle control). They further subdivide the muscular system into *local* and *global muscle systems*, in which the local muscle system includes deep muscles and the deep portions of some muscles that have their origin or insertion on the lumbar vertebrae (Table 10.1).

The local muscle system is capable of controlling the intervertebral relationship of the spinal segments and the posture of the lumbar spine. The global muscle system's main function is to balance the external loads applied to the trunk, so the residual forces transferred to the lumbar spine can be handled by the local muscles.

The multifidi and the transversus abdominis are thought to be the key muscles responsible for local stabilization. Dysfunction of these muscles may be associated with back pain, and specific training of these muscles is indicated (Richardson et al. 1999).

Although the mechanism of muscle insufficiency associated with low back pain is not well understood, it is commonly believed that the passive structures of the spine are increasingly stressed with increasing functional muscle insufficiency. In the spine, the health of the joints depends largely on repeated low-stress movements (Twomey 1992). The intervertebral joints and the facet joints require movement for the

Table 10.1. Categorization of the Lumbar and Abdominal Muscles Based on Their Role in Stabilization

Local Stabilizing System	Global Stabilizing System
Intertransversarii	Longissimus thoracis, pars thoracis
Interspinales	Iliocostalis lumborum, pars thoracis
Multifidus	Quadratus lumborum, lateral fibers
Longissimus thoracis, pars lumborum	Rectus abdominis
Iliocostalis lumborum, pars lumborum	Obliquus externus abdominis
Quadratus lumborum, medial fibers	Obliquus internus abdominis
Transversus abdominis	
Obliquus internus (fiber insertion into thoracolumbar fascia)	

Source: Reproduced with permission from C Richardson, G Jull, P Hodges, J Hides. Therapeutic Exercise for Spinal Segmental Stabilization in Low Back Pain. London: Churchill Livingstone, 1999.

proper transfer of fluid and nutrients across the joint surfaces (Frank et al. 1984). In the same way, the intervertebral disk depends largely on movement for its nutrition (Bogduk 1986).

The predominance of type I fibers in both the erector spinae (Johnson et al. 1973) and the multifidus (Kalimo 1989) is consistent with their function of maintaining spinal posture and stabilizing the trunk. Nicolaisen and Jorgensen (1985) performed studies of isometric trunk extensor performance and found that patients with low back pain had significantly shorter endurance than controls. Despite the difference in muscle endurance, there were no differences in isometric back muscle strength between patients and controls. In a subsequent study (Jorgensen and Nicolaisen 1987), they found that back muscles have a relatively longer endurance capacity than other muscle groups. They attributed this to the fiber composition of the back muscles—largely slow-twitch, oxidative fibers. They also found that people with earlier attacks of back pain had less endurance capacity but similar strength in their back muscles. They interpreted this to mean that the composition of back muscles in the patients was dominated by a greater proportion of easily fatigable, type II fibers. This observation was confirmed by Mannion et al. (Mannion 1999, Mannion et al. 1997), Kankaanpaa et al. (1998), and Roy et al. (1989). Explanations for this observation included a greater proportion of type II fibers in low back pain patients than control subjects or high precontraction metabolite levels in low back pain patients, resulting from persistent muscle spasm and prolonged muscle tension. Kalimo et al. (1989) found significant selective type II atrophy in the multifidus muscle, not only in patients with disk prolapse, but also in controls. They attributed this to deconditioning and a sedentary lifestyle.

Based on these studies, there seems to be evidence that lack of trunk muscle endurance plays an important role in CLBP. A problem often cited is that measurement is difficult, as various trunk muscles seem to have distinctly different fiber composition and function. For instance, the innervation and function of the erector spinae and the multifidus muscle are so different that they cannot be classified as a single unit. Considerable individual variation exists among individuals in the fiber type distribution of these muscles. Changes in muscle fiber type may be related to the location of the back pain. Zhao et al. (2000), for instance, showed differences in the characteristics of the multifidus muscle between the diseased and normal sides in patients with lumbar disk herniation. The changes in muscle characteristics primarily were related to disk protrusion. In addition, different locations of the low back pain seemed to cause different secondary effects on the muscle characteristics.

Arendt-Nielsen et al. (1996) showed that back muscle pain (induced by experiment) alters electromyographic activity of the back muscles during gait. Increased electromyographic activity during the swing phase correlated significantly with pain intensity. They concluded that musculoskeletal pain alters motor performance during gait, probably through reflex pathways. Zedka et al. (1999) also found evidence of modulation of the voluntary activation of back muscles in experimentally induced pain. Geisser et al. (1995), however, found no relationship between electromyographic activity and pain intensity in patients with CLBP.

PATHOPHYSIOLOGY

Back pain (with or without leg pain) can arise from disks, facets, ligaments, muscles, tendons, and mechanical or chemical irritation of nerve roots or the spinal cord. It is estimated that 75% of back pain episodes are nonspecific. Thus, in only 15% of patients with low back pain can an established diagnosis be made (Spitzer 1987). Mechanical low back pain, spinal stenosis, herniated disk with or without radiculopathy, spondylolisthesis, and failed back syndrome are some of the common diagnoses of patients referred to physical therapy.

Mechanical low back pain is attributed to abnormal posture. The most common postural abnormality in back pain seen is the one in which the patient presents with hyperextension of the knees, increased lumbar lordosis, and a protruding abdomen. This tends to be a result of a distinct pattern of muscle imbalance in which the muscles are either tight or weak (Table 10.2) (Janda 1986).

Tightness of the hip flexors, for example, results in an inability to extend the hip sufficiently for walking, which results in increased anterior rota-

Table 10.2. Pattern of Muscle Imbalance Contributing to Back Pain According to Janda (1986)

Tight	Weak
Hamstrings	Abdominals
Rectus femoris	Gluteals
Hip flexors	Multifidi
Gastrocnemius	Rotatores
Soleus	
Back extensors	
Piriformis	
Quadratus lumborum	

tion of the ilium, and therefore increases stresses across the lumbar spine. Insufficient pelvic stabilization due to weakness of the gluteus medius and minimus and abdominal muscles results in similar increased stresses across the lumbar spine. The development of trigger points in the gluteus medius and minimus can refer pain into the leg, simulating sciatica (Travell and Simons 1992).

Boden et al. (1990) studied magnetic resonance imaging findings in asymptomatic subjects. Twenty percent of subjects younger than 60 years of age had a herniated disk according to magnetic resonance imaging, and 1% had spinal stenosis. In the group of subjects 60 years of age and older, 57% of the scans were abnormal, 36% had a herniated disk, and 21% had spinal stenosis. There was degeneration or bulging of a disk on at least one level in 35% of the subjects between 20 and 39 years old and in all but one of the 60- to 80-year-old subjects. Similar findings in asymptomatic subjects were reported by Jensen et al (1994). This confirms the importance of matching findings on magnetic resonance imaging to findings in clinical examination. Beattie et al. (2000) write the following:

> The presence of disk extrusion and/or ipsilateral, severe nerve compression at one or multiple sites is strongly associated with distal leg pain. Mild to moderate nerve compression, disk degeneration or bulging, and central spinal stenosis are not significantly associated with specific pain patterns. Although segmental distributions of pain can be determined reliably from pain drawings, this finding alone is of little use in predicting lumbar impairment. The self-report of lower extremity weakness or dysesthesia is not significantly related to any specific lumbar impairments.

Spinal stenosis is generally due to degenerative changes of the disk and facet joints. A bulging disk and hypertrophic facet joints may narrow the central canal (*central stenosis*), causing bilateral leg pain, or narrow the foramen (*lateral or foraminal stenosis*), causing radicular pain in one leg (Kirkaldy-Willis et al. 1974). In the classic scenario, the patient will complain of leg pain with walking that subsides with bending forward or sitting down. This is termed *neurogenic claudication*. Neurogenic claudication can be differentiated from vascular claudication by putting patients on a treadmill and a bike (Deen et al. 1998). Patients with neurogenic claudication do not incur leg symptoms with bicycling, whereas patients with vascular claudication incur leg problems with bicycling and treadmill walking. *Intermittent claudication* was recently described, owing to ischemia of the lumbosacral plexus in patients in whom spinal stenosis was ruled out (Wohlgemuth et al. 1999). The major symptom of this pathology is buttock pain on walking, with sensory and motor deficits in both legs.

Case Example

The patient is a 43-year-old woman who weighs 320 lb and presents with complaints of low back pain and pain in the back of her legs. The onset of her pain was insidious, approximately 1 year ago.

Magnetic resonance imaging of her lumbar spine shows minimal intervertebral disk space narrowing between L3 and L4 and minimal to moderate central spinal stenosis at L4–L5. She was treated approximately 6 months ago with physical therapy that included hot packs, ultrasound, knee-to-chest exercises, and quadriceps strengthening, none of which helped her pain or function.

Her medical history is significant for chronic renal failure, hypertension, hypothyroidism, and schizophrenia. She is under the care of a psychiatrist, and her schizophrenic symptoms are controlled. She takes numerous medications.

Pain The patient describes piercing pain in the middle of her low back and aching pain in the back of her legs. She rates her average pain as 8 on a 10-point scale. At best, there is no pain. She rates her worst pain as an 8. Her pain is increased with walking and decreased by sitting and lying down.

Function The patient is single and lives alone. She was very functional until approximately 1 year ago. She was volunteering 20 hours per week and would walk 15 minutes to her volunteer work. She stopped volunteering and walking owing to her pain. She no longer goes to the grocery store or pharmacy owing to the pain of walking. She has difficulty performing housekeeping chores. She has begun to sleep 12 hours per night and to lie down in the afternoon for several hours owing to her pain.

Physical examination Patient is morbidly obese. Posture is remarkable for a forward-bent position of the trunk on the hips that she claims eases her leg pain. Pelvic symmetry cannot be palpated.

Range of motion (ROM) of the lumbar spine is essentially normal with forward bending with fingertips to the shins. Extension, rotation, and sidebending of the lumbar spine are within normal limits and do not cause pain. ROM of both hips is within normal limits.

Manual muscle testing of both lower extremities is 5 out of 5. Hip flexors are 3 out of 5.

Straight-leg raising is 50 degrees owing to hamstring tightness and is negative for radicular pain. Sensation and deep tendon reflexes are normal. No muscle spasm is palpated in the lumbar spine. The sciatic notch is not tender. Gait is abnormal with small step length. The patient uses a cane for support.

Aerobic fitness This could not be assessed, owing to the patient's medication use.

Pain behaviors Verbal pain complaints about pain and abnormal posturing are present.

Patient goals To decrease pain; to be able to walk to the grocery store (20 minutes).

Impairments: Pain, hip flexor weakness, hamstring tightness, abnormal standing posture.

Functional limitation: Activity intolerance due to deconditioning and obesity, decreased ability to walk because of pain.

Disability: Decreased instrumental activities of daily living, including her ability to get around her community. Patient is no longer able to perform volunteer work. Patient relies on assistance of others for grocery shopping and going to her pharmacy.

Evaluation, diagnosis, and prognosis: The patient has central spinal stenosis, superimposed with deconditioning. Impairments include pain with walking, hip flexor weakness, hamstring tightness, abnormal standing posture, and activity intolerance due to deconditioning. The patient will demonstrate improved activities of daily living and instrumental activities of daily living through increased tolerance to walking.

Interventions: Functional restoration sessions are completed two times a week for 6 weeks, with careful monitoring of the patient's blood pressure. Borg's Rating of Perceived Effort is used to monitor intensity of cardiovascular exercise. Behavioral medicine group treatment is included.

Treatment contract goals

1. Decrease such behaviors as walking bent over, complaining about pain, needing to sit down constantly, and lying down during the day.
2. Physical therapy goals include walking for 1 minute and gradually increasing the amount of time until able to walk 20 minutes to the grocery store. Also, improve flexibility of hamstrings from 50 degrees to 70 degrees in straight-leg raising, and improve posture until a normal upright position is maintained.

Intervention

1. The patient is educated in the use of heat and cold after walking and in using transcutaneous electrical nerve stimulation while walking for independent pain management.
2. The patient begins a 1-minute quota-based home walking program, which is increased 1 minute every 2 days to 20 minutes by the sixth week.
3. A home program for stretching of the hamstrings and back extensors and a quota-based strengthening program of the gluteals and abdominals are also begun.
4. Exercises performed in physical therapy sessions include review of the home program and appropriate progression of number of repetitions as set by the quota schedule. Quota-based squatting exercise, abdominal exercises with pulleys, and latissimus dorsi

exercises with pulleys are also performed. Her blood pressure remains stable during exercise.

5. Finally, treadmill walking is included to increase aerobic capacity. At the first visit, the patient is able to walk for 4 minutes at 0.5 mph with a 1-minute break. Her blood pressure remains stable, and the rate of perceived exertion is 14.

In the second week of treatment, the patient is redirected in her home program because she is not following the quota-based program and is only walking occasionally. Use of the transcutaneous electrical nerve stimulation unit is discontinued, because she does not think it is helpful. In the sixth week, she is walking on the treadmill for 22 minutes at 0.7 mph with three short rests and stable blood pressure. Rate of perceived exertion is 11. She is independent in her home program and is performing 25 repetitions of all her exercises. Her posture is now normal, and she walks to the grocery store without a cane. She continues to complain of pain and plans to see an acupuncturist for it.

Patients may present with a *radiculopathy* due to mechanical compression of a herniated disk's impinging on a nerve root or due to chemical inflammation associated with annular tears. It is speculated that the inflammatory polypeptides associated with these annular tears cause local irritation of the adjacent nerve root (Gundry and Heithoff 1999). Complete improvement with conservative therapy is possible in the case of a herniated disk, although it may take up to a year. A prospective study followed patients with documented herniated disks and performed repeat computerized axial tomography scans after complete clinical improvement at 6–18 months after the initial study. In 43% of the scans, the herniated disk had completely resolved (Ellenberg et al. 1993). The Quebec Task Force classification for spinal disorders (Spitzer 1987) was shown to be valid for the severity, treatment, and outcomes of patients with sciatica and spinal stenosis (Atlas et al. 1996).

Lumbar radiculopathies can be treated with epidural steroid injections (Lutz et al. 1998, Abram 1999), affording short- and sometimes long-term pain relief sufficient for patients to tolerate a rehabilitation program.

Many patients with herniated disks—with more leg than back pain—have surgery and are referred to physical therapy postoperatively. Some of these patients may experience reherniation of their operated disk in physical therapy. Patients will then complain that physical therapy is responsible for reherniating their disk. Reherniation of a disk postoperatively occurs in 8–19% (Keskimaki et al. 2000, Loupasis et al. 1999) of cases. There is no evidence in the literature of a causal link with physical therapy intervention.

Postsurgically, some patients complain of a new onset and a slow increase of their radicular pain over time. This is likely an unfortunate result of scarring around the nerve root, as a result of surgery. Clinical practice in other countries involves practicing straight-leg raises immediately after surgery, presumably to prevent the lumbosacral roots from scarring down. There is no research to support this practice, but, theoretically, it seems like a good idea.

Arachnoiditis is marked by diffuse involvement of nerve roots and includes nerve roots' adhering to each other. The final stage of arachnoiditis is atrophy of the nerve roots, which are displaced circumferentially and encased in collagen deposits in the lumbar canal (Dubuisson 1994).

Spondylolisthesis refers to a slip of one vertebra on another. Most commonly, this is a result of degeneration. With degeneration of the disk and subsequent loss of height, the superior vertebral body becomes displaced forward on the lower vertebral body, resulting in central spinal stenosis.

Isthmic spondylolisthesis refers to a slippage of vertebrae due to a bilateral fracture of the pars interarticularis. Over the subsequent years, the disk yields, and the upper vertebra slips forward on the lower. The slippage is graded as follows:

- First degree: less than one-third of the distance between the front and the back of the vertebral body.
- Second degree: between one-third and two-thirds of this distance.
- Third degree: more than two-thirds of this distance.
- Fourth degree, or spondyloptosis: slippage of one body completely forward on the body below, with rotation through 90 degrees. These patients present with lower back pain or uni- or bilateral leg pain, or both (Quon et al. 1999).

Patients often referred to pain-management programs are patients with chronic intractable back pain, often after a history of multiple failed interventions.

Case Example

The patient is a 35-year-old man complaining of CLBP. He was diagnosed with a grade II spondylolisthesis 11 years ago, after a work-related injury, and underwent decompression and stabilization with fusion 9 years ago. For 2 years, he was pain free, but then his pain returned. It steadily increased until 3 years ago, when he underwent further stabilization using pedicle screws, which actually made the pain worse.

Previous interventions have included epidural steroid injections without pain relief, seven admissions to the hospital for pain control and medications, and 14 separate courses of physical therapy.

Other medical history includes a C5–C6 disk bulge, bilateral carpal tunnel syndrome, right ulnar nerve entrapment, and irritable bowel syndrome.

Pain The patient complains of constant low back pain that radiates into the right leg and down the posterior thigh and calf into the great toe. During periods of extreme pain, it radiates into the posterior left thigh and lower leg, as well. He rates his average pain as an 8 on a 10-point scale. At best, it is a 5, and at worst, an 8. He describes his pain as *shooting* with *severe cramping*. Coughing and sneezing increase his pain, as do all physical activities. Sitting and walking aggravate the pain the most. His pain is decreased with medications and temporarily decreased with cold and heat.

Function The patient is a computer scientist and is required to sit throughout the day. He has not worked for 3 years but still has a position available to him with his former employer. He is married and has two children, whom he believes he is unable to take care of owing to his pain. He spends the day on the couch, reading occasionally. He does not socialize, exercise, or engage in recreational activities. He is able to sit for 5 minutes and stand and walk for 10 minutes. His sleep is interrupted owing to his inability to tolerate a particular position for any length of time.

Physical examination Posture is abnormal with right leg bent. Patient claims it makes his pain worse to straighten his leg. Pelvis is level. The left shoulder is elevated. Lumbar spine ROM is limited to 25% in all directions and is painful. Flexion, extension, and sidebending to the left increase his right leg pain. Hip ROM is limited in all directions owing to significant muscle guarding. He is unable to flex his hips beyond 45 degrees owing to muscle guarding and reported severe pain. In prone position, he is unable to extend his thighs owing to pain. Flexion of the knees in the prone position is limited to 90 degrees owing to rectus femoris shortness. He is able to stand on his toes and heels. With manual muscle testing, he has give-away weakness in all muscle groups in both lower extremities. Abdominal strength is 3 out of 5. Straight-leg raising is 20 degrees bilaterally owing to muscle guarding and is negative for radicular pain. The Achilles reflex is absent on the left. Sensation is decreased in the entire left leg. Palpation with the patient in supine position does not reveal muscle spasm in his back or buttocks. Sciatic notch is not tender. Sacroiliac testing is negative. All Waddell signs are positive (see Table 5.1).

Gait is abnormal with decreased step length and decreased weight bearing on the right leg. Knees remain flexed throughout the gait cycle. The patient ambulates with a cane in the left hand.

Aerobic fitness The patient was unable to achieve steady state on either bike or treadmill, so this could not be measured.

Pain behaviors The patient remains standing throughout the interview, with significant guarding, inappropriate illness signs, verbal pain complaints, moaning, sighing, and rubbing.

Patient goals To decrease pain.

Impairments: Decreased trunk and hip flexibility, muscle imbalance, with muscle weakness and tightness in the trunk and lower extremities, abnormal movement patterns, abnormal gait, altered sensation, deep-tendon reflex changes, fear-related lack of movement, and activity intolerance owing to deconditioning.

Functional limitations: Decreased tolerance to sitting, standing, and walking. Sleep is interrupted.

Disability: Patient is unable to work or engage in parental, spousal, social, or recreational activities.

Evaluation, diagnosis, and prognosis: The patient has intractable chronic back pain with superimposed myofascial pain due to prolonged avoidance of physical activities and muscle guarding. The patient has multiple impairments that interfere with his ability to function. The patient will benefit from a graded progressive exercise program, in conjunction with behavioral medicine intervention. He should be seen three times per week for 6 weeks to achieve reintegration into home, community, and work.

Interventions: The patient will participate in a graded progressive exercise program, behavioral medicine group, and individual behavioral medicine treatment, and he will have a treatment and medication contract.

Treatment contract goals

1. Decrease behaviors that indicate to others that the patient is in pain, such as slow walking, reclining, complaining, and using medications.
2. Formulate a plan for returning to work by the tenth day of the program.
3. Progressively increase time sitting until in the third week, the patient is able to sit for 60 minutes.
4. Lift and carry 20 lb as necessary for grocery shopping by the third week.
5. Walk for 60 minutes by the fourth week.
6. Increase trunk and hip flexibility to normal ranges by the sixth week.
7. Increase trunk and leg strength to normal by the sixth week.
8. Increase aerobic capacity.

Intervention

1. The patient is educated on pacing and the use of heat and cold after exercise and sitting and self-massage for neck and shoulder pain.
2. The patient is instructed in a home stretching program for gastrocnemius, hamstrings, rectus femoris, hip flexors, and back extensors; a quota-based strengthening program for the gluteals, abdominals, and back extensors; a quota-based program to improve sitting tolerance to 6 hours per day; and a walking program with a goal of 60 minutes of walking by the third week.
3. Exercises in physical therapy include a review of the home program, squatting with hand-held weights, abdominal exercises, multifidus exercise, latissimus dorsi exercise with pulleys, and ball exercises.
4. Biking is used to increase aerobic capacity.

By the end of the second week, the patient is able to walk for 30 minutes and sit long enough to watch a movie or eat a meal. He believes that he is unable to increase his sitting tolerance in a straight-backed chair beyond 30 minutes, as this consistently increases his pain. Ergonomics are discussed. The patient finds a recliner that does not increase his pain and allows him to perform his work duties. By the fourth week he is able to walk 60 minutes per day without his cane. At the sixth week, he is able to sit enough to work for a day without an undue increase in pain. His back ROM improves to 80% in all directions, and his hip ROM is within normal limits. Trunk and extremity strength improve to within normal limits. He is independent in his home exercise and decides to engage in a swimming program to further increase his aerobic capacity, strength, and endurance. He is off his diuretic patch and not taking any pain medications. At 6- and 12-month follow-ups, he is working full time and swimming three times a week.

INTERVENTION

Guidelines for the treatment of acute low back pain were published to promote better management of acute low back pain to prevent chronicity, initially in the United States (Bigos et al. 1994), and later in New Zealand (Accident Rehabilitation and Compensation Insurance Corporation and the National Health Committee 1997), the United Kingdom (1998) (http://www.rcgp.org.uk/backpain/index.htm), and Australia (Bogduk 2001). The guidelines, in general, have defined *red flags* for potentially serious conditions: physical risk factors, such as features of cauda equina syndrome (very urgent referral); significant trauma; weight loss; history of cancer; fever; intravenous drug use; steroid use; patient age older than 50 years;

severe unremitting night-time pain; and pain that gets worse when the patient is lying down. In the absence of red flags, factors that may limit an early return to usual activities should be identified, which include screening for *yellow flags*, or attitudes and beliefs about back pain, behaviors, compensation issues, diagnostic and treatment issues, emotions, family, and work. Many of the psychosocial factors that constitute yellow flags stem from the fear-avoidance model (Waddell et al. 1993, Vlaeyen and Linton 2000).

After initial consultation to rule out red flags, early management strategy includes nonsteroidal anti-inflammatories, encouraging early activity, and promotion of a positive attitude toward activity and work. Referral to physical therapy for "a supervised program of general stretching, strengthening, and aerobic exercises, conducted in a manner to encourage activity may be beneficial for patients who are not improving after 6 weeks of onset of low back pain" (Bogduk 1999).

Clearly, early activation is encouraged in all available guidelines for the management of acute low back pain. Indahl et al. (1995) randomized patients on sickness leave for more than 8 weeks into two groups: intervention (n = 463) and control (n = 512). Intervention consisted of information and instruction designed to increase activity and reduce fear associated with the low back pain. The control was treated within the conventional medical system. The intervention group showed a highly significant reduction in sick time as compared to the control group. At 200 days, 60% were still on sickness leave in the control group, versus 30% in the intervention group (Figure 10.2).

There is no support for the use of passive modalities, as is common clinical physical therapy practice (van Tulder et al. 2000). Passive treatment and discouraging regular physical activity are risk factors for the development of chronic back pain. Tacci et al. (1999) reviewed clinical management over the course of 1 year of (work) compensable acute low back pain cases (n = 98). Modified duty was prescribed for more than 90% of the sample, and 29% were prescribed bed rest. Sixty-two percent of the sample was referred to physical therapy. Forty-seven percent of the cases were prescribed back exercises, and 37% were instructed in back stretching. Heat and ice application were provided in the office setting for 26% and 18% of the cases, respectively. Ultrasound (27%), electrical stimulation (22%), massage therapy (21%), and corsets as treatment (21%) constituted the majority of the passive treatments. This study clearly demonstrated that physical therapists are continuing to use modalities that have lack of proven efficacy in the treatment of acute back pain.

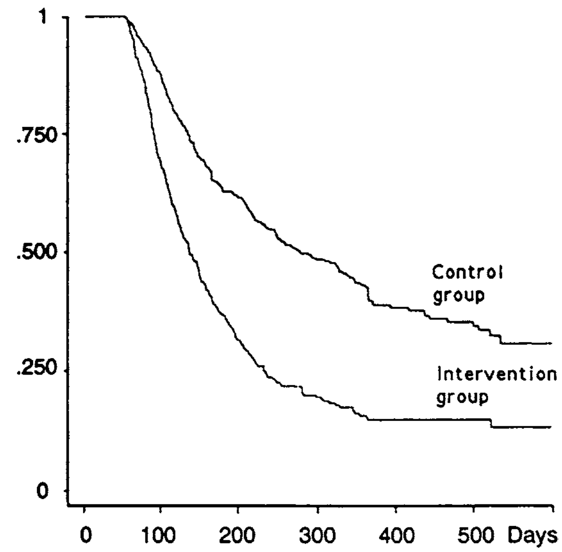

Figure 10.2. Sickness leave rates in the control group and the intervention group expressed as a survival analysis, where *survival* is defined as still on sickness leave. (Reprinted with permission from A Indahl, L Velund, O Reikeraas. Good prognosis for low back pain when left untampered. A randomized clinical trial. Spine 1995;20[4]:473–477.)

Williams flexion and (McKenzie) extension exercises were found not to be effective in patients with acute low back pain (van Tulder et al. 2000). This is not surprising, as both types of exercise lack the necessary requirements that facilitate adaptive responses to deconditioned tissue (Mooney 1995).

The McKenzie system for the treatment of patients with low back pain relies on subgrouping patients into three categories for evaluation and treatment. The *derangement syndrome* is thought to be due to frank tears of the annulus fibrosi with nuclear displacement and annular bulging. Classification of patients according to the McKenzie system was shown to have poor reliability (Riddle and Rothstein 1993, Donahue et al. 1996). Treatment includes repeated end-range spinal movements to "centralize" the pain from the feet, legs, or buttocks to the back. Patients are taught to perform exercises that centralize their symptoms and avoid movements that peripheralize them. McKenzie states that this method of treatment is applicable to patients with chronic intractable pain, as well (McKenzie 1994). Extension exercises should be avoided in patients with spinal stenosis, as they usually exacerbate patients' leg pain. Aerobic training should be part of the program, and bicycling is mostly well tolerated. Bicycling, however, is not a functional task for most patients. Treadmill walking simulates normal walking, which is closer to the functional ability patients need to regain. Holding on to the handrails allows for flexion in the lumbar spine, reducing the occurrence of leg symptoms while walking. Dong and Porter (1989) showed that a flexed posture increased both walking and cycling distances in patients with spinal stenosis. Education on the nature of spinal stenosis and the benefits of a flexed position may help the patient self-manage his or her pain by postural control of this position. Patients may benefit from concurrent epidural steroid injections while engaged in an exercise program. In comparing conservative to surgical management of spinal stenosis, the long-term results were superior for surgery (Amundsen et al. 2000). Although conservative management (physical therapy) is often recommended, other than a report on two case studies of patients with spinal stenosis, there is a paucity of research on outcomes of physical therapy intervention for patients with spinal stenosis.

The benefits of spinal stabilization in conjunction with epidural steroids for patients with radiculopathy due to herniated disk are described by Saal and Saal (1989). The goal of back stabilization exercises is development of the ability to maintain a simultaneous contraction of the abdominal, buttock, and back extensor muscles. Exercises such as the "dead bug" and "drawing in the stomach" are helpful. Other exercises include bridging with both feet on a ball, partial sit-ups, lying prone on a ball while alternating arm and leg raises, and pulley exercises performed standing with a pelvic tilt and both knees slightly bent. The difficulty of these exercises is increased by changing from a sitting to standing position or from straight plane to diagonal patterns and incorporating rotations. O'Sullivan et al. (1997, 1998) demonstrated the effectiveness of specific training of the deep abdominal muscles, with coactiviation of the lumbar multifidus proximal of the pars defect in patients with a diagnosis of spondylolisthesis.

Maintaining a "neutral spine" achieves elastic equilibrium and minimizes passive tissue forces on the spine to reduce the risk of injury while the spine is under load from muscular contractions (McGill 1998).

Patients with a diagnosis of failed back syndrome, arachnoiditis, and chronic radiculopathy have neuropathic pain. Stretching of the hamstrings will likely increase their radicular pain and should be avoided, as should other exercises that simulate the straight-leg raise. Epidural steroid injections may provide (leg) pain relief and facilitate an active exercise program. Some of these patients may be helped with transcutaneous electrical nerve stimulation in conjunction with exercise.

ERGONOMICS

Andersson et al. (1989) proposed that factors contributing to low back pain include physically heavy work, static work postures, frequent bending and twisting, lifting and forceful movements, repetitive work, and vibration. Sustained postures, bent postures, and prolonged sitting also have been associated with low back pain. Job dissatisfaction, blue-collar work, and depression have been associated with the occurrence of low back pain. Depression, low activity levels, significant pain behavior, and negative beliefs regarding the ability to function despite pain have been associated with the occurrence of chronic disability.

Andersson et al. (1989) reported on a study in which a triaxial dynamometer was used to measure torques, angular positions, and velocities while the subjects, who were in upright positions, moved through an extension and flexion arch repeatedly, until fatigued. As the muscles fatigued, ROM increased in the secondary planes of motion, indicating diminishing control and coordination of the fatigued neuromuscular system (Andersson et al. 1989). McGill (1998) warns repeatedly against a fully flexed spine, as it is associated with a posterior herniation of the disk, characterized by annular failure and posterior protrusion of nuclear material.

An excellent review on the assessment of an individual's capacity for work in relation to the physical effort requirements of a job is provided by

Rodgers (1988). A recent review of Functional Capacity Evaluations was published by King et al. (1998).

Lifting instruction is essential. Patients should not lift objects that are too heavy or lift without a secure foothold. The weight should be held close to the body, and foot position should turn with the weight (the spine should not twist with the weight) (McGill 1998).

EVIDENCE FOR INTERVENTION

The evidence of the frequency, intensity, duration, and type of exercise that would be most helpful in the treatment of patients with CLBP is sparse.

High-dose dynamic exercise is reported to provide superior results over low-dose exercise (Manniche 1996, Manniche et al. 1991, Hazard et al. 1989, Sachs et al. 1990, Nelson et al. 1999, McGill 1998). Jette and Jette (1996) reported that endurance-type exercise for spinal problems was associated with positive outcomes, whereas the use of heat and cold was associated with negative outcomes. More frequent exercise is also associated with a stronger belief in personal control over back pain (Harkapaa et al. 1991). Hilde and Bo (1998) performed a systematic review to evaluate the efficacy of exercise in the treatment of CLBP with emphasis on dose and type of exercise and were unable to come to firm conclusions owing to the poor methodology of the studies reviewed. They emphasized the need for studies with exercise protocols grounded on established theoretical (exercise physiology) principles concerning dose and type of exercise. Despite the plethora of papers on functional restoration, only two randomized controlled trials could be found searching Medline entries dating from 1966 to March 2001 (Mitchell and Carmen 1994, Bendix et al. 1998). Michell and Carmen (1994) conducted a prospective randomized trial in 542 injured workers, comparing a functional restoration to a control group. The functional restoration group was treated 7 hours per day, 5 days per week for a total of 40 treatment days. The control group included a wide range of treatment methods, including active or passive physical therapy (or both), medication, manipulation, acupuncture, work hardening, and back schools. At the end of 12 months of follow-up, 79% of the functional restoration patients were working full time, versus 78% of the control group. There were no statistically significant differences between the groups in compensation and disability award costs. The functional restoration approach provided better results for back pain patients than all types of injuries combined in terms of treatment costs. Bendix et al. (1998) compared the clinical outcomes of a functional restoration program to a nontreated control group and to two intensive but different training programs in 238 patients with chronic low back disability. Total hours of treatment were 135 for the functional restoration group and 24 in the two training programs. At 2-year follow-up, patients post-functional restoration reported significantly less contact with the health care system, fewer sick days, and a less-disabled lifestyle compared to the control group and the less-intensive training programs.

Torstensen et al. (1998) compared conventional physical therapy (mostly passive) to medical exercise therapy and self-exercise by walking in patients with CLBP. There was no difference in 1-year outcomes between conventional physical therapy and medical exercise therapy, although both were superior to the self-exercise group. The lack of treatment specificity was supported by Mannion et al.'s study (1999), which demonstrated no difference in 1-year outcomes between active physical therapy, muscle reconditioning using training devices, and aerobic and stretching classes. The authors concluded that because all groups performed equally well in relation to the outcomes variables (decreased pain and disability, psychological variables), the main effect of treatment was not effected by specific physiologic adaptations, but rather through some "central" effect. This central effect may be a change in belief that exercise is harmful. Reduction of fear-avoidance beliefs has been associated with a reduction in self-rated disability. Other central effects of exercise, such as pain modulation, the antidepressant and anxiolytic effects, and immune system stimulation are discussed in Chapters 3 and 6.

Cochrane systematic reviews on the effects of health care for back pain have concluded that there is "moderate evidence of positive effectiveness of multidisciplinary rehabilitation for subacute back pain (more than 4 weeks and less than 3 months) and work place visits increases the effectiveness"

(Karjalainen et al. 2000), and "exercises may be helpful for chronic, non-specific, low back pain patients (not treated in multidisciplinary programs) to increase return to normal daily activities and work. . . there is no evidence that exercise therapy is superior to inactive treatments for chronic pain" (van Tulder et al. 2000).

van Tulder inventoried the current state of the art regarding the effectiveness of conservative treatment of CLBP and concluded, "There is strong evidence that exercise therapy and multidisciplinary treatment programs are effective in CLBP and moderate evidence that nonsteroidal anti-inflammatory drugs, back schools, and behavioral therapy are effective in CLBP. There is also strong evidence that traction is not effective in CLBP" (van Tulder et al. 2000a). A Cochrane review for evidence on the efficacy of functional restoration is ongoing, and the results are not known yet.

Guzman et al. (1997) performed a systematic review of multidisciplinary team approaches for the treatment of CLBP and concluded that multidisciplinary programs are more effective than nonsystematic treatment in the management of CLBP. Haigh and Clarke (1999), in a review on the effectiveness of rehabilitation for spinal pain, concluded that the available evidence strongly supports exercise and a cognitive-behavioral approach to spinal pain.

RECOMMENDED READINGS

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RECOMMENDED WEB SITES

All Web sites listed here were last accessed on: June 6, 2001.

Acute back pain guidelines, Australia: www.health.gov.au/nhmrc/advice/pdfcover/paincov.htm

Acute back pain guidelines, New Zealand: www.nzgg.org.nz/library/gl_complete/backpain1/index.cfm#contents

Agency for Health Care Policy and Research guidelines for acute lower back pain guidelines: http://text.nlm.nih.gov/ftrs/tocview

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Chapter 11

Chronic Neck Pain

Harriët Wittink

At any given time, approximately 9% of men and 12% of women will have neck complaints (Lawrence 1969). Depending on the industry, neck-related disorders can account for as many days of absenteeism as can low back pain (Kvarnstrom 1983). Motor vehicle accidents account for a sizable portion of neck complaints, with 24% of subjects experiencing persistent symptoms at 12 months post injury (Radanov et al. 1994). Two different follow-up studies show that more than 80% of patients with neck or shoulder complaints continue to have symptoms 2 years after participating in a rehabilitation program (Ekberg et al. 1994a) and that 57% still experience neck pain 10 years after the onset of symptoms (Gore et al. 1987).

ANATOMY

The cervical spine and musculature not only have to stabilize and balance the head, but also are exposed to virtually constant traction from the hanging upper limbs. The shoulder and neck muscles are activated during all movements of the upper extremity in space (Janda 1988). Correct dispersal of segmental movement of the cervical spine depends on the balanced relationship between the head, cervical spine, and thorax and dynamic muscular control. Total movement of the cervical spine is the composite of segmental motion of all the cervical vertebrae and the first three thoracic vertebrae. The majority of rotation occurs in the upper three cervical segments. Movement patterns on a poor postural base contribute to repetitive microtrauma of the cervical structures, which include the facets, disks, ligaments, articular capsules, and muscles. These poor patterns of movement contribute to habitual overuse at isolated motion segments and minimize normal movement at others. Furthermore, the alteration of the position of the glenoid fossa results in altered biomechanical forces across this joint, leading to increased muscle activity of the upper trapezius, levator scapulae, and the rotator cuff.

Habitual dysfunction at isolated segments may generate bony hypertrophy, ligamentous laxity, and breakdown of disk and facet articulations. This dysfunction can perpetuate itself in a cycle of pain, muscle imbalance, and postural abnormality.

The upper extremities are actively suspended by the levator scapulae and the upper trapezius. Holding a weight in the upper extremities or active elevation of the scapula initiates a brisk response by the levator scapulae (De Freitas et al. 1980) and the upper trapezius (Bearn 1961), and therefore places an increased load on the head and neck. De Freitas et al. (1980) demonstrated high activity in the levator scapulae and rhomboid muscles during free movements with manual submaximal resistance against arm abduction or flexion.

Inman et al. (1944) identified force couples composed of upper and lower segments that produce upward rotation of the scapula. For the serratus anterior, the levator scapulae was considered to be the upward force unit. Within the trapezius, the upper segment displayed consistent action in both abduction and flexion. The reduced participation of the lower trapezius leaves the scapula free to move anteriorly (Inman et al. 1944). To attain maximal scapular rotation, both the trapezius and the serratus anterior must be active. Clinically, a disruption of normal force couple action is often seen; with a weak serratus anterior, the levator scapulae becomes overactive to compensate. A weak lower trapezius is compensated for by an overactive upper trapezius. As a result, movement patterns become abnormal (e.g., shrugging the shoulders when elevating the arms). This can lead to the neck and shoulder pain seen often by physical therapists.

Habitual postures can lead to neck pain. Harms-Ringdahl (1986) demonstrated that the extreme flexed neck position leads to neck pain within 1 hour. Work with an abducted arm leads to increased activity in the trapezius, cervical erector spinae, and thoracic erector spinae and rhomboid muscles (Schuldt 1988) and subsequently leads to muscle fatigue and pain.

Therefore, upper-extremity movement will necessarily exert forces on the neck and head. Evaluation and treatment of neck pain therefore must include evaluation of the interscapular muscles and the *suspension mechanism* of the upper extremities, the trapezius and levator scapulae. Any dysfunction in these muscles can contribute to neck pain.

Subtle changes in postural muscle activity can have important functional consequences. The recommended level for maintained static muscle work is 2% of a maximum voluntary contraction, and the suggested acceptable limit is 5% (Jonsson 1982). At this level of static contraction, the energy yield to the muscle is most likely aerobic. At a higher maximum voluntary contraction level (e.g., that generated by poor posture), pain and significant increases in sick leave owing to musculoskeletal complaints occur (Ashton-Miller et al. 1990). This may be owing to the anaerobic energy supply to the muscle, which results in a buildup of lactic acid and decreased contractile strength. A maximum voluntary contraction of higher than 30% results in a decrease of blood flow in the muscle, provoking an even greater energy crisis (Astrand and Rodahl 1986).

Larsson et al. (1988), confirm these findings by documenting a decreased level of high-energy phosphates and the presence of ragged-red fibers, a finding suggestive of mitochondrial damage in biopsies taken from the upper part of the trapezius in patients with static work-related chronic myalgia with clinical findings suggestive of myofascial pain. Chronic neck and shoulder pain was found to be associated with decreased blood flow in the trapezius muscle and lower mean electromyographic frequency, as compared to the non-painful side and as compared to pain-free subjects (Larsson et al. 1998).

Musculoskeletal disorders of the neck and shoulder are strongly related to repetitive movements that demand precision, light lifting, uncomfortable sitting positions, work with lifted arms, and a rushed work pace (Ekberg et al. 1994b). Therefore, addressing work postures and ergonomics to reduce static muscle activity must be a part of the treatment of patients with neck pain.

PATHOPHYSIOLOGY

Trauma, overload, or poor posture is responsible for many cases of cervical pain. Spinal degeneration may be either a causative or contributing factor. Trauma superimposed on degeneration may result in a complex clinical picture (Rossi 1994).

The most common diagnoses treated by physical therapists are mechanical neck pain, neck and shoulder pain, disk pathology, and cervical radiculopathy.

The most common postural abnormality involves the forward head position, elevation and protraction of the shoulders, rotation and abduction of the scapulae, and a variable degree of winging of the scapulae. This abnormality is usually associated with the *proximal syndrome*, or *shoulder-crossed syndrome* (Janda 1988), a muscle imbalance characterized by tightness and weakness of upper body musculature. Table 11.1 is a list of the muscles that are typically tight or weak in this syndrome.

This altered posture likely stresses the craniocervical junction as well as the cervicothoracic junction. Muscles such as the upper trapezius, levator scapulae, and sternocleidomastoid not only play a role in the development of neck pain, but also in the development of cervicogenic headache (Janda 1988). The forward head position also plays a role in the development of temporomandibular dysfunction and the development of facial pain (Janda 1986b). Posture training was shown to result in a significant reduction of neck and temporomandibular symptoms (Wright et al. 2000). Jordan et al. (1998) compared intensive exercise training, physical therapy (ultrasound, massage, mobilization), and manipulation (chiropractor) in patients with nonradicular chronic neck pain and found no differences at baseline and 4- and 12-month follow-up between the groups. All patients also received a home exercise program and education regarding their neck pain. All groups experienced significant improvements in pain and disability.

Exercise promotes the necessary strength, coordination, and endurance to maintain the cervical spine in a stable and safe position during loading, mobility, and weight-bearing activities. Exercise training optimizes the capacity of the cervicothoracic muscles to absorb loads in all directions while minimizing direct strain and stress on individual cervical tissues, thus reducing repetitive microtrauma to the cervical segments. Training the upper, middle, and lower trapezius; serratus anterior; and rhomboids provides scapular stability and thus indirect stability for the cervical spine. Dynamic stabilization exercises superimpose extremity movement on stable spine positions and can be performed with or without aids, such as balls, bolsters, pulleys, and weights (Saal and Saal 1989). This type of program was proven more effective in the treatment of chronic neck pain without radicular symptoms than a supervised home program or a lecture about neck pain immediately after treatment and at 1-year follow-up (Taimela et al. 2000). Saal and Saal (1989) report having patients perform three sets of 15 repetitions per exercise before the patient is progressed to the next exercise. This endurance exercise ensures motor learning that is thought to establish a motor pattern that becomes automatic, rather than conscious. Active cervical stabilization exercise is also helpful for neck and shoulder pain (Grant et al. 1997). Sweeney et al. (1990) provide an excellent treatment outline for cervical stabilization.

Table 11.1. Pattern of Muscle Imbalance Contributing to Neck Pain According to Janda (1986, 1988)

Tight	Weak
Sternocleidomastoid	Serratus anterior
Pectoralis major and minor	Lower and middle trapezius
Levator scapulae	Rhomboids
Upper trapezius	Neck flexors
Suboccipital muscles	Suprahyoid
Masseter	Mylohyoid
Temporalis	
Digastric	

Case Example

The patient is a 64-year-old woman who has had total body tightness and stiffness for many years, mainly in her neck and shoulders. She also complains of daily headaches. Her previous history includes a lumpectomy 5 years ago for breast cancer, followed by radiation. Interventions for her pain included splint therapy for her temporomandibular joint dysfunction, which was thought to be associated with her headaches, and physical therapy, in which she was instructed in a general stretching program.

Pain On a 10-point pain scale, the patient rates her headache as 5 on average, 3 at best, and 8 at worst. She describes her neck pain as stiffness. Her pain is decreased by stretching and heat and increased by all physical activities.

Function The patient is an artist and makes small statues, which requires her to be in a sitting position, working with her arms overhead. She is able to sustain this for 10 minutes. She occasionally goes for a walk. She performs her stretching exercise daily. Her social functioning is decreased owing to her discomfort and headaches.

Physical examination Posture is remarkable for forward head and thoracic kyphosis with internally rotated shoulders. Cervical, lumbar, and hip range of motion is normal. Manual muscle testing of both upper and lower extremities is 5/5. Interscapular strength is 4/5. Pectorales major and minor are tight. Reflexes and sensation are normal. Palpation reveals diffuse musculoskeletal tenderness of the neck and shoulders.

Aerobic fitness The patient is in the “low-fit category” for her age group.

Pain behaviors This patient has no verbal or nonverbal pain behaviors.

Patient goals To sustain overhead positions for 1 hour at a time as necessary for her work.

To decrease the frequency and average intensity of her headaches.

Impairment: Pain, abnormal posture associated with weakness of her interscapular muscles and tightness of her pectorales muscles, and poor aerobic fitness for her age and gender.
Functional limitation: Patient is unable to sustained prolonged positions with arms overhead.
Disability: Patient's ability to work is decreased, and her social functioning is diminished.
Evaluation, diagnosis, and prognosis: The patient is a 64-year-old woman who presents with muscle imbalance, poor aerobic capacity, and insufficient muscle endurance to sustain overhead work. The patient will demonstrate the ability to maintain preferred posture during various activities, including work and instrumental activities of daily living, and increase her ability to socialize through aerobic conditioning; stretching of the pectorales; endurance training of the serratus anterior, rhomboids, and lower and middle trapezius; postural training; patient education; independent stretching; walking program; and transition into an independent health club program, three times per week for 6 weeks.

Treatment contract goals

1. Walk for 20–30 minutes each day, starting at 10 minutes and increasing by 5 minutes per week.
2. Work with arms above head. Start at 10 minutes a day, with a goal of 60 minutes continuously.

Intervention

1. The patient is instructed on correct posture and building in short breaks during her work. Working on a lower table is discussed; however, the patient believes that this would interfere with the quality of her work.
2. The patient's stretching program is reviewed, and specific stretches are added for the pectorales, levator scapulae, and suboccipitals.
3. Instruction in a home walking program, starting at 10 minutes per day, increasing by 5 minutes per week to achieve a goal of a 30-minute walk per day in 1 month.
4. Instruction in a rubber-band home exercise program is given, including exercise for the upper trapezius, rhomboids, serratus anterior, and lower trapezius (using diagonal patterns), starting at five repetitions each, adding one repetition per exercise per day to a maximum of 25 repetitions per exercise to increase interscapular muscle endurance.
5. The physical therapy program consists of a quota-based program of treadmill walking; upper-extremity ergometer exercises; pulley exercises for the rhomboids, latissimus dorsi, and serratus anterior; proprioceptive neuromuscular facilitation pattern of flexion; external rotation and abduction to increase endurance of upper trapezius, rhomboids, serratus anterior, and lower trapezius using the pulleys in standing; and abdominal exercises while sitting to increase interscapular muscle endurance and improve trunk stabilization.

After eight sessions, the patient's pain decreases from an average of 5 to 3, and her work tolerance increases to 1 hour. She is independent in her home exercise and stretching and walking program.

She is seen for a total of 15 sessions. At this time, she has no more headaches. Her interscapular strength is normal, her posture is improved, and she is able to work continuously for several hours. She joins a health club and performs her exercises there two to three times per week. At follow-up 6 months later, she is headache free and independent in her health club program.

Chronic neck and shoulder pain is a frequent complaint in patients referred to physical therapy. Causes for neck and shoulder pain include repetitive work (Ekberg et al. 1994b), stress (Vasseljen and Westgaard 1996, Westgaard et al. 2001), working with the arms abducted (Schuldt 1988), and C4–C5 radiculopathy and facet arthropathy.

Hagberg et al. (2000) compared a program of isometric strength exercise to a program of isometric endurance exercise in female industrial workers with neck and shoulder pain. Both programs were equally successful in improving perceived pain, perceived rate of exertion, and shoulder function.

The authors concluded that patients with neck and shoulder pain should be treated with strength exercise in addition to endurance-type exercise. Waling et al. (2000) compared three different types of exercise intervention in women with work-related trapezius myalgia. One group trained strength; the second, muscular endurance; and the third, coordination. The exercise groups met three times weekly for 10 weeks. All three exercise programs showed similar decreases of pain, which indicates that the type of exercise is of less importance to achieve pain reduction. Feldenkrais intervention was superior to physical therapy intervention in female workers with neck and shoulder pain in reducing pain complaints and disability in leisure time (Lundblad et al. 1999).

In a study in which magnetic resonance scans of the cervical spine were reviewed by three neuroradiologists on 100 patients, scans demonstrating an abnormality were found in 19% of asymptomatic subjects; 14% of abnormalities were found in people younger than 40 years of age and 28% in those older than 40 years. The disk was degenerated and narrowed at one level or more in 25% of the subjects younger than 40 years old and in almost 60% of those older than 40 years (Boden et al. 1991). Thus, degenerative changes are quite common in people in general, including those without symptoms. Factors associated with increased risk for disk disease include heavy manual labor requiring lifting of more than 25 lb, smoking, and driving or operating vibrating equipment (Malanga 1997).

Cervical radiculopathy occurs at an annual incidence rate of 85 per 100,000, with much less frequency than radiculopathy of the lumbar spine (Ahlgren and Garfin 1996). In the younger population, it is the result of a disk herniation or an acute injury's causing foraminal impingement of an exiting nerve. In the older patient, it is often the result of foraminal narrowing from osteophyte formation (Malanga 1997). Neck retractions were shown to promote cervical root decompression and reduce radicular pain in patients with C7 radiculopathy (Abdulwahab and Sabbahi 2000). Persson et al. (1997) found no difference in outcomes at 1 year between patients with long-lasting cervical radicular pain treated with surgery, physical therapy (exercise, massage, heat, cold, mobilization, and ergonomic instruction), or a cervical collar in pain, function, and mood measurements.

Case Example

The patient is a 45-year-old man who underwent neck surgery after a work injury 3 years ago. His injury occurred with a heavy lift, and he experienced immediate right arm and hand numbness with neck pain. Surgeries included an anterior cervical diskectomy at C5–C6 2 years ago and an anterior cervical diskectomy and fusion at C4–C5 1 year ago. Both surgeries were unsuccessful in alleviating his pain and numbness.

Electromyography shows mild chronic denervation of the left C5 and the right C6 nerve roots. His computed tomography scan shows marked narrowing of the neural foramen at C4–C5 that is worse on the left than on the right.

Previous treatment included two courses of physical therapy with ultrasound, electrical stimulation, and soft-tissue mobilization. This treatment was not helpful in decreasing his pain or improving his function.

The patient has been diagnosed with bipolar affective disorder. He sees a psychiatrist for treatment.

Pain The patient complains of neck pain that radiates into the back of his skull, shoulders, shoulder blades, and right arm in the triceps area. He states that his pain is constant and rates it as a 7 to 8 on average on a 10-point scale. His pain intensity is 4 at best and 8 at worst. His pain is increased by walking and standing for more than 10 minutes and sitting for more than 30 minutes. His pain is eased by changing positions. His sleep is interrupted by his pain.

Function The patient owned his own business, but closed it 2 years ago owing to his sense of inability to take care of it. He has not worked since. He does not socialize because he believes he is poor company. All of his functional activities are limited owing to his pain.

Physical assessment Posture is unremarkable. Cervical spine range of motion is 50% in forward bending, backward bending, and rotation and is reported to be painful. Sidebending is 20% in both directions with pain. Flexion of both shoulders is 135 degrees. Manual muscle testing is 5/5 in the left upper extremity and 4/5 in the right upper extremity. Deep tendon reflexes in the right biceps and brachioradialis are decreased. He has decreased sensation to light touch and pinprick in his right thumb and lateral index finger. He has significant tenderness and pain in the right upper quadrant musculature with palpation.

Aerobic fitness The patient's fitness is very low for his age group.

Pain behaviors The patient exhibits moderate verbal and nonverbal (grimacing, bracing, and guarding) pain behavior.

Patient goals Pain relief, increased general function, re-establishing business.

Impairment: Pain, decreased cervical spine and glenohumeral range of motion, muscle weakness in the right upper extremity, decreased reflexes in right biceps and brachioradialis with impaired sensation to light touch and pinprick in the right thumb and lateral index finger, and poor physical fitness for age and gender.

Functional limitation: All physical functioning is limited by pain.

Disability: Patient is unable to work and has decreased ability to take care of self and home. Patient does not socialize.

Evaluation, diagnosis, and prognosis: Patient is a 45-year-old man who presents with chronic neuropathic pain superimposed by myofascial pain and chronic pain syndrome. Impairments include decreased cervical spine and shoulder motion, fear-related lack of movement, and activity intolerance due to deconditioning. This patient will demonstrate increased tolerance to physical activities and improved performance in activities of daily living, instrumental activities of daily living, and ability to socialize with functional restoration three times a week for 6 weeks, behavioral medicine group and individual treatment, and a treatment contract.

Treatment contract goals

1. Decrease behaviors that communicate to others that the patient is in pain (e.g., crankiness, decreased socialization, reduced activity participation, complaining, grimacing, and moaning).
2. Return to work. Plan the re-establishment of former business.
3. Bike 10 minutes with a goal of 30 minutes.
4. Improve flexibility to better reach behind back in the shower.
5. Floor-to-chest lifting starting at 5 lb, with a goal of 50 lb and 20 repetitions.
6. Lifting 5 lb overhead, with a goal of 15 lb and 20 repetitions.
7. Walking for 20 minutes, with a goal of 60 minutes.
8. Eliminate down time required after exercise.
9. Prepare to make the transition to an independent health club program.

Intervention

1. The patient is educated regarding pacing and use of heat, cold, and self-massage with tennis balls for independent pain management after activities and exercise.
2. Home stretching exercises for latissimus dorsi, upper trapezius, scalenes, and levator scapulae are assigned. Five repetitions of each are performed three times per day. The patient is instructed in a walking program that begins at 20 minutes and increases by 1 minute per day to 60 minutes by the sixth week.
3. Lifting is an essential part of work for this patient. Lifting requires strength in the quadriceps, gluteals, trunk stabilizers, interscapular muscles, and arms. The patient is instructed in bridging, sit-ups, and back extension exercises. He starts with 10 repetitions of each and adds two repetitions per day until he reaches 30 repetitions. After this, the level of difficulty of each exercise is increased. These exercises are part of his home exercise plan. Exercises done in physical therapy include quota-based pulley exercises for rhomboids, serratus anterior, and latissimus dorsi; abdominal and multifidi exercises while standing; diagonals in flexion, external rotation, and abduction; and lifting simulation. Squatting and lunging exercises are performed with 5-lb weights. Five additional pounds are added per week until 25-lb weights are used in each hand.
4. The patient is instructed in proper lifting techniques, starting with five repetitions and increasing by seven lifts per week.

5. The patient bicycles 20 minutes at 25 W on his first visit and is progressed to 30 minutes at 90 W in 1 month.

At the sixth week, all physical therapy goals are met.

INTERVENTIONS

The Quebec Task Force on Whiplash-Associated Disorders made recommendations on the management of whiplash-related pain and dysfunction (Spitzer et al. 1995). Subsequently, guidelines for the management of acute whiplash-related disorders, based mostly on the available literature updated from the Quebec Task Force and in part on consensus, were published by the Motor Accidents Authority of Australia. The guidelines recommend assessment for red and yellow flags. *Yellow flags* are predictors for potentially poor outcomes of treatment and should alert the practitioner to the potential need for more intensive treatment or earlier referral. Recommendations include assurance that symptoms are a normal reaction to being hurt and encouragement to return to usual activity as soon as possible.

> Range of motion exercises, muscle re-education and low-load isometric exercise to restore appropriate muscle control and support to the cervical region should be implemented immediately, if necessary in combination with intermittent rest if the pain is severe. Rest and collars should only be prescribed if the patient has neck pain and musculoskeletal signs and/or neurological signs, and not for more than 72 hours.
>
> —Motor Accidents Authority of Australia 2001

Manual therapy is a frequently used intervention in patients with neck pain. Inter-examiner reliability in assessing passive intervertebral motion of the cervical spine ranges between 0.28 and 0.43, which is considered only fair to moderate (Smedmark et al. 2000). Di Fabio (1999) reports that the complication rate of mobilization and manipulation of the cervical spine is between 1 in 200,000 and 1 in 3 million. Several studies provided evidence for the efficacy of manual therapy. Mobilization of acute neck pain was shown to be better than rest or a collar, but exercise was equally effective. Subacute and chronic neck pain mobilization and manipulation provide short-term pain relief and increased motion (Coulter 1996, Hurwitz et al. 1996).

ERGONOMICS

Factors considered to increase the static level of activity or fatigue in neck and shoulder muscles include excessive horizontal distance between work object and the worker, high position of the work objects, high worktable surface, narrow constraints on the sitting posture, postures with flexed shoulder joint, postures with abducted arms, and postures with flexed neck (Schuldt 1988). The duration of each contraction (i.e., the interval between muscular contractions) is thought to be of major importance, as is the duration of the whole work process.

Schuldt (1988) investigated neck muscle activity and load reduction in sitting postures and found that it is possible to reduce neck and shoulder muscular activity significantly by choosing a sitting position with the trunk slightly inclined backward and with the cervical spine vertical. In addition, muscle activity of the neck and shoulder was reduced by using forearm support and avoidance of arm abduction (Figure 11.1).

Tan and Nordin (1992) make the following recommendations for ergonomic adjustments of the sitting workplace:

- The distance between the eye and the object worked on should be 12 in. This is considered normal for reading a book or a computer screen.
- Work should be done at the same height as the elbows.
- The work surface should be arranged so that everything is within easy reach.
- The chair should have a back support below the shoulder blades with well-designed lumbar support, swivel, rollers, and arm rests for support. The seat height should be low enough for the feet to be resting comfortably on the floor.

Those involved in primarily static work are also advised to take small breaks to delay muscle fatigue and avoid abnormal postures, such as cradling the phone or sleeping on the stomach.

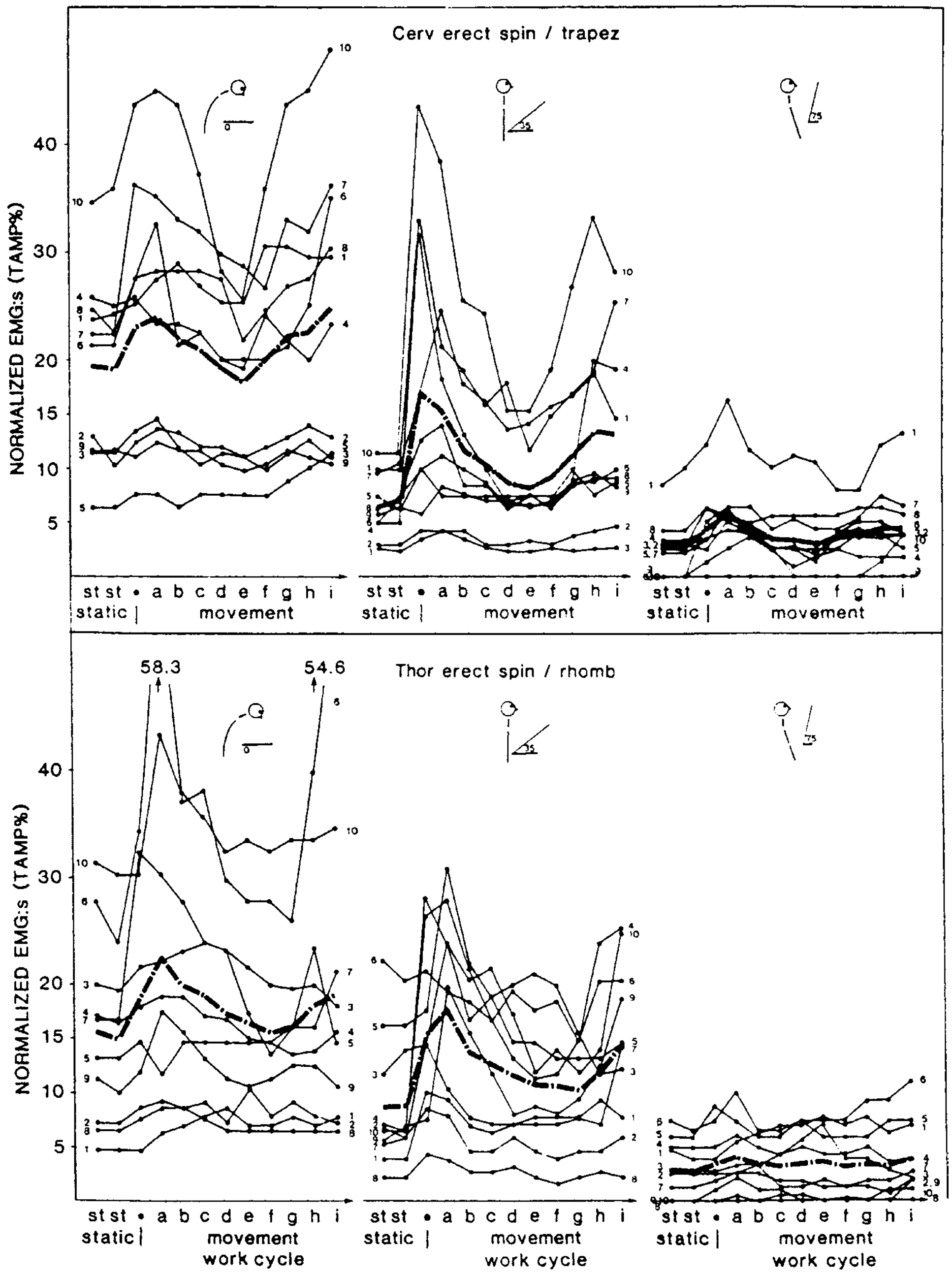

Figure 11.1. Effect of sitting postures on level of muscular activity in cervical erector spinae/trapezius and thoracic erector spinae/rhomboids (vertical axis, TAMP%) during simulated work cycle (horizontal axis), starting with last part of static phase and continuing with movement phase with arm/hand moving from position *a* though *i*. Sitting postures as indicated: the whole-spine-flexed, whole-spine-vertical-and-straight, trunk-slightly-inclined-backward and vertical neck position. Numerals at beginning and end of curve indicate each subject. (Cerv erect spin/trapez = cervical erector spinae/trapezius; EMG = electromyography; TAMP% = percentage of time-averaged myoelectrical potential; thick segmented line = mean; thor erect spin/rhomb = thoracic erector spinae/rhomboids.) (Reprinted with permission from K Schuldt, J Ekholm, K Harms-Ringdahl, et al. Influence of sitting postures on neck and shoulder EMG during arm-hand work movements. Clinical Biomechanics 1987;[2]:126–139.)

Ergonomic guidelines for arranging a computer workstation can be found on the Cornell ergonomics Web site.

BEST EVIDENCE FOR INTERVENTIONS

Systematic reviews are equivocal concerning evidence-based treatment of chronic neck pain owing to the often poor quality of existing studies. Evidence points to pulsed electromagnetic therapy, manipulation (short term), mobilization (short term), and active physical therapy having a positive result, in which cervical traction and acupuncture negatively influence outcome (Aker et al. 1996, Gross et al. 1996, Hurwitz et al. 1996, Kjellman et al. 1999, Coulter 1996). Active treatments were shown to have a beneficial long-term effect in the treatment of whiplash injury on at least one of the following primary outcome measures: pain, global perceived effect, and participation in daily activities (Peeters et al. 2001).

Karjalainen et al. (2001) were only able to find two studies on multidisciplinary biopsychosocial rehabilitation for neck and shoulder pain among working-age adults, both of poor quality. They concluded that there is little scientific evidence for the effectiveness of multidisciplinary biopsychosocial rehabilitation compared with other rehabilitation facilities on neck and shoulder pain. This confirmed earlier findings (Ekberg et al. 1994a).

More-intensive exercise programs for chronic neck-shoulder pain did not show superior results over less-intensive exercise programs at 12 months (Randlov et al. 1998).

CONCLUSION

In searching Medline documents dating from 1966 to March 2001, looking for back pain and randomized controlled trials (114 studies) and neck pain and randomized controlled trials (18 studies), it is clear that (1) there is a disappointing amount of research being done that is randomized and controlled, and (2) back pain has received a great deal more attention than neck pain. The evidence in the literature points to similarities and disparities between neck and back pain treatment.

In both neck and back pain, there is evidence that active treatment is at least as effective as, if not more effective than, passive treatment, but treatment is better than no treatment in improving pain and decreasing disability. In the more recent studies on neck and back pain, there appears to be a lack of exercise specificity (Mannion et al. 1999, Waling et al. 2000, Hagberg et al. 2000, Persson et al. 1997).

More-intensive exercise appears to be superior over less-intensive exercise in patients with low back pain, although this evidence is still lacking in patients with chronic neck pain.

In patients with chronic back pain, exercise appears to be superior over other treatments, and multidisciplinary treatment is recommended. Behavioral treatment was shown to be effective in the treatment of patients with chronic low back pain (van Tulder et al. 2000). The evidence for more-intensive exercise's showing superior results over less-intensive exercise is lacking, as is the need of multidisciplinary treatment for patients with chronic neck pain. This may be due to a paucity of research in patients with chronic neck pain, or there may be differences in how chronic neck and back pain should be treated, or both.

As with many chronic pain conditions, a behavioral approach involving modification of fear-avoidance beliefs and behaviors may have a more significant impact on pain and disability than specific interventions, as cited above.

RECOMMENDED WEB SITES

Ergonomics for Computers by the Ergonomics Department of Cornell University: http://ergo.human.cornell.edu/ergoguide.html/ Last accessed on: June 6, 2001.

Occupational Safety and Health Administration guidelines for ergonomics: http://www.osha-slc.gov/SLTC/ergonomics/ Last accessed on: June 6, 2001.

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Chapter 12

Physical Therapy Management of Repetitive Strain Injuries

Lisa Janice Cohen

The economic impact of occupationally related musculoskeletal injuries of the spine and the extremities is estimated at $54 billion, given costs of compensation, lost wages, and decreased productivity. No doubt the human cost is much higher in terms of impact on the individual, family, and community. Because of the enormity of the problem, the National Research Council and the Institute of Medicine were tasked by Congress to investigate and answer a number of specific questions in regard to occupational musculoskeletal disorders (MSDs). The complete report details the scope of occupational MSDs, the state of medical diagnosis and classification, the scientific evidence supporting work as a causal factor, and the relative contribution of other factors, as well as an analysis of the prevention literature. They conclude that well-designed intervention programs can reduce MSDs but that the literature does not support the cost and benefit of such programs (Commission on Behavioral and Social Sciences and Education, National Research Council 2001).

Physical therapists are likely to treat individuals with occupationally related MSDs. Specifically, MSDs of the upper extremity (UE), also commonly referred to as *repetitive trauma syndrome*, *cumulative trauma disorder*, or *repetitive strain injuries* (RSIs), are likely to be a common source of pain and impairment for workers and a common source of patients for physical therapists. Although RSIs can be seen as a type of chronic pain, there are many features of RSIs that are distinct from a more generic discussion of chronic pain. Specific ergonomic and human factors related to sitting, use of computer workstations, keyboards, and pointing devices, and repetitive hand movements are areas in which the body of knowledge related to chronic pain in general may not overlap with the management of RSIs.

PATHOPHYSIOLOGY OF REPETITIVE STRAIN INJURIES

RSIs of the UE include many musculoskeletal disorders. Carpal tunnel syndrome (CTS), cubital tunnel syndrome, medial and lateral epicondylitis, and rotator cuff tendonitis are commonly associated with RSIs. Just as chronic back pain is not a single entity, neither is RSI. Rather, it is a collection of primary and secondary impairments with concomitant dysfunction and disability related to, but not solely caused by, repetitive work tasks.

Numerous studies have related RSIs to heightened job stress and job dissatisfaction (Haufler et al. 2000, Leclerc et al. 1998), work habits (postural deviations, poor pacing, high-velocity tasks, high cumulative load) (Stal et al. 1999, Ohlsson et al. 1995, Helliwell et al. 1992), repetitive work (Haufler et al. 2000, Ohlsson et al. 1995, Latko et al. 1999, Scheuerle et al. 2000), and psychological stress (Leclerc et al. 1998). Thus, the pathophysiology of UE musculoskeletal disorders, such as that of back pain, includes physiologic as well as psychological factors. There is a growing acceptance of viewing UE musculoskeletal disorders as an entity that may encompass all of the separate diagnoses that fall under the broad umbrella of *cumulative trauma*: tendonitis, tenosynovitis, bursitis, and entrapment syndromes. This may be of particular value in cases in which symptoms become chronic and associated with significant disability. In all cases, the clinician must exercise caution in attributing all of the symptoms to work-related factors (Mahoney 1995, Szabo and King 2000, Bell 2000).

In fact, MacFarlane et al. (2000) conducted a prospective study of almost 2,000 participants taken by random sample from the United Kingdom. The authors obtained complete data from approximately 1,200 individuals. The participants were free from arm pain on initial contact. Extensive data were collected to analyze the factors associated with onset of forearm pain. Approximately 8% of participants experienced onset of forearm pain during the 2-year study. A high percentage of these symptomatic individuals also reported onset of other somatic pain problems, as well as psychological distress. Repetitive movements of the arm or wrist were a factor but not the sole predictor of development of UE pain. The authors conclude that high levels of psychological distress and work-related stress could predict onset of symptoms.

DIAGNOSIS OF REPETITIVE STRAIN INJURIES

Given the lack of clarity in the literature on the nature of repetitive trauma, it is not surprising that there is little agreement on the diagnostic pathway in these syndromes. Nerve conduction studies have long been seen as the gold standard in diagnosis of UE neuropathies. In a study of a sample of active workers, Salerno et al. (1998) investigated how the electromyographic definition of *normal* might affect the accurate diagnosis of CTS, for example. In a sample of 326 subjects, they determined that age, gender, hand temperature, and anthropometric variables were crucial in setting thresholds in determining normal comparison values for diagnostic purposes. They concluded that fixed and absolute thresholds for normative values that do not take these variables into consideration may result in false-positive and false-negative results. Rosenbaum (1999) argues, in the case of CTS, that ". . . a perfect test for [CTS] based on measuring conduction in median nerve myelinated fibers is mythical and unattainable." In fact, there is no exact correspondence between symptoms of patients with CTS and their electrodiagnostic status. Stevens et al. (1999) described a wide variety of sensory symptoms in individuals with electromyograph-verified CTS. In another study, researchers found a significantly higher correlation between electromyographic findings and the common CTS symptoms of numbness, tingling, and nocturnal symptoms than they did with pain, weakness, and clumsiness (You et al. 1999). This may point to a difference in pathophysiology and natural history of isolated CTS and more diffuse UE musculoskeletal disorders with features of carpal tunnel.

PHYSICAL THERAPY ASSESSMENT OF UPPER-EXTREMITY REPETITIVE STRAIN INJURIES

Accurate physical therapy assessment of UE musculoskeletal disorders must take into account a multisystem approach, integrating evaluation of the musculoskeletal system, as well as the neuromuscular system in the context of an individual's functional roles. Much of the assessment will mirror the process of assessing a patient with any type of chronic pain (Michel 1997). A thorough patient interview is an essential beginning to a complete assessment. Questions that assess specific activity tolerances and pain pattern with activity will help the clinician focus the assessment further. In addition to a more general chronic pain assessment, the evaluation must also look for specific patterns of impairment in the UE. A neurologic screen can help to rule in or rule out cervical involvement masquerading as a peripheral problem. Postural habits in standing and sitting and an assessment of the scapulo-humeral rhythm are key elements in the assessment process. Multiple studies support looking beyond the hand and peripheral arm in the management of RSIs (Ohlsson et al. 1995, Ranney et al. 1995, Lazaro 1997, Keller et al. 1998, Helfenstein and Feldman 2000).

ERGONOMIC FACTORS AND REPETITIVE STRAIN INJURIES

In addition to the impairments related to decreased range of motion, pain, and decreased functional use of the hands, patients with RSIs present with postural deviations and poor movement patterns. The physical therapist should look at ergonomic factors as well as human factors in the management of RSIs. Ergonomic factors include job tasks and demands and the physical setup of the job, including equipment. Ergonomists and occupational therapists are highly skilled practitioners who can consult and treat a patient in conjunction with the physical therapist vis à vis ergonomic factors. There is a rich literature on ergonomic redesign of the workplace, focusing on workplace design and equipment design, specifically analysis of keyboards (Treaster and Marras 2000), workstations (Dowler et al. 2001, Demure et al. [part I] 2000, Demure et al. [part II] 2000), pointing devices (Burgess-Limerick et al. 1999), and wrist and arm supports (Visser et al. 2000).

Human factors may be even more crucial than ergonomic factors in injury prevention. Issues of pacing (Wood et al. 1997), body mechanics, posture and work positions, and amount of force used (Snook et al. 1995) are examples of human factors in work-related musculoskeletal disorders. Studies, for example, link increased risk of RSIs with repetitive movements with an extended and radially deviated wrist (Stal et al. 1999, Serina et al. 1999). Sustained, repetitive work is also a risk factor for development of RSIs. Ergonomic management software, such as RSIGuard (available at www.rsiguard.com), has been advocated as a retraining device for proper work and rest pacing. In a study of one such product in an asymptomatic population at Lockheed Martin, Hedge and Evans (2001) found that alerting computer users to take frequent short rest periods (micro-breaks) did not change their total amount of keystroke or mouse work, while significantly improving work accuracy. This is powerful evidence for the cost effectiveness of improving pacing on job performance. The authors agree that future research on break software needs to include symptomatic individuals.

EVIDENCE FOR TREATMENT EFFICACY

Treatment approaches for RSIs are varied. They include, but are not limited to, decompressive surgery, splinting, ergonomic redesign of the workplace, application of physical agents (ultrasound, ice), manual therapy, anti-inflammatory medications, and injections. Clinicians involved in treating RSIs include physicians, nurses, physical therapists, occupational therapists, and ergonomists. A review of the literature on CTS dating back to 1985 reveals a plethora of review articles and case studies, along with efficacy studies of single interventions (Feuerstein et al. 1999). There has been little consensus on the appropriate management of RSIs. This is due, in part, to the lack of consensus on what constitutes an RSI. The clinician is faced with a multitude of diagnostic labels, each with its own purported pathophysiology, etiology, treatment, and outcome.

TREATMENT STUDIES RELEVANT TO PHYSICAL THERAPY

A randomized, controlled trial (Ebenbichler et al. 1998) investigating the effectiveness of ultrasound treatment for CTS found significant short-term improvement in subject report of pain and nerve conduction with ultrasound treatment as compared with sham ultrasound treatment. This study cannot easily be generalized to the population of individuals with work-related MSDs, as the patients in this study had mild to moderate isolated CTS. Patients who used regular analgesic or anti-inflammatory medications for their symptoms were excluded.

Tal-Akabi and Rushton (2000) compared the effectiveness of two types of manual therapy for treatment of CTS. They looked at carpal bone mobilization and median nerve mobilization in a small group of patients. They found no significant differences in treatment effectiveness between the two treatment groups on either subjective or objective functioning.

There is increasing recognition that work-related MSDs are a multidimensional problem. In a retrospective study of 24 cases of UE RSIs, Barthel et al. (1998) present outcome data for patients who were treated at a multidisciplinary hand clinic. Patients were managed by a team including a physician, occupational therapist, and psychologist. Interventions included medication, workplace simulation and job site evaluations, pain management, and biofeedback training. The authors measured subjective reports of symptoms, objective measurement of work tolerance, return-to-work rates, and medical disability status. Of the 12 patients who were receiving medical disability compensation, seven returned to work at the conclusion of treatment. They found that most of the patients in this study showed both objective and subjective improvement in symptoms and function; however, work disability remained high.

In a search of the Cochrane database, there was only one relevant review. Karjalainen et al. (2001) reviewed the literature on biopsychosocial rehabilitation for RSIs. Their review found only two studies that met their standards for inclusion, and neither showed strong evidence for positive outcome of comprehensive rehabilitation for RSIs.

CENTRAL NERVOUS SYSTEM CHANGES WITH REPETITIVE STRAIN INJURIES

There is increasing evidence that the impairments in RSIs are not confined to the musculoskeletal tissues. There is evidence of altered mapping in the somatosensory cortex in the case of chronic RSI. This has been demonstrated in animal models (Druschky et al. 2000, Byl 1996), as well as in human models (Byl et al. 2000). Byl et al. describe significant differences in the somatosensory evoked potentials to light taps on the fingers using magnetoencephalography in a comparison of a healthy flutist and a flutist with focal hand dystonia. The impaired flutist showed a disorganized pattern of firing, with a short latency and excessive amplitude in the affected hand. The healthy flutist showed a consistent pattern of response to the sensory stimuli. The authors conclude that the pattern seen in the impaired flutist indicates compromise in sensory differentiation with impairment of the sensorimotor feedback loop and disruption of normal motor control. This can lead to a lack of normal reflex inhibition with involuntary co-contraction of the flexors and extensors. These studies point to an interaction between repetitive task, motor learning, and sensory-motor feedback in the development of work-related musculoskeletal disorders. There is little in the literature on using sensory retraining as a treatment technique for these disorders. Byl and McKenzie (2000) present a descriptive study that shows promising functional improvement in 12 patients with repetitive stress injury and focal dystonia. The patients underwent intensive sensory retraining under the care of a physical therapist over a 3- to 6-month time frame. Patients were seen one to two times per week for sessions of 1.0–1.5 hours each. Sensory discrimination activities included identifying sensory stimulation of the skin using objects of varying textures and temperatures, identifying objects and designs drawn and pressed on the hands, reading Braille and Braille games, playing dominoes, identifying or matching pairs of small objects, identifying raised letters and numbers, shape sorting, and localizing touch stimuli. Stimuli were presented with the eyes closed. Therapist feedback was given, and patients were given trials with eyes open or repetition of the stimulus until the patient was correct. Biofeedback was incorporated to reduce co-contraction, and patients were asked to do sensory tasks in a mirror. In addition, patients were expected to complete 1–2 hours of sensory discrimination activities each day at home, as well as a home exercise program. Patients were evaluated before and after treatment on a variety of assessment tests. Significant gains were demonstrated in all patients in motor control, motor accuracy, sensory discrimination, and physical performance. Eleven out of 12 patients were able to return to work after treatment. Further studies with control groups will be needed to investigate this promising treatment avenue.

CONCLUSION

There exists a tremendous amount of disability and suffering attributed to RSIs. However, there is a lack of consensus as to what RSIs include. The taxonomy appears to be changing to favor the term *occupationally related MSD*. Many conditions fall under the umbrella of MSDs, including the widely used RSI and cumulative trauma disorder. Specific syndromes, such as CTS, medial and lateral epicondylitis, and shoulder tendonitis, can occur as primary specific disorders or as a part of a larger occupationally related MSD. There are differences in the etiology and natural history of an isolated and local impairment versus the more globally impairing MSD. The pathophysiology of MSDs is multifactorial and includes physical stresses, as well as psychological stresses. Work factors are a part of the etiology of occupationally related MSDs, but they are not the sole cause. Occupationally related MSDs can be seen as a specific subset of chronic pain, and thus, management of MSDs share many of the same features as management of chronic pain. In addition, biomechanical, ergonomic, and human factors play a large role in the management of MSDs.

Case Example

The patient is a 33-year-old, left-hand–dominant, married, male software engineer who presents to physical therapy with chief complaint of bilateral hand pain. He is currently working full time and taking graduate courses in the evening.

History The pain began in the left hand several years ago without specific trauma. He was treated conservatively with rest and anti-inflammatories, which did not help. He was referred to an orthopedic surgeon, who diagnosed him with CTS. He underwent surgery at that time, but the surgeon reported no operable findings and closed the patient's wrist without surgical intervention. After the exploratory surgery, the patient had several months of decreased pain. Ultimately, the pain returned in the left hand and began in the right.

Functional limitations The patient reports significant difficulty in using his hands for functional tasks, both at home and at work. Keyboard and mouse use is particularly painful. His pain did not follow any specific neurologic pattern.

Previous medical history Episodic low back pain, panic attacks.

Medications None.

Goals Return to sports activities; use keyboard and mouse without pain.

Physical examination

Posture: Thoracic scoliosis, left lower extremity short, left hip dropped, increased arm and flank distance on the left, posterior pelvic position in sitting with loss of spinal curves, and significantly forward head.

Palpation and observation: Rotator cuff fibrosis, right more than left; biceps fibrosis, right more than left; pronator fibrosis, right more than left; common extensor fibrosis, right more than left; significant co-contraction of the muscles of the right UE, including the pronators and supinators and the elbow flexors and extensors; increased muscle tone, right UE; decreased muscle tone, bilateral scapular stabilizers; abnormal scapulo-humeral rhythm bilaterally.

Strength, range of motion, and sensation: Decreased wrist extension, bilaterally; strength within normal limits. Sensation within normal limits to light-touch bilateral UE.

Impairments Postural deviations, soft tissue scarring, poor UE neuromuscular control, increased distal UE muscle tone, decreased proximal UE muscle tone, decreased wrist mobility, UE pain.

Functional limitations Unable to type or use a pointing device without pain; unable to play soccer or other sports owing to UE pain.

Disability Difficulty working full time as a computer programmer.

Diagnosis Patient diagnostic classification: Impaired Muscle Performance (American Physical Therapy Association 2001). This patient demonstrates a chronic pattern of overuse of his bilateral upper extremities with co-contraction of arm muscles in function. Posterior pelvic posture in sitting with abnormal scapulo-humeral rhythm contributes to overuse of distal UE muscles. Soft tissue scarring and lack of fascial sliding between UE compartments are likely secondary impairments from abnormal hand and arm use.

Prognosis Patient would benefit from a physical therapy approach, including soft tissue mobilization, neuromuscular re-education, scapular stabilization, pain control modalities, and body mechanics and posture retraining. Given the chronic nature of this patient's problems, he will benefit from less-frequent therapy over a longer period of time to facilitate true functional change and motor relearning. Physical therapy once a week for 8–10 weeks; then, decrease frequency as needed for follow-up, with a total time course of 6 months.

Therapy course The patient was treated as indicated. As the fibrosis and reflex contractions in his arms decreased, his pain decreased, and his functional use of his arm increased. Scapular stabilization and scapulo-thoracic retraining were accomplished, using external taping as an adjunct to hold the scapular stabilizers (lower traps in particular) in a shortened range, so the patient could begin to access them in function. The home exercise program relied heavily on proprioceptive neuromuscular facilitation diagonals in standing and sitting, beginning without resistance and adding resistive bands. The patient was instructed in use of a sacral wedge to facilitate more neutral pelvic and lumbar position in sitting. A computer workstation was simulated in the clinic to identify ideal arrangement of equipment and best body mechanics for work tasks. He was instructed in the use of ice and ice massage and self-massage for pain relief. Concurrently, the patient was working with a Feldenkrais practitioner both individually (functional integration) and in a group class (awareness through movement) to recognize and change his habitual poor work habits and sitting posture. He was able to return to sports activities and full keyboard and mouse use without pain. At 1- and 2-year follow-ups, UE function continued to be normal, and he did not experience any UE pain with work or leisure activities.

RECOMMENDED READING

Linden P. Comfort at Your Computer: Body Awareness Training for Pain Free Computer Use. Berkeley, CA: North Atlantic Books, 2000.

RECOMMENDED WEB SITES

Guidelines for initial evaluation for patient with acute musculoskeletal pain: www.rheumatology.org/research/guidelines/musc/musc-dis.html

Treatment guidelines from the American College of Rheumatology: www.rheumatology.org/research/guidelines/index.asp

National Occupational Safety and Health Commission (Australia): overuse syndromes http://www.nohsc.gov.au/OHSInformation/NOHSCPublications/fulltext/docs/h3/00997_01.htm

Links for ergonomic resources: www.s-sc.com/links.htm

American Orthopaedic Surgeons cumulative trauma: www.aaos.org/wordhtml/research/cumtraum.htm

American Pain Society paper on cumulative trauma disorders of the upper extremities: www.ampainsoc.org/pub/bulletin/jan98/facts.htm

National Institutes of Health guidelines on cumulative trauma disorder: http://tlc.nlm.nih.gov/resources/publications/ergo/ergonomics.html

Information on RSI and prevention in lay language. Extensive links: www.engr.unl.edu/ee/eeshop/rsi.html

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Chapter 13

Chronic Pain Treatment of Common Rheumatologic Diagnoses

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ARTHRITIS

The Arthritis Foundation (2000) reports that nearly 43 million Americans are affected by arthritis. *Arthritis* is a global term used to describe a broad set of rheumatic diseases causing pain, stiffness, and swelling in or around joints. Although arthritis is a chronic disease process, the pain of arthritis is best described as acute, persistent, and recurring. Persistent pain is the most common complaint of patients with arthritis and the most frequent reason they seek help from health professionals (Keefe and Caldwell 1997). It is this persistent, recurrent nature of arthritic pain that supports a combined medical and cognitive-behavioral management approach. This chapter focuses on the rehabilitative management and treatment of clients with osteoarthritis (OA), rheumatoid arthritis (RA), and fibromyalgia (FM).

RHEUMATOID ARTHRITIS

RA is a systemic disease characterized by inflammation, pain, and structural changes in the affected joints. Between 0.5% and 1.0% of the population in the United States is estimated to have the disease (Felson 1997). Annual costs due to medical care and lost wages are estimated to be more than $64 billion (Arthritis Foundation 1997). Women have a higher prevalence of this disease than do men, and it is most commonly first diagnosed between the ages of 25 and 50 years (Arthritis Foundation 2000). In RA, the synovial lining surrounding the joint becomes inflamed. Eventually, this inflammation leads to a thickening of the synovium, bone destruction, and damage to ligaments, tendons, and cartilage in the joint. Through progression of the disease process, this destruction may result in deformity of the joint. The hands, knees, and feet are most commonly involved, and typically, the joints are affected in a symmetric pattern (Lorig and Fries 2000). Joint warmth, swelling, stiffness, and tenderness characterize the acute phase of RA. Pain is present at rest and aggravated by range of motion (ROM) of the joint. Decreased ROM and muscle guarding are evident secondary to pain and swelling. Muscle imbalance, soft tissue distension, and joint instability and deformities are distinguishing features of the chronic phase of RA. In approximately two-thirds of patients, remissions and exacerbations are common characteristics of their chronic conditions (Hicks 2000). Treatment of the patient with RA is geared toward management of pain and inflammation; maintenance of ROM, strength, and joint integrity; and preservation of functional abilities in activities of daily living (ADLs).

OSTEOARTHRITIS

OA is the most common cause of disability in the United States, affecting 21 million Americans (Felson 1988, Burkholder 2000). Its estimated cost to the

United States (in 1994 dollars) is $15.5 billion, three times the cost of RA, with more than half due to work loss (Burkholder 2000). Identification of OA is generally based on the presence of symptoms and radiographic change, including increased bone density, asymmetric joint space narrowing, and new bone formation in an irregular pattern (osteophytes). Laboratory tests reveal no abnormalities, and no systemic symptoms are present (Burkholder 2000). OA is generally characterized as severe, localized cartilage erosion extending to bone (Felson 1998). Because cartilage is not innervated, multiple theories have been proposed to explain the source of the pain, including activation of capsular pain fibers and mechanoreceptors, periosteal pain fibers from intraosseous hypertension, subchondral microfractures, or bursitis or inflammation of the tendons or ligaments at the site of insertion (Kraus 1997). There are various types of OA, and a number of risk factors have been identified as contributing to the development of OA.

Types of Osteoarthritis

Primary idiopathic OA can occur in two patterns: interphalangeal OA and primary generalized OA. Interphalangeal OA significantly affects the proximal and distal interphalangeal joints. Primary generalized OA has the same hand-involvement pattern, along with diffuse involvement of additional joints (Burkholder 2000). It is distinguished from other types of OA by its symmetric presentation of distal and proximal interphalangeal (DIP and PIP, respectively), carpometacarpal (CMC), sternoclavicular, acromioclavicular, temporomandibular, sacroiliac, hip, and knee joints. Often, there is more evidence of osteophytes, although the level of discomfort is less significant. Erosive inflammatory OA affects the DIP and PIP joints but includes an erosive component, eventually lending to joint deformities and ankylosis. Secondary OA can involve any joint, and the distribution is more random (Burkholder 2000). Traumatic OA usually affects joints, such as the shoulder and elbow, and is preceded by a single trauma or microtrauma over time.

Risk Factors

Systemic and local factors contribute to the possibility of developing OA (Dieppe 1995). Systemic factors include a person's age, gender, heredity, and some not-yet-identified factors. These factors are thought to make cartilage more vulnerable to daily injuries with a decreased ability to repair itself, accelerated enzymatic destruction of matrix, and affected bone factors that may have secondary effects on cartilage and repair capabilities (Felson 1998). Local factors begin to affect joint breakdown once the systemic factors are in place. These include major and minor repetitive joint injury, joint deformity that decreases joint protection, obesity, and muscle weakness.

FIBROMYALGIA

FM is a form of soft tissue or muscular rheumatism, rather than arthritis of a joint (Arthritis Foundation 2001). Because there are no definitive diagnostic tests for FM, it is diagnosed by careful history taking, exclusion of other rheumatologic and systemic illnesses, and chronic widespread pain. Associated symptoms may include sleep disturbances, fatigue, headaches, abdominal pain, bloating, or alternating constipation and diarrhea, and changes in mood and cognition that may include depression, anxiety, and difficulty in concentration. The mandatory symptom is chronic widespread pain not explained by an inflammatory or degenerative disorder. This widespread pain, often called *total body pain* by patients, is defined as pain in all four quadrants (i.e., left, right, and above and below the waist) and the presence of at least 11 out of 18 possible trigger points. Trigger points are determined by palpation of approximately 4 kg of pressure with the thumb pulp over the following nine paired locations:

Two cm below lateral epicondyle of elbow
Insertion of nuchal muscle into occiput
Intertransverse ligaments of C5–C7
Upper border of the trapezius
Supraspinatus, medial aspect just above the scapular spine
Pectoralis, over upper border of second rib, approximately 2 cm from sternum
Upper gluteal area, just below iliac crest in outer quadrant
Insertion of muscle into greater trochanter

Medial condyle of femur approximately 2 cm above joint line of the anterolateral aspect of the bone.

The prevalence of FM is 2% for both genders, 3.4% for women, and 0.5% for men, and increases with age (Goldenberg 1999). FM is the second most common diagnosis in rheumatology clinics (Marder 1991). It is also commonly associated with other disorders. FM is present in 10–40% of patients with systemic lupus erythematosus and in 10–30% of patients with RA (Goldenberg 1999, Wolfe 1983). Fifty to seventy percent of patients with FM have a current or past diagnosis of chronic fatigue syndrome, irritable bowel syndrome, migraine, or depression (Hudson 1992, Triadafilopoulos 1991, Goldenberg 1999).

The cause and pathophysiology of FM are unknown. Initially, FM was thought to be related to peripheral sensitization secondary to disturbed microcirculation and reduced levels of high-energy phosphates within the muscle (Bengtsson et al. 1986, Henriksson 1994). As advanced technology was unable to detect any pathologic changes in muscle (Simms et al. 1994, Vestergaard-Poulsen et al. 1995), the focus shifted from peripheral to central causes of FM. Currently, the pathogenesis of FM is associated with abnormal levels of central neurochemicals that include substance P, nerve growth factor, dynorphin A, and serotonin (Russell 1998), and with a reduced activity of the pain inhibiting (antinociceptive) systems (Mense 2000) (see Chapter 3).

Although FM symptoms are extremely variable, ranging from moderate to severe pain and fatigue and sleep disturbances, to minimal interference with daily activities, outcome studies show that the symptoms remain stable over time (Goldenberg 1999, Felson 1986). Goldenberg (1999) concluded that FM patients and other patients with chronic pain diagnoses had better outcomes if health care use was less. He found that health care use and functional status are related more to premorbid and current psychosocial factors than to core symptoms of the syndromes. Factors found to be associated with impaired function in FM patients include pain levels, self-assessed disability, pending litigation, education, sense of helplessness, coping ability, and psychological distress (Goldenberg 1995, 1999). This lends importance to the multidisciplinary approach to treatment of the FM, which would include goal-oriented quota-based functional exercises, psychological profiling with subsequent counseling on the effects of pain on lifestyle, and education on pain management and behavior modification, including avoidance of pain behaviors.

TREATMENT

Thermal Modalities

To enhance function, it is essential to “arm” patients with tools they can use to help them control the persistent pain that can accompany arthritis. Because arthritis is a chronic condition, it is imperative that clients have modalities they can apply themselves in their home environments, thus reducing dependency on health care providers and increasing self-efficacy. This is particularly important because individuals who perceive themselves as unable to control pain have a low sense of self-efficacy and have been found to have higher levels of pain, as well as psychological and physical disability (Lorig et al. 1989, Keefe et al. 1996). Smarr et al. (1997) found that when RA patients’ self-efficacy scores increased, pain and depression decreased, whereas health status and disease activity improved.

Superficial heat and cold have similar positive effects on pain in OA and RA, although there is little evidence that either alters the immunologically controlled inflammatory process (Kangilaski 1981, Mainardi et al. 1979). Heat can provide analgesia, promote relaxation, reduce muscle spasm, and enhance flexibility of muscle and periarticular structures (Michlovitz 1990). Hot packs, paraffin, and hot water are common methods of obtaining superficial heat. It is possible to rent paraffin machines for home use, or a more economical alternative is to purchase blocks of paraffin and mineral oil at the local supermarket, and melt them in a double boiler. Several studies have demonstrated the benefit of the use of heat, combined with exercise, to promote a reduction in pain and stiffness and increased strength and function (Dellhag et al. 1992, Harris and Millard 1955). Dellhag et al. (1992) and Harris and Millard (1955) found that heat without exercise produced short-term pain relief only. Heat may be contraindicated if significant edema is present or if the patient is in an acute RA flare-up.

The benefits of deep heat via ultrasound are questionable for the treatment of arthritis. It can only be performed in a clinical setting by a health care professional, which increases passive behavior and dependency. Falconer et al. (1992) found that it was no better than a placebo in treating OA of the knee. Additionally, a 1990 review of the research concluded that its effectiveness could not be confirmed for pain relief or improvements in ROM (Falconer et al. 1990).

Cold provides a local analgesic effect and reduces inflammatory responses and muscle spasm (Minor and Sanford 1999). It can be applied independently via cold packs, ice massage, or cold water. Cold, when applied regularly, appears to provide the most relief. RA patients who applied cold packs three times per day for 1 month reported increased motion, decreased pain and medication use, and improved sleep (Kangilaski 1981). Some patients may find cold uncomfortable and report increased joint stiffness after its use.

Incorporating thermal modalities proactively, on a regular schedule throughout the day, can assist patients in increasing function and avoiding pain flare-ups. Generally, the use of heat before an activity or exercise can promote muscle relaxation and enhance flexibility. Using cold upon completion of a task can provide an analgesic, anti-inflammatory effect. Of course, the patient's individual needs and preferences should be considered when determining the most effective modality routine.

Exercise

The American College of Rheumatology includes exercise as a mainstay of treatment for knee OA in its published guidelines. Research has shown that muscle strength declines in both affected and unaffected joints in the presence of OA (Minor 1994). Aerobic exercise, in addition to improving aerobic fitness, decreases inflammation, joint pain, and erythrocyte sedimentation rate in RA patients (Hicks 2000). The goal of exercise for OA patients is to increase the stability of a joint by increasing flexibility, muscular strength and endurance, and overall cardiovascular fitness for maximal function and reduced disability. This should be done by adhering to exercises that will minimize joint compression forces, teaching the individual to use proper posture and mechanics during exercises and functional activities, and setting goals that are functional and measurable.

Exercise for individuals with RA differs from the typical chronic pain patient in that the therapist must alter activity and exercise in response to unpredictable exacerbations. The therapist should look for objective findings to substantiate whether complaints of pain indicate a true flare-up, which would alter activity, or are due to muscle soreness or other reasons that may be emotionally induced. The goal of therapy for an RA patient is to prevent, restore, or maintain function, based on whether involvement is acute, subacute, or chronic. The type, intensity, and duration of exercise for the RA patient may vary, depending on disease activity. Ligamentous laxity, joint effusion, and degree of joint destruction also affect the choice of exercise (Hicks 2000). An individual with minimal findings in these areas would not be restricted in types of exercise, whereas someone with significant laxity and effusion would have to address the effusion first, then start isometric exercise and ROM.

Because OA and RA usually occur in more than one joint, and the level of pain and disability may or may not be supported by radiographic findings, it is necessary to evaluate the possible existence of OA in other joints, despite lack of symptomatology. This is important because stabilizing exercises in one joint may exacerbate a problem in another. For example, a person holding dumbbells during partial squats for a knee-strengthening exercise may exacerbate previously asymptomatic arthritis in the hand, such as in the CMC, DIP, or PIP joints. Exercises may be altered to allow the individual to do the exercise with minimal stress on involved joints. The patient with arthritic hands could use a splint, wrist strap, or built-up hand grip to minimize tight gripping while maintaining the weight needed to properly challenge other muscles when using hand weights or hand pulleys. Alternatively, cuff weights could be used. Another example is a person doing an exercise with an increased thoracic kyphosis and forward head position with increased lower cervical flexion and upper cervical extension. Poor posture will increase the joint compressive forces in the vertebrae and may exacerbate arthritic symptoms there.

High load strengthening exercises often produce increased symptoms in the arthritic joint. Low load resistance used to improve muscle endurance and contraction velocity are better tolerated (Lockard 2000). In addition, Fisher et al. found that an exercise program focusing on contraction velocity and muscle endurance accounted for 75% of the subjects' functional improvement (Fisher 1991).

Attaining full ROM should not be a goal of exercise. Many individuals with OA and RA present with limited ROM. Articular cartilage is dependent on regular loading and unloading forces for its nutrition and waste removal because it is aneural and avascular, so regular, daily motion is necessary. However, because OA and RA can cause articular cartilage damage at specific areas of the joint, continual movement involving these areas could exacerbate the problem. ROM goals should be based on what is functionally necessary for that individual, rather than optimal range. For example, an individual with post-traumatic shoulder OA may present with 110 degrees of shoulder flexion. Functionally, the patient has difficulty washing and combing his hair, as well as pulling a sweater on overhead. The 180 degrees of normal ROM would be a difficult and unreasonable goal to attain, especially because 125 degrees is what is required for most functional tasks. It would be prudent for the therapist to instead focus on reaching the patient's functional goals instead of normal range.

Objective measurements for functional activities that have been used in studies and could easily be used in the clinic at evaluation and discharge include distance walked in 6 minutes, timed stair climb and descent, a timed task (e.g., lifting and carrying a 10-lb weight), and a timed task of getting in and out of a simulated car. If the equipment is available, maximal or estimated maximal oxygen consumption ($\dot{V}O_2$) could be measured. Measures that can be used for health status specific to OA include the Western Ontario and McMaster Universities Osteoarthritis Index score (Bellamy 1995). This consists of 24 questions corresponding to a visual analog scale and has been shown to be reliable and valid as an outcome measure for patients with hip and knee OA (Bellamy 1988).

The Fitness Arthritis and Seniors Trial (FAST) study demonstrated an improvement in self-reported disability, pain, and performance measure among exercise and aerobic exercise group participants, regardless of age, gender, race, and degree of obesity (Ettinger 1997). This study also showed no worsening of the disease with moderate activity. Compliance among the exercise groups declined to 50% at 18 months. Another study showed improvements in self-perceptions of pain and function and improved walking distance in 6 minutes after eight sessions of manual physical therapy and exercise (Deyle 2000). (Manual therapy was described as passive physiologic and joint accessory movements, stretching, and soft tissue mobilization. It should be noted that passive therapy is not beneficial for chronic pain patients for reasons described in Chapter 7.) Improved performance in the 6-minute walk test was maintained after 1 year; however, the Western Ontario and McMaster Universities Osteoarthritis Index scores decreased, although they remained higher than baseline. Also, by 1 year, patients in the placebo group had more surgeries and steroid injections compared with the exercise group. This study did not isolate the effects of manual therapy alone, so it is not known how much the manual aspect of this study actually affected the results. Overall, there is only a small number of good studies, with most focusing on OA and exercise of the knee. All studies include a component of strengthening, stretching, and aerobic exercise.

McCain (1986) evaluated aerobic fitness in a group of women with FM and found that 84% of this group was below average in physical fitness, based on their maximum oxygen uptake. He concluded that FM patients are commonly aerobically unfit and that deconditioning may be of relevance to some of the symptomatology. McCain (1988) and McCain et al. (1988) found that aerobic exercise was effective in reducing perceived pain and improving psychological profiles.

Range of Motion Dance

An alternative form of exercise is the Range of Motion Dance, designed by Harlow and Yu (1984). This is a progression of slow flowing movements that involves joint motion in all ranges. The exercise sequence is based on t'ai chi ch'aun, and it incorporates music with a scripted visual imagery sequence. Although it can be used with any patient population, it was designed with arthritis patients

Table 13.1. Splints for Specific Joints

Joint	**Type of Splint**
Wrist involvement	Volar resting splint (see Figure 13.1)
Wrist and MCP involvement	Full resting hand splint
MCP joint deformity	MP extension radial deviation splint
PIP or DIP joint deformity	Finger gutter splint or ring splints
CMC joint involvement	Long or short opponens splint (see Figure 13.2)

CMC = carpometacarpal; DIP = distal interphalangeal; MCP = metacarpophalangeal; MP = metaphalangeal; PIP = proximal interphalangeal.

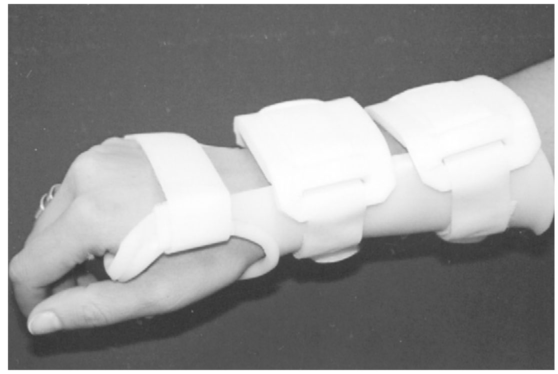

Figure 13.1. Volar resting splint.

in mind. Studies have shown that compliance with home exercise programs tends to be low with this patient population (Carpenter and Davis 1976, Parker and Bender 1957). By combining relaxation and movement, the Range of Motion Dance attempts to increase the frequency and enjoyment of exercise, enhance a patient's ability to cope with stress and pain, and promote improved body awareness and a sense of well-being (Van Deusen and Harlow 1997).

Preliminary studies by Harlow and Yu (1984) show that participants trained in the Range of Motion Dance increased exercise involvement to 85% immediately after treatment, dropping down to 64% after 1 year. In a study by Van Deusen and Harlow (1987), significantly greater upper-extremity ROM was noted in subjects practicing the Range of Motion Dance, as compared to a control group 4 months after completing treatment. This exercise program can be very effective. It is only 7 minutes long, facilitates a relaxation response, and involves active ROM for the major joints in the body. Some patients, however, may find it confusing to try to match particular movements with the lines in the prose and prefer more traditional programs.

Splinting

In the conservative management of OA and RA, therapists may provide splints or orthoses to decrease inflammation, manage pain, provide support to weakened joints, and improve function by maintaining proper joint alignment (Falconer 1991, Fess and Philips 1987).

Splints can be static or dynamic, depending on the goals of treatment. A static splint, such as the resting pan splint, immobilizes the wrist, metacarpophalangeal, and PIP and DIP joints. This type of resting splint is often recommended during periods of acute exacerbation, characterized by inflammation and pain (Fess and Philips 1987). Functional splinting is another type of static splinting that immobilizes one joint but allows for functional movement of the surrounding joints. The cock-up wrist splint is described as a static functional splint, as it immobilizes the painful wrist but allows for motion at the metacarpophalangeal and interphalangeal joints. Dynamic splints may also be used in the management of arthritic hands. This type of splinting facilitates movement and increases a person's function, while supporting and aligning the involved joints.

Materials used in splint fabrication are an important consideration in the management of arthritic joints. Generally, the choice of splinting materials used and the splint design are influenced by the patient's involved joints and particular needs (Table 13.1). The therapist has the option to fabricate a custom-made splint for the patient (commonly using low-temperature thermoplastics) or to provide the patient with a commercially prefabricated model.

Pain management is a major goal of arthritis treatment and an important outcome measure. The following studies suggest that splinting plays an important role in the management of arthritic pain. Callinan and Mathiowetz (1996) compared soft versus hard resting hand splints on pain and evalu-

Figure 13.2. Short opponens splint.

ated splint preference as it relates to compliance with splint wear. Both the hard (custom-made splint) and soft (commercially prefabricated splint) were effective in the relief of pain in RA; however, compliance with splint wear was significantly better with the soft, prefabricated splint. In a study by Stern et al. (1997) comparing three commercial wrist extensor orthoses, 73% of the patients reported a reduction in wrist pain. Satisfaction with a particular orthosis was based on comfort and fit and linked to a sense of joint protection during stressful tasks. Nordenskiold (1997) investigated the relationship between elastic wrist orthoses and perceived pain when used in specific ADLs. Patients using the wrist orthosis while setting a table, lifting a milk carton and filling a glass of milk, and vacuuming for 3 minutes reported a significant decrease in perceived pain compared with perceived pain when these tasks were performed without the orthosis. In addition to pain relief, the orthosis significantly improved grip force. Kjeken et al. (1995) demonstrated a similar reduction of pain when using an elastic wrist orthosis while engaged in daily tasks.

Assistive Devices

The terms *assistive device*, *assistive technology*, and *adapted equipment* are used synonymously and defined as "any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (Mann et al. 1995, 811). Patients with rheumatic diseases use such devices to compensate for impairments in ROM, strength, endurance, mobility, and manual dexterity. The use of devices in the areas of self-care, home management, mobility, work, and recreation and leisure is recommended to facilitate the ease with which an activity is performed (Table 13.2). Assistive devices are often recommended by health care providers to reduce joint stress, conserve energy, and provide stability. It is critical that the therapist evaluates the patient's use of the particular device to assess its functional benefit and its biomechanical impact on the surrounding, unaffected joints. In a study by Nordenskiold (1997), it was shown that significant pain relief was achieved when certain ADL tasks were performed with adapted equipment rather than standard tools. Perceived difficulty in ADL tasks was reduced in 42% of situations with the use of assistive devices or altered

Table 13.2. Common Assistive Devices Recommended for Patients with Rheumatic Conditions

Area of Functional Limitation	Available Assistive Devices
Dressing	Reachers, dressing sticks, long-handled shoe horn, sock/stocking aide, button hook, zipper pull
Grooming	Enlarged or extended handles on toothbrush, comb, razor, floss holder; mounted nail clipping device
Eating/meal preparation	Adapted utensils (enlarged or extended handles, rocker knife, utensil cuffs), two-handled mug, lightweight cookware, electric can/jar openers
Home management	Utility carts, adjustable height ironing board, long-handled duster/dust pan
Mobility	Large-handled cane, walker, forearm crutch
Work	Enlarged handle grips for pens/pencils, telephone headset, book/document holder, extended key holder
Recreation/leisure	Adaptive large-handled sports equipment

working methods. Assistive devices were most frequently used for self-care and kitchen activities.

COGNITIVE-BEHAVIORAL TREATMENT

Cognitive-behavioral treatment helps patients with arthritis understand the effects that their thoughts, beliefs, and behaviors have on pain. It emphasizes the need to take an active role in controlling pain through patient education on specific techniques, such as energy conservation, pacing, body mechanics, joint protection, relaxation training, assertive behavior, and flare-up management. Keefe and Caldwell (1997) and Parker et al. (1993) provide critical reviews of current research on cognitive-behavioral approaches to arthritis pain. In general, it is agreed that there is significant improvement after cognitive-behavioral treatment interventions. However, the areas of improvement (i.e., pain, emotional status, function, disease activity) and the ability to maintain gains remain controversial and require further research.

Energy Conservation and Pacing

Education regarding activity pacing and energy conservation is an important component of the cognitive-behavioral treatment approach to the management of arthritis pain. Patients may adopt differing approaches to managing their pain. Some patients may limit or completely avoid activity secondary to pain, whereas others tend to overdo activity until their pain level has escalated, and they are forced to rest or take pain medications. The goal in rehabilitation and pain management programs is to help the patient learn how to safely increase his or her activity tolerance and find the optimal balance between activity and rest. This goal is accomplished by activity-rest cycling and following a preplanned schedule (Keefe et al. 1996).

Pacing involves setting a limit on activity and planning for limited rest periods. Energy conservation techniques are learned habits that allow for the greatest amount of work to be done with the least amount of effort required. This is accomplished by prioritizing daily and weekly activities, planning ahead, and simplifying tasks as appropriate and assuring optimal positioning for task completion.

Case Example

The patient is a 39-year-old woman with RA who has expressed frustration over her inability to complete her home management tasks without significant increases in her pain level. The patient's primary goal was to be able to prepare an entire meal with adequate pain control. To evaluate the task, the therapist asks the patient to determine how much time she can spend preparing a meal before she experiences a noticeable pain increase. During the meal preparation task, the patient reports an increase in her hand pain after 15 minutes of activity. She informs the therapist that, at home, she would "push through" the task to complete it and then deal with the pain later. As part of the treatment plan, the therapist educates the patient in the areas of energy conservation and pacing. The patient is instructed to take a 5-minute break from the task at the point when she begins to experience an increase in her pain and engage in relaxation exercises or light stretches to prevent a flare-up in her symptoms. Setting a timer was recommended to alert the patient of the need for a break. Alternating activity and rest in this manner allows the patient to be productive without increasing her pain. The therapist works with the patient to develop a schedule that allows her to increase her activity time and to gradually reduce the length of her breaks. This enables the patient to accomplish her goal with minimal increases in her pain.

Joint Protection and Body Mechanics

Many authors agree that patient education about the disease process and the need for joint protection is essential for successful outcomes (Swanson and de Groot Swanson 1985, Tiger 1986, Culver and Fleegler 1987, Poole and Pellegrini 2000). Joint protection principles are ways to perform tasks that reduce the loading on articular cartilage and subchondral bone (Estes et al. 2000, Strickland et al. 1990, Cordery and Rocchi 1998, McCloy 1982). These principles include

Distributing the load over the largest possible area (Figures 13.3 and 13.4)

Figure 13.3. Distributing load—incorrect. By attempting to lift this bottle with one hand, using her fingers primarily, this person puts excessive strain on all of her joints.

Figure 13.4. Distributing load—correct. The weight is evenly distributed across both hands.

Using assistive devices or orthoses as needed (see Tables 13.1 and 13.2)
Avoiding positions that promote deformity, such as ulnar deviation of the fingers and lateral pinch of the thumb (Figures 13.5 and 13.6)
Balancing activity and rest, avoiding prolonged positions (refer to Energy Conservation and Pacing)
Maintaining ROM and muscle strength (refer to Exercise)
Asking for assistance when needed
Using safe body mechanics

Proper *body mechanics* involves using the body in the most energy-efficient manner to avoid excessive loading on the joints (Cordery and Rocchi 1998, McCloy 1982). Some of the primary principles of body mechanics are

Maintaining the natural curves of the spine
Using the body symmetrically, keeping weight evenly distributed
Using the largest muscle groups to perform the work
Maintaining a good base of support
Avoiding twisting or sudden movements
Using equipment as needed
Keeping objects close to the body
Bending from the knees and hips, not from the spine

Teaching these principles is most effective when the clinician performs a thorough activity analysis and has the client discuss and practice the specific tasks he or she needs to perform (Poole and Pellegrini 2000). Each task needs to be adapted based on the capabilities and limitations of the individual. According to the principles of good body mechanics, one should bend from the knees and squat to retrieve low items; however, the knees are frequently affected in arthritis sufferers. Thirty-three percent of persons from ages 63 to 94 years old are affected by OA of the knee (Felson et al. 1987). Alternative strategies that protect both the

Figure 13.5. Distributing load—incorrect. This person supports the weight of the load with her digits, causing them to ulnarly deviate.

Figure 13.6. Distributing load—correct. This person uses the palmar surfaces of her hands and avoids placing excessive strain on her finger joints.

knees and the spine include the *golfer's lift* (Figure 13.7) or performing the task from a seated position (Figure 13.8). The use of body mechanics and joint protection strategies allows patients to participate in previously painful daily activities without exacerbating symptoms.

Relaxation Training and Biofeedback

The goal of *relaxation training* is to induce a relaxation response. A *relaxation response* is a physiologic response, which brings about a reduction in sympathetic nervous system activity. This results in decreased heart rate, blood pressure, respiratory rate, muscle tension, and oxygen consumption (Benson 1975). Multiple studies have demonstrated the benefit of relaxation training for patients with chronic pain (Kabat-Zinn 1982 and 1985, Caudill et al. 1991, Gaghan 1991). Specific studies have demonstrated its effectiveness as part of a cognitive-behavioral treatment program for RA (Bradley et al. 1987, Applebaum et al. 1988, Young 1992), OA (Keefe et al. 1990, 1997), and FM (Burckhardt et al. 1994, Kaplan et al. 1993).

One can achieve a relaxation response using a variety of techniques, including, but not limited to, diaphragmatic breathing, visual imagery, progressive muscle relaxation (tense and relax), mindfulness meditation, and autogenics. It is extremely important that the clinician works with the patient to choose appropriate relaxation exercises. Personal preferences and physiologic needs must be taken into account. For instance, the use of autogenics—which involves the repetition of phrases, such as "my arms are warm, heavy, relaxed" (Dossey 1988) to facilitate increased peripheral blood flow—would not be an appropriate choice for patients with peripheral edema. Equally, progressive muscle relaxation, which involves maximally contracting a muscle and releasing it, may have limited benefit for patients who demonstrate decreased muscular recovery time. This is often the

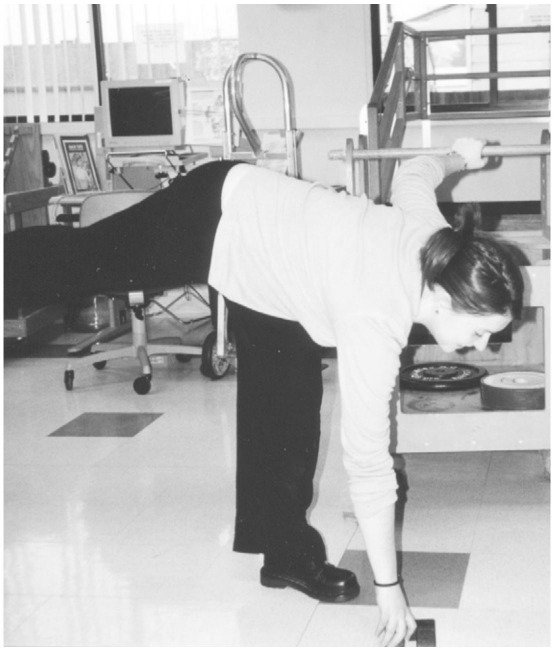

Figure 13.7. Golfer's lift. This person maintains her normal spinal curves while minimizing stress on knees, neck, and back.

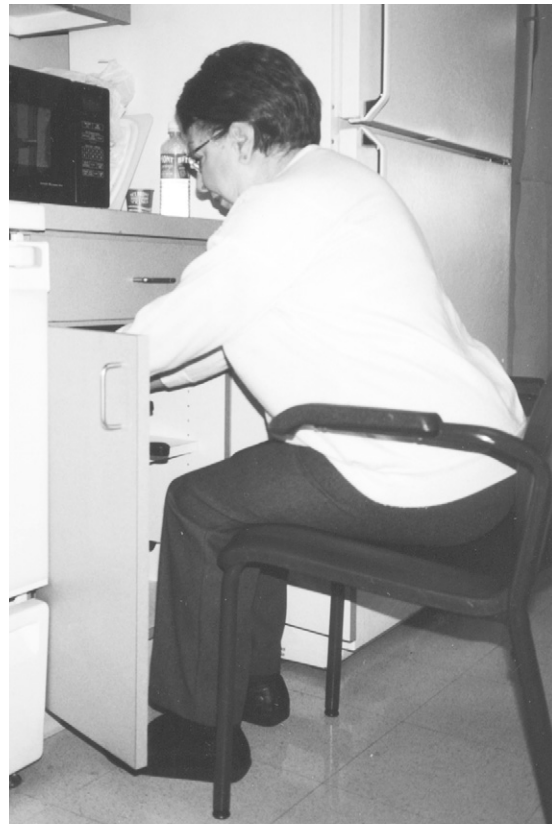

Figure 13.8. Performing task from seated position. By performing this task from a seated position, this person protects her knees and back while minimizing strain throughout her body.

case for people with FM. Relaxation strategies are not only helpful in the moment, but Keefe et al. (1997) have shown that the daily use of pain-reduction efforts and relaxation strategies also can contribute to *next day* pain relief and an enhancement of positive mood.

Biofeedback can be used as an adjunct to relaxation training and for neuromuscular re-education. Biofeedback provides the user with information about physiologic responses that he or she may not be aware of, such as excessive muscle tension and guarding, or vascular responses to pain. Studies have demonstrated that cognitive-behavioral therapy, incorporating relaxation training and biofeedback, reduces pain, pain behavior, and depression while improving daily function, ROM, and coping skills in patients with arthritis (Applebaum et al. 1988, Parker et al. 1985). Young et al. (1995) demonstrated a significant reduction in health care use for RA patients who had biofeedback training as part of a cognitive-behavioral program 18 months post treatment. Biofeedback is an extremely useful tool, because it visually demonstrates to the client that he or she is attaining a relaxation response or using his or her muscles in an appropriate pattern. The ultimate goal of biofeedback training is that once the user gains this increased awareness, he or she will be able to learn to independently replicate the response without using the biofeedback equipment.

Basmajjian and Deluca (1985) write, "Surface electromyography [sEMG] is the study of muscle function via the electrical signal the muscle emanates." Abnormal co-contraction of muscles can put excessive strain on the joints. Through the use of sEMG, patients can relearn movement patterns, decreasing the amount of strain on muscles and joints (Case Example 1). In doing so, people gain an increased sense of control over their bodies and their pain. sEMG training may be misleading for people with FM, however. Trigger points, which are the hallmark for the diagnosis of FM, tend to register artificially low at rest and contract at a higher level of activation than the contralateral muscle without a trigger point (Donaldson et al. 1994). Cram et al. (1998) believe that it may be impossible to retrain a movement pattern using sEMG without eliminating the trigger points first. With this population, thermal or galvanic skin response biofeedback may be a more appropriate choice. These techniques involve monitoring autonomic nervous system activity to train the patient to reduce overall physiologic arousal by either increasing peripheral blood flow, and thus hand temperature (thermal), or decreasing perspiration rate (galvanic skin response).

Assertiveness Training

Assertive behavior involves expressing oneself in a way that is direct and respects the feelings and opinions of others. Assertiveness training helps people with arthritis set appropriate boundaries, say no when they need to, and ask for assistance as appropriate. This allows them to conserve energy as needed to manage pain and fatigue. Additionally, people are trained to express feelings rather than internalize them. Passive behavior can lead to increased stress, resulting in increased muscle tension and subsequent aggravation of inflamed joints (Clark 1983). Silverman (1971) recalls one of his patients who reported dramatic reduction in his arthritis pain when he expressed his anger directly. Through assertive behavior, people learn to attend to their needs. This can help to reduce pain and nonverbal pain behaviors, such as guarding and grimacing, which can actually exacerbate pain (Keefe et al. 1996).

Case Example

Patient is a 46-year-old woman with FM. She is married and has two teenaged daughters. All housework and meal preparation activities significantly increase her pain; however, maintaining a neat home is extremely important to her. She drives her daughters to a variety of after-school activities, assists her husband with maintaining his office, and volunteers for her local church. On beginning the Functional Restoration Program, she became extremely distressed that she could not fit everything in and that her pain was flaring up. In communication skills group, she role played, asking her children if they could car pool to some events and explaining to her church group that she would need to cut back on her volunteer hours while she was in the program. She also formulated a list of chores with which the rest of the family could help. She was concerned that everyone would be angry with her for not being able to do what she used to. To her surprise, everyone agreed to her requests and actually seemed glad that there was something they could do to help. Her family did need frequent reminders to do the chores, however. In group, she practiced reminding them assertively and got support regarding not just doing the chores herself when she felt frustrated. With these changes in place, she reported not only feeling less overwhelmed, but also that her pain level reduced.

Family Education

The biopsychosocial model of pain stresses the importance of addressing biological, cognitive-behavioral, and environmental variables (Fordyce 1995). Pain does not only affect the individual, but also his or her family, friends, and loved ones. The responses of family and friends to pain and dysfunction can further exacerbate the problem. For instance, an overly helpful partner may inadvertently be facilitating increased dependence, decreased feelings of self-worth, and decreased physical tolerances. Radojevic et al. (1992) demonstrated that RA patients who participated in a cognitive-behavioral program with family support had the greatest reduction in swelling. Keefe et al. (1996) demonstrated that OA patients who participated in spouse-assisted cognitive-behavioral training had the best results in six out of seven outcome measures. Ongoing family education is an integral part of treatment to help maintain gains after discharge, reinforce skills learned, and decrease maladaptive patterns that may be exacerbating pain and dysfunction.

Flare-Up Management

Data from follow-up studies indicate that although some patients are able to maintain treatment gains, many are not (Keefe and Van Horn 1993). Pain and disease activity exacerbations, or *flare-ups*, are an inevitable part of arthritis management. For patients to be successful dealing with these difficult times, it is necessary to address flare-up and relapse management early and consistently throughout treatment. Some strategies based on Marlatt and Gordon's (1985) relapse prevention model include the following: (1) Help patients identify some potential antecedents to flare-ups (i.e., overdoing, underdoing, weather changes, stress, illness); (2) identify early warning signs of relapse, such as skipping exercise because of too much pain, planning too many activities for one day, and discontinuing relaxation training exercises; (3) develop a written flare-up plan that has reminders not to panic, schedules for pain control modality use and relaxation exercises, specific diversional activities to pursue, and a clear plan of how to modify the home exercise program; (4) develop a written relapse plan, including people to contact and tools to resume using. *Behavioral rehearsal*, which involves the therapist's modeling coping skills, allowing the patient to practice them, and providing feedback, has been found to be one of the most effective ways to increase self-efficacy in coping with setbacks and symptom flares (Keefe et al. 1987). Helping patients gain the skills and confidence in managing flare-ups can minimize the negative cognitions and behaviors that can result from pain exacerbations and help prevent relapse.

CASE EXAMPLES

Case Example 1

Patient is a 68-year-old married woman with OA of her shoulders and knees, type II diabetes mellitus, peripheral neuropathy, angina, hypothyroidism, left shoulder bursitis, and an old shoulder fracture. She was referred for treatment to address pain and increased falls. She is retired and lives with her husband, who is very caring and supportive, but also overly helpful. Patient was tearful during the initial evaluation.

Status on admission:

Pain Located in both shoulders (right more so than left), neck, and both knees. On admission, patient reported her pain as 6 out of 10 currently, 3 out of 10 at best, and 8 out of 10 at worst. She describes it as a constant aching, hot and burning at times, and said that it gets worse as the day progresses. Pain aggravators are upper extremity activity, standing, walking, and being fatigued. Pain alleviators are Excedrin PM and "trying to ignore it."

Function Patient has increased pain while bathing, dressing, and toileting. Her husband is performing all of the housework and cooking. She has stopped all of her avocational activities, which include shopping, going to restaurants, and visiting friends. The only time she leaves the house is for medical appointments.

Physical examination Remarkable for increased thoracic kyphosis, decreased active ROM in both shoulders. Flexion is 0–110, abduction 0–90, internal rotation 0–60, and external rotation 0–80. Manual muscle testing was 4/5 for upper and lower extremities throughout, except for 3/5 with right shoulder flexion, abduction, and ankle dorsiflexion. Sensation intact. Patella and Achilles reflexes absent. Standing balance poor.

Aerobic fitness Poor for age group. Patient tolerates less than 5 minutes' ambulation.

Pain behaviors Guarding, moaning, verbal somatic focus.

Patient goals Take care of the house; stand and walk without falling.

Assessment Patient presents with postural dysfunction, excessive muscle guarding and tension, balance dysfunction, decreased upper- and lower-extremity strength and ROM, decreased independence in ADLs, decreased activity tolerance, decreased pain coping skills, and decreased safety awareness.

Plan Patient to receive occupational and physical therapy twice a week for 8 weeks and see the physiatrist for trigger point injections and medication management.

Treatment contract goals Independence in the following tasks with good safety awareness and without increased pain: dressing, bathing, car and tub transfers, dishes, vacuuming, and cooking. Be able to go to restaurants and the mall. Eliminate falls. Have supervised community mobility with walker. Ambulate 20 minutes or more. Independently use pain control strategies. Independent home program. Increase upper-extremity active ROM by 15 degrees.

Treatment

Thermal modalities Patient was instructed in the use of ice massage for her shoulders and knees and heat for her neck. She reported dramatic relief using the ice massage and integrated it into her daily routine three times a day. She found that if she used ice before and after tasks, such as vacuuming or cooking, she was able to complete the task without increased pain.

Exercise Patient was given a written quota-based exercise program that included self-ranging, theraband, and isometric strengthening exercises. A walking program was initiated with a three-wheeled walker, beginning at 5 minutes per day and progressing until she reached her goal of 30 minutes per day at discharge.

Muscle tension reduction training and biofeedback Patient was given a custom-made visual imagery tape to practice twice a day. This technique was chosen over autogenics or body scanning techniques secondary to her somatic focus and complaints of hot, burning pain. sEMG on her upper and lower trapezius muscles was used for neuromuscular re-education to decrease excessive activation of her upper trapezius muscles during upper-extremity tasks.

Body mechanics Patient was instructed in safe body mechanics for ADLs.

Adaptive equipment Although initially resistant, she agreed to purchase a tub chair and a three-wheeled rolling walker. With the new walker she was able to walk safely in the community. Her falls resolved. The built-in walker seat enabled her to pace herself and take rest breaks during tasks requiring increased ambulation (i.e., shopping).

Pacing and energy conservation During treatment sessions, she performed household tasks and exercises, taking frequent minibreaks and using diaphragmatic breathing. A written daily schedule helped her incorporate rest periods, exercise, social and household activity, and pain control modalities.

Family education As the patient became progressively more independent, the therapists noticed that her husband continued to do a large amount of the cooking and cleaning, although she stated that she wanted to do it herself. She confided to the therapists that she was letting him do it because she was concerned that he would no longer feel needed. Although he saw how capable his wife had become during treatment sessions, he continued to express concerns for her safety. Together, the patient, her spouse, and the therapist devised a chart listing the chores she should do independently and the ones that her husband should continue to perform. Additionally, it was recommended that the two of them attend couples counseling.

Status at discharge Pain level decreased to 0 out of 10 at best, 3 out of 10 on average, and 5 out of 10 at worst. All contract goals were achieved. She was independent in all self-care and light homemaking activities. She was able to go to the mall and restaurants and ambulate for 30 minutes without falls. She achieved independence in the use of pain control strategies and a home exercise program. Patient and her spouse declined Social Service intervention at this time.

Case Example 2

The patient is a 26-year-old man complaining of fatigue, nausea, dizziness, and headaches. He sustained a whiplash injury from a motor vehicle accident 6 years ago. The patient was wearing a seatbelt and did not lose consciousness. He reported having some soreness immediately and said that he was taken to a local emergency room. X-rays were negative for fracture or dislocation of cervical spine. He was sent home with muscle relaxants and was told to follow up with his primary care physician. He reported a gradually increasing frequency and severity of headaches with nausea and dizziness over the next 6 months that required him to drop out of college and return to live with his mother. Medical management of his headaches included muscle relaxants and narcotics.

The patient began to complain of increasing fatigue, loss of concentration, and diffuse soreness approximately 4 years ago. Tests for Epstein-Barr, Lyme disease, hepatitis, or other infectious disease were negative. The patient was eventually diagnosed with FM with chronic fatigue and headaches.

Pain Patient rates current pain as 7 on a 10-point scale. He rates it 5 at best and 10 at worst. Pain is described as a diffuse, deep, throbbing ache of the shoulders, back, hips, and knees. His fatigue was described as *numbing* and *wearing*. His headache is sharp, stabbing pain over both temples and the back of the head. The pain follows no temporal pattern. Increased headache severity is accompanied by nausea and dizziness. The headaches occur one to two times per week for 2–12 hours. His muscle ache is constant, with significant flare-up accompanied by fatigue.

Pain worsens with activity, damp weather, and trying to read or concentrate. It is relieved by rest and medication.

Function The patient has not worked or studied in the past 5.5 years. On "good" days, he is in bed for 12–15 hours; on "bad" days, he is in bed all day. He gets out of the house only for medical appointments and depends on his mother for transportation, meals, and laundry. He is able to sit for 30 minutes, stand for 5 minutes, and walk one block with shortness of breath.

Physical examination The patient displays forward head posture with significant increased thoracic kyphosis, with loss of all other spinal curves and the left shoulder girdle elevated. He has pain on palpation of suboccipital muscles, upper and middle trapezius regions, shoulders, chest wall, paraspinals, and bilateral piriformis at the sciatic notch. He has decreased muscle tone and atrophy of the shoulder girdle and paraspinals and tightness of the pectoralis and latissimus dorsi. Cervical spine ROM is limited to 50% with pain.

Aerobic fitness The patient's aerobic capacity is poor for his age group.

Pain behaviors The patient exhibits marked verbal and nonverbal pain behaviors, with rubbing, sighing, moaning, and frequent position changes.

Patient goals To live independently, have no pain, and have more energy.

Assessment The patient has chronic pain syndrome. Impairments include postural abnormality, decreased neck ROM, decreased muscle strength and endurance, and activity intolerance due to perceived pain and deconditioning.

Plan Physical therapy sessions will be conducted twice a week for 10 weeks, focusing on a self-management and graded functional restoration approach that incorporates education, exercise, and pain control.

Treatment contract goals The patient will be able to tolerate being up and somewhat active for 8 hours a day. He will learn independent use of pain control modalities and follow a structured, independent, daily home exercise program.

Treatment

1. The patient is taught pain control modalities, including ice massage and self-massage.
2. The patient is given a structured, quota-based exercise program beginning with five repetitions of chin tucks, shoulder squeezes, shoulder shrugs, diagonals, and sitting pelvic tilts. The patient is instructed to increase by one repetition every 3 days until he is able to perform 10 repetitions twice a day.
3. A mirror for cueing is used to improve the patient's posture.
4. Patient's limited cervical ROM is improved with diagonals, head and neck movements, and contraction and relaxation techniques in the supine position.
5. Strengthening exercises are added in the fourth week, including a rubber band exercise program for upper quadrant musculature.
6. Flexibility is addressed in the home exercise program. Stretches for pectoralis, upper trapezius, and levator scapulae are added.
7. Aerobic fitness is increased with an ergometer and treadmill program.

After three sessions, patient experiences a significant pain flare-up and cancels appointments for several weeks. The patient returns to therapy, and the program is reinstated. Patient's progress is slow owing to multiple complaints and extreme somatic focus. He requires frequent redirection within and between sessions. After 6 weeks of therapy, the patient remains somatically focused but shows some improvement in pain and independent program compliance. He makes a transition to conditioning and stretching groups for his last 4 weeks of therapy. At the end of treatment, all goals are met, with the exception of tolerating 8 hours of active time per day. He remains inconsistent with this owing to his excessive somatic focus. It is recommended that the patient seek behavioral medicine treatment for his excessive somatic focus.

Case Example 3

The patient is a 48-year-old woman with a complaint of pain all over her body. She fell in the parking lot of her workplace 3 years ago and injured her back. X-rays and magnetic resonance imaging were negative at the time of injury. She reports that the pain "spread" to her entire body in the subsequent 2 years and that she was diagnosed with FM last year. She also complains of fatigue and has been diagnosed with irritable bowel and chronic fatigue syndromes. She receives workers' compensation and has secondary litigation pending against the owners of the parking lot.

Pain She rates her average pain as 8 on a 10-point scale. At best, her pain is an 8, and at worst, a 10. Her pain is made unbearable by all activities and decreased only by medication.

Function The patient has not worked since her injury. Until 6 months ago, she was performing some housework and occasional grocery shopping. For the past 6 months, she has been bedridden. Her husband dresses her for appointments with health care providers. She showers every third or fourth day with help from her husband. Her husband performs all the housework, grocery shopping, and meal preparation and works full-time.

Physical examination The patient asks to lie down during the interview owing to her pain. She is transferred with her husband's help from her wheelchair to a table. She stays in a fetal position during her interview. When asked to sit up, she does so with great difficulty. Examination is conducted with patient seated. Posture is remarkable for slumped sitting with forward head, thoracic kyphosis, and forward flexed trunk.

ROM of both shoulders is limited to 80 degrees of flexion and abduction. ROM of the elbows, wrists, ankles, and knees is within functional limits. Neck ROM is 50% in all directions. She reports that all these movements cause pain. Assessment of strength of both lower and upper extremities is not possible owing to patient's complaint of pain with all muscle contractions. Sensation and reflexes were normal.

Aerobic fitness This could not be assessed.

Pain behavior The patient exhibits severe verbal and nonverbal behaviors, including sitting in wheelchair, lying down during interview, lack of cooperation with physical assessment, moaning, sighing, grimacing, and narcotic dependence.

Patient goals To decrease pain and be able to play with her grandchild.

Assessment The patient's impairments include pain and associated symptoms; loss of general strength and endurance; loss of shoulder, neck, and hip ROM; fatigue; and activity intolerance.

Plan The patient will participate in a functional restoration program, behavioral medicine group, and individual treatment, and will develop treatment and medication contracts.

A treatment contract with functional goals is established. After a very lengthy discussion, however, she refuses to sign her medication contract, which is designed to decelerate her narcotics use after the second week of the program. She is asked to reconsider and return in 1 week if she changes her mind. The patient refuses, because she believes she cannot survive without her medication. The team refers her to her primary physician for medication management. Treatment is delayed until this issue is resolved.

RECOMMENDED WEB SITE

For information on arthritis research and support: www.arthritis.org Last accessed on: December 6, 2001.

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Chapter 14

Pain in the Elderly

Anne Marie Barrett

As Americans continue to live longer, health care providers will encounter many older patients with chronic illnesses, such as pain, and the resulting functional decline. Statistics from the Bureau of the U.S. Census and reported by the American Association of Retired Persons found that in 1998, persons 65 years of age and older comprised approximately 13% of the U.S. population, or one in every eight Americans. In 1997, persons reaching the age of 65 years could expect to live, on average, another 17.6 years. The growth of the number of persons 65 years of age and older is projected to be 20% of the population by 2030 (American Association of Retired Persons 1999). How will health care providers meet the pain management needs of this growing population? We must learn about the disorders that challenge an elder's quality of life and develop practical approaches to reduce functional decline (Cassel 2001).

Physical therapists are among those likely to treat elders in pain. Physical therapists encounter elders regularly at home, in the hospital, in the ambulatory clinic, in rehabilitation clinics, and in long-term care settings, such as nursing homes. Whether it is to help an elder to recover from a hip fracture or to improve gait in an elder with polyneuropathy, the physical therapist is well suited to identify and treat the patient in pain. The goal of this chapter is to impart knowledge and thereby create a well-informed health care provider to manage pain in the aging patient.

IDENTIFYING BARRIERS TO PAIN ASSESSMENT AND MANAGEMENT

Pain is a common symptom among the elderly. Twenty-five percent to 50% of community-dwelling seniors have been reported to experience pain (Crook et al. 1984), whereas the figure ranges from 45% to 80% for seniors residing in nursing homes (Ferrell et al. 1990, Roy and Michael 1986).

Multiple factors contribute to these staggering figures, including lack of education in pain assessment and management by health care providers. Other contributors are the beliefs and attitudes of the older person that lead them to under-reporting of pain, along with inadequate services to meet the pain management needs of elders in various health care settings.

Health care providers may lack the knowledge to assess and treat pain (McCaffery and Pasero 1999). This author recalls receiving only a few short lectures on opiate medication administration in her basic nursing curriculum. The development of Acute (Carr 1992) and Cancer Pain Management (Jacox 1994) guidelines by the Agency for Health Care Policy and Research were starting points for dissemination of educational information to aid health care professionals and patients with the assessment and management of pain. The guidelines for managing chronic pain in the elderly developed by the American Geriatric Society in 1998 serve to meet the same needs. Finally, regulating bodies, such as the Joint Commission on Accreditation of Hospitals, required all health care institutions pursuing accreditation to integrate pain assessment and management into their facilities by January 2001. Still, the need to assimilate this information into everyday clinical practice continues as episodes of inadequate pain management continue to be reported.

Physiologic changes, which occur as a process of aging, make pain assessment and management more challenging in the older person. Often, the elder has multiple medical problems that can confound the diagnosis and treatment of pain (Gloth 2000). The prevalence of hearing and visual impairments make the process of conducting a pain assessment somewhat more complicated. When interviewing elders or showing them a pain scale, make sure you are speaking at a level and tone that they can hear, and face them directly. Ensure that they are wearing any required hearing aids or glasses. Medication distribution is altered in the elderly, and when prescribing medications, these factors must be taken into account (Gloth 2000) (see also Chapter 4).

The presence of depression makes assessment and treatment of chronic pain more difficult. An association between pain and depression has been demonstrated, and it has been shown that one may even intensify the effect of the other (Gallagher 2000). For instance, elders with depression were found to report pain intensity and number of pain complaints more often as compared to nondepressed elders (Parmalee 1991). Gloth (2001) reports that depression needs to be managed aggressively, or attempts to manage their pain will be ineffective.

Cognitive impairments, such as dementia and delirium, make assessment of pain more challenging. Little is known on proven techniques for assessing and managing pain in this group. Evidence suggests that pain in this population is under-reported and may be one reason why pain is undertreated in this population (Parmalee 1996).

Attitudes and beliefs of the older person may affect pain assessment. A belief that pain is a normal part of growing old, not wanting to be a bother to family or health care providers, and believing that the health care provider is doing all that he or she can to help the patient's pain may result in the under-reporting of pain. Some elders may believe that if they complain of pain, they are not being a good patient. Some may not take their medicines for fear of becoming addicted to medicine, or they may believe that they should save the strong medicines for later (Mcaffery and Pasero 1999, Gloth 2000).

Although older people are more likely to experience more painful conditions than their younger counterparts, pain is not a normal part of the aging process (McCaffery and Pasero 1999).

The health care setting may prove to be a barrier. For example, nursing homes may have limited access to diagnostic facilities, lack on-site pharmacy services, and have limited routes of administration for pain medications (Stein and Ferrell 1996). Most nursing homes may be staffed with one registered nurse for a facility or unit during the night.

Identification of barriers to the effective management of pain in the elderly will allow the clinician to create practical solutions to overcoming such obstacles of care.

ASSESSMENT OF PAIN

Assessing pain in the older person is best accomplished using a systematic approach and taking into consideration age-specific changes that occur in the elderly client. An initial assessment of pain includes the description, location, onset, duration and frequency, what aggravates the pain and what alleviates the pain, and how it affects sleep and daily function. A major focus in a complete pain assessment should be how pain affects the quality of life. Pain can lead to compromising an elder's ability to complete simple activities of daily living, such as walking and bathing, resulting in functional decline. Once the elder's ability to carry out basic activities of daily living is affected, further disability and dependence can occur (Won 1999).

Start by asking the patient about his or her pain, using terminology familiar to him or her. The older patient may use terms such as *soreness, aching, burning* instead of the word *pain* (American Geriatric Society 1998). Health care providers must recognize and use familiar verbiage that the elder uses to explain his or her pain to identify the presence of pain.

Identify the role the pain may play in impairing the elder's activities of daily living. For example, "Mrs. Smith, are you having any discomfort, soreness, aching? Are you able to take care of yourself? How does this [use her word for pain] affect your daily routine?" See Figure 14.1 (Stein 1996) for a guide to be used when initially assessing pain in the elderly.

Simple questions, such as, "Do you have pain? Where?" become more difficult when assessing pain in the cognitively impaired elder. The perception that the cognitively impaired elder does not perceive pain and cannot report the pain is unsupported (Gloth 2000). Assessment of the cognitively impaired elder requires the use of basic assessment

NAME: ______________________ AGE: ______________________

PRIMARY DIAGNOSES: ______________________

MEDICATIONS & SCHEDULE: ______________________

NONPHARMACOLOGIC PAIN TREATMENTS: ______________________

SUCCESS OF ABOVE: ______________________

PAIN INTENSITY: NOW: 0 1 2 3 4 5

None Mod Severe

WORST IN 24 HOURS:

0 1 2 3 4 5

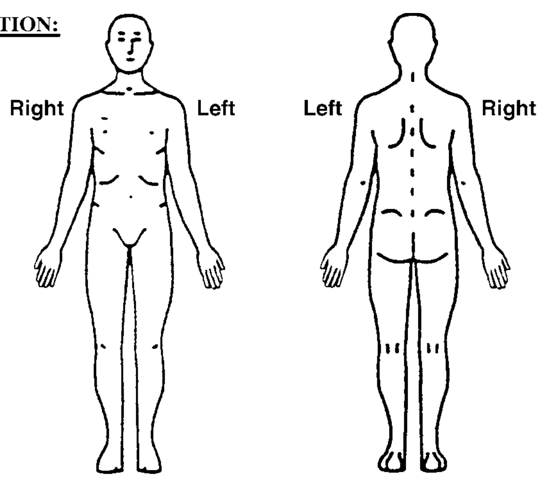
None Mod Severe

PAIN DESCRIPTORS: ______________________

MANEUVERS THAT EXACERBATE: ______________________

MANEUVERS THAT ALLEVIATE: ______________________

PAIN LOCATION:



VISUAL ANALOG SCALE (PLACE AN X ON SCALE TO INDICATE PAIN SEVERITY)

|—————————————————————————|

EFFECTS OF PAIN ON: MOOD: ______________ SLEEP: ______________

ADLs/IADLs: ______________________

MMSE SCORE: ______________ DEPRESSION SCALE SCORE: ______________

GAIT & BALANCE ASSESSMENT: ______________________

Figure 14.1. Sample initial geriatric pain assessment sheet. (ADLs = activities of daily living; IADLs = instrumental activities of daily living; MMSE = Mini-Mental State Examination.) (Reprinted with permission from WM Stein, BA Ferrell. Pain in the nursing home. Clin Geriatr Med 1996;12[3]:601–613.)

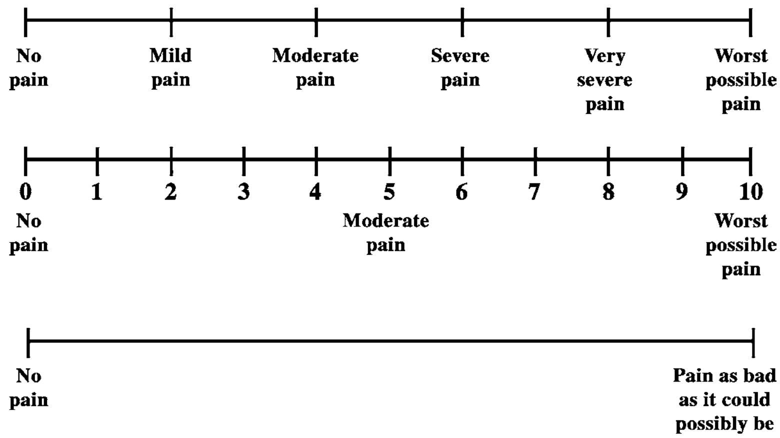


Figure 14.2. Visual analog scales. (From Acute Pain Management Guideline Panel. Acute Pain Management: Operation or Medical Procedures and Trauma. Clinical Practice Guideline. Agency for Health Care Policy and Research pub. no. 92-0032. Rockville, MD: Agency for Health Care Policy and Research, Public Health Service, US Department of Health and Human Services, 1992;116.)

skills, including observation. An older person in pain may suddenly become more agitated, or, alternatively, withdrawn. Identifying a change in behavior should prompt you to look for pain as the source of this change.

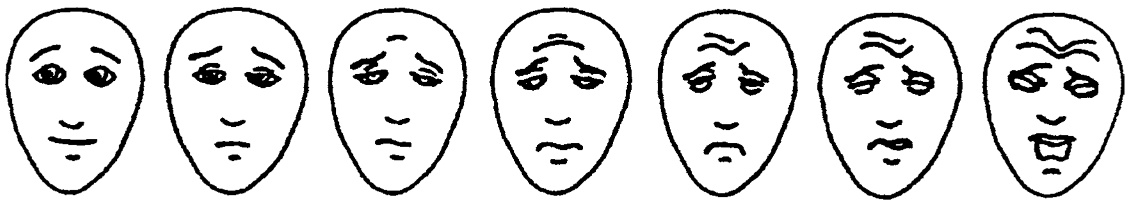
To determine the intensity of the pain, a number of tools are available. The Agency for Health Care Policy and Research guidelines for acute and cancer pain assessment suggested the use of pain intensity tools, such as the visual analog scale, a numeric scale, and a word scale (Figure 14.2).

The faces scales are useful tools to identify pain intensity in the cognitively impaired elder or an individual with language barriers (Figure 14.3).

It is this author's clinical experience that elders prefer the simple word scale as compared to the numeric scale. Appropriate selection of a tool allows the patient to verbalize his or her report of pain. Patient self-report of pain is well known to be the gold standard for rating pain (McCaffery and Pasero 1999). However, if the patient is unable to provide information about his or her pain, the caregiver may be helpful in identifying a specific change in the older person that indicates pain.

The goal of assessment is to direct the provider toward a diagnosis and subsequent treatment options. In certain cases, the diagnosis is beyond the scope of the general health care provider. For patients who may have psychiatric, abuse, or addiction issues, referral to the appropriate psychiatrist or pain and addiction specialist is indicated. For those patients with intractable pain, referral to a pain management clinic should take place. When referring an older patient to a pain facility, it is important to ascertain the services provided at the center. An older person may be best served in a facility that offers multidisciplinary pain management services. Specialists in pain management are often well suited to evaluate and treat these complex patients. Physicians, nurses, psychologists, psychiatrists, pharmacists, and physical therapists each contribute significantly to multidisciplinary pain assessment, as does the patient.

The comprehensive assessment should include a medical history and physical examination with pertinent lab data and diagnostic testing. The medical history should focus on the history of the present pain complaint. Delineation of the onset of pain facilitates identification of the mechanism of injury, which is crucial to planning rational drug and nondrug therapy. Also, the circumstances and context of the initial injury—or exclusion of any such sentinel event at the start of symptoms—have obvious psychosocial implications. For example, a fall resulting in a broken hip requires treatment of the fractured hip but also dictates investigation to determine the etiology of the fall. Did the elder have a dizzy spell? Was the elder pushed? Is the elder dehydrated and hypotensive?



0 1 2 3 4 5 6

Figure 14.3. Faces scale. (Reprinted from D Bieri, RA Reeve, GD Champion. The Faces Pain Scale for the self-assessment of the severity of pain experienced by children: development, initial validation, and preliminary investigation for ratio scale properties. Pain 1990;41[2]:139–150, with permission from Elsevier Science—NL, Sara Burgerhartstraat 25, 1055 KV Amsterdam, The Netherlands.)

The physical examination should focus on the neuromuscular system and the musculoskeletal system, because common pain disorders in the elderly are exhibited in these areas. Osteoarthritis affects more the 80% of individuals older than 65 years of age (Davis 1988, McCaffery and Pasero 1999). Postherpetic neuralgia is noted to occur in 75% of the elderly after an episode of herpes zoster, versus 10–15% in younger persons (Baumel and Eisner 1991, Rowbotham 1994). Other common conditions are compression fractures due to osteoporosis, diabetic neuropathies, temporal arteritis, peripheral vascular disease, and post stroke (Ferrell 1991, McCaffery and Pasero 1999).

Medication history should include current and past medications, including how they are prescribed and ingested, their effectiveness, and side effects. This author has found it helpful to ask the older person to bring in all of his or her prescription medications, over-the-counter medications, and any herbal or natural remedies. This is an excellent opportunity to identify the number of medications being taken, discuss the purpose for the medication, and review for effectiveness and side effects. Doing so may be time consuming, but it is crucial. As previously mentioned, multiple medications and drug-to-drug interactions in the elderly are barriers to pain treatment.

Nowhere are the assessment skills of the physical therapist more essential than in determining the physical function of the older person. Use of scales such as the Katz Activities of Daily Living Scale and Lawton Instrumental Activities of Daily Living Scale can reveal how the pain affects the patient's ability to carry out activities of daily living. Further measures of function can be ascertained by the use of the Up-and-Go Test and the Tinetti Gait and Balance Test (American Geriatric Society 1998).

As an initial assessment tool, pain diaries are helpful in assessing the severity of pain, the use of pain medications to relieve pain, the side effects of medications, and the effects of the pain on activities of daily living. The individual and the caregiver can record entries.

Assessing the psychosocial aspects of pain in the elderly is necessary, because depression and pain go hand in hand. It is sometimes unclear what occurred first, the depression or the pain. Regardless, treatment for both must occur. It is a pervasive myth that a patient is depressed solely because of his pain and that treating the pain will alleviate the depression (Gloth 2001).

With these thoughts in mind, aggressive treatment of the depression must be pursued. A quick screening tool to use when assessing depression is the Short Geriatric Depression Scale (S-GDS) (Brink et al. 1982, Yesaviage 1983, Sheikh and Yesaviage 1986). This scale is a 15-item questionnaire that asks questions with *yes* or *no* responses (Appendix 14.1). Certain responses indicate depression. If the client selects six or more of the depression indicators, further evaluation for depression is suggested. Tools for assessing depression in the cognitively impaired elder include the Hamilton Depression Scale, which is an observer-rated depression scale (Inouye 2000). Another tool is the Beck Depression Scale (Beck 1961), which is frequently used in patients with chronic pain.

This author often encounters elders with pain and depression. It may be helpful to tell the patients that there is hope, that we can offer help to treat and manage the depression and pain, and they don't need to suffer. Offering hope to an older pain patient and partnering in his or her care are two strategies this provider has found for successfully managing pain.

MANAGING THE PAIN

Once a comprehensive assessment has been completed, a treatment plan can be developed specific to the individual's needs. When developing a treatment plan for the older person's pain, diagnosis of the painful condition and type of pain will direct treatment options. The physiologic changes, economic status, functional status, and overall quality of life in the older person must be considered, as well. Treatment options include pharmacologic agents, opioid and nonopioid; adjuvant agents; and nonpharmacologic therapies. The plan should be reassessed frequently during initiation or change of any therapies to ascertain effectiveness of therapy, and identify and treat side effects.

Pharmacologic Options

Pharmacologic intervention in the elderly requires knowledge of the physiologic changes of the aging process to safely prescribe medications. Medications are recommended for the older person whose quality of life is diminished owing to chronic pain (American Geriatric Society 1998). As a person ages, physiologic changes occur that affect the absorption, distribution, metabolism, and elimination of medications. For these reasons, frequent assessment of the intervention is required, and the familiar saying "start low and go slow" should be heeded.

Discussing the goal of care with the patient is paramount to successful interventions. Learning about the individual's expectations for and expected outcome of therapy allows the patient and provider to develop mutual understanding and realistic goals for care. Expecting the pain of a compression fracture to completely diminish may be unrealistic. Ascertaining functional goals, such as being able to walk to the corner store or pick up a grandchild, identifies a clinical end point by which to judge the effectiveness of therapies. That some older persons may be on fixed incomes and cannot afford expensive medications and therapies must be considered when developing the management plan. Pharmacologic management of pain in the elderly is included in Chapter 4. As many medications have side effects, patients need to be educated on these side effects, and strategies for managing them are discussed.

Nonpharmacologic Modalities

Nonpharmacologic modalities can be used alone but are frequently used in conjunction with pharmacologic therapies to manage chronic pain. These modalities are usually inexpensive, noninvasive, and easy to use or learn how to use. For these reasons, they may be particularly useful for managing the older patient in pain. Simple application of heat or cold, transcutaneous electrical nerve stimulation, exercise, and cognitive-behavioral therapies, including distraction, relaxation, and biofeedback, are common modalities. Newer therapies include acupuncture, magnet therapy, and chiropractic care.

The use of heat and cold in managing pain is often overlooked by health care professionals, but it may be the first line of choice for the consumer. An example is the person who burns a hand on a hot pot and runs it under cold water to help reduce the pain. A common sense approach for the use of heat and cold when managing pain is to use whatever feels best.

Heat and cold help manage pain by decreasing sensitivity and reducing muscle spasm (McCaffery and Pasero 1999). Common methods of heat include hot water bottles and dry or moist heat in the form of compresses, heating pads, hydrocollator, and hot tubs. Often, heat is helpful in the treatment of arthritis, scleroderma, muscle spasm, fibromyalgia, joint contracture, tendinitis, bursitis, and superficial thrombophlebitis, and it can be used before exercise to optimize benefits of exercise (Minor and Sanford 1999). Heat should not be used in the obtunded patient, or in those insensitive to it, or over topical application of products containing menthol, owing to potential tissue damage (Nyugen 1996, McCaffery and Pasero 1999).

Cold appears to have an advantage over heat owing to its rapid analgesic effect and its ability to reduce inflammation and swelling when used after an injury or surgery. It has been noted to permeate the subcutaneous fat and last longer than heat for pain relief. Methods to apply cold include cold packs, ice, immersion in cool or ice water, and cooling sprays, such as fluoromethane. Contraindications are cold sensitivity, Raynaud's phenomenon, ischemia, cold allergy, and general insensitivity. Care should be taken when applying heat or cold to prevent tissue trauma resulting in blistering or burns. For guidelines on the selection and application of heat or cold, and patient information, refer to McCaffery and Pasero's *Pain: Clinical Manual*, pages 408–411.

Transcutaneous electrical nerve stimulation is recommended for the treatment of pain in osteoarthritis. It works by the gate-control theory of pain, which provides relief by increasing large fiber stimulation and suppressing small fiber activity (Minor and Sanford 1999). Transcutaneous electrical nerve stimulation has also been shown to provide relief by stimulation of the body's own endogenous chemicals, endorphins and enkephalins. This may explain why pain relief lasts even after the therapy is stopped (Nyugen 1996). Cost may be one barrier to care, so it is necessary check with the elder's insurance provider. Another barrier is ease of use, as elder patients may have difficulty selecting sites, applying the patches, and using the different settings to achieve the most effective pain relief. In these situations, referral to a physical therapist who is well versed in the methodology is warranted.

Exercise is often overlooked as a nonpharmacologic approach to pain management, the reasoning being that elders cannot exercise if they are in pain. But analysis of the literature in relation to the treatment of arthritis found that regular physical activity in the form of exercise did not exacerbate pain or disease. Exercise improves cardiovascular fitness, enhances muscular strength, increases joint mobility, and improves functional capacity. Regular exercise can reduce pain, fatigue, and depression (Minor and Sanford 1999).

A physical therapist is well suited to determine which exercise is indicated and to prescribe the frequency, duration, and intensity of the exercise. The physical therapist will educate and supervise the specific exercises. Patient-focused goal setting to promote positive outcomes should be discussed. Weight-bearing exercise, such as walking and low-impact aerobics, aquatic exercise, and stationary bicycling, may be some exercises used with the older person. Contraindications to exercise include uncontrolled arrhythmias, third-degree heart block, recent electrocardiogram changes, unstable angina, acute myocardial infarction, and acute congestive heart failure. Relative contraindications include cardiomyopathy, valvular heart disease, elevated blood pressure, and uncontrolled metabolic disease (O'Grady et al. 2000). Medical clearance by the primary care provider or cardiologist is recommended before all exercise.

Cognitive-Behavioral Therapies: Distraction, Relaxation, and Biofeedback

Distraction is redirecting the focus away from the pain. Methods used can be as simple as talking, watching television, or listening to music. Many providers believe a patient is not in pain if the patient can be distracted from the pain or does not appear to be in pain. This is untrue. A patient's husband recounted how his wife had 3 weeks of pain relief without use of her pain medications during a vacation to Florida. He reported she did restart her medications the third week, just before preparing to come home. This is a good example of the use of distraction. This patient has significant vertebral disease but was paying decreased attention to her pain owing to her immersion in a new environment. To use distraction, the patient must be amenable to its use, understand instructions, and have the mental capacity to complete physical activities if they are the expected mode of distraction. Benefits to distraction include decreased intensity of pain, increased pain tolerance, improved mood, and a sense of control. One disadvantage is that health care providers may not observe the person in pain and may not provide necessary analgesics. It has been reported that increases in the intensity of pain, fatigue, and irritability can occur at the conclusion of the distraction exercise; therefore, rest and analgesics should be available (McCaffery and Passero 1999).

Relaxation is used to decrease pain and reduce anxiety. It is defined as "a state of relative freedom from both anxiety and skeletal muscle tension" (McCaffery and Pasero 1999, 417). Relaxation methods include deep breathing, imagery, massage, and music. Application of heat and massage were shown to be two methods selected by older patients with chronic cancer pain (Rhiner et al. 1993). Relaxation in the elder may be exhibited in recalling pleasant past life events versus using progressive muscle relaxation techniques or deep breathing. In the cognitively impaired elder, passive nonpharmacologic modalities, such as massage, may be more appropriate (McCaffery and Pasero 1999).

Biofeedback is a method that uses monitoring devices to assess bodily functions. The patient is taught to use various relaxation or distraction techniques to consciously alter his or her bodily functions. Tools used to asses the bodily functions include electromyogram to assess muscle tension, thermal probes to assess temperature, electrodermal activity or changes in perspiration to indicate anxiety, finger pulse measurements to detect heart rate, and breathing rate to assess hyperventilation and relaxation. The National Institutes of Health recommends biofeedback as moderately effective as a complementary therapy for treating chronic pain and insomnia. It is a safe, noninvasive therapy, which would make it a desirable tool in the elderly. However, biofeedback requires a trained and certified professional to assist in the use of and interpretation of the device. Its use in the older person is limited in the cognitively impaired elder and may be limited by the older person's ability to gain access to the device on a regular basis. Expense must be noted and insurance of the older person evaluated for coverage of this type of modality (National Institute of Health Technology 1995).

Acupuncture has come of age in the United States; more than 1 million Americans currently receive acupuncture each year (National Institutes of Health 1997). It has demonstrated efficacy in the treatment of chemotherapy- and postoperative-related nausea and in dental pain. It is frequently used in the management and treatment of many pain disorders. However, its efficacy has not been proven by scientific studies. Benefits include the fact that it is low risk and relatively accessible. Disadvantages include cost, with consultations ranging from $50 to $125 and a routine treatment plan consisting of a series of 10 sessions. Some insurers are covering the cost for such therapies, if performed by a physician. Many acupuncturists are licensed only as acupuncturists and therefore may not be covered under routine insurance. Medicare does not at this writing cover acupuncture services. The prevalence of use among the elderly has not been determined. However, it is an alternative therapy that should be monitored for studies promoting its use in pain management in the elderly.

The recent explosion of alternative medicine and remedies encourages the clinician to identify proven therapies that may aid the elder in pain. Studies are lacking that prove the efficacy of magnet therapy in chronic pain, although one study showed a benefit over placebo in patients with diabetes and post-polio syndrome (Vallbona 1997). The older person might pursue such therapies and spend what little money he or she has on such unproven therapies. Until more evidence-based science is available, the use of magnet therapy is still questionable.

Chiropractic care should be mentioned as a frequently used modality for the treatment of low back pain. Hawk (2000) sought to determine the characteristics of patients aged 55 years and older who pursued this type of care. Two-thirds of patients studied relied solely on a chiropractor to cure their back pain. Older patients are pursuing this therapy, and further studies that monitor the outcome of care in relation to reducing pain should be conducted.

To meet future challenges in managing pain in the elderly, we must continue to educate health professionals on the management of pain in this population, prepare pain specialists with expertise in geriatrics, and pursue studies to identify the most effective therapies in this population.

RECOMMENDED WEB SITES

Guidelines for managing chronic pain in older persons:
http://jama.ama-assn.org/issues/v280n4/fpdf/jmn0722.pdf or www.ascp.com/public/pubs/cc/1999/supp6.shtml or http://www.americangeriatrics.org/products/chronic_pain.pdf Last accessed on: November 30, 2001.

http://www.medinfosource.com/gericongress/123s.html Last accessed on: November 30, 2001.

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Appendix14.1.

Short Geriatric Depression Scale

Choose the best answer for how you have felt over the past week:

1. Are you basically satisfied with your life? Yes **/ No**
2. Have you dropped many of your activities and interests? **Yes /** No
3. Do you feel that your life is empty? **Yes /** No
4. Do you often get bored? **Yes /** No
5. Are you in good spirits most of the time? Yes **/ No**
6. Are you afraid that something bad is going to happen to you? **Yes /** No
7. Do you feel happy most of the time? Yes **/ No**
8. Do you often feel helpless? **Yes /** No
9. Do you prefer to stay at home, rather than going out and doing new things? **Yes /** No
10. Do you feel you have more problems with memory than most? **Yes /** No
11. Do you think it is wonderful to be alive now? Yes **/ No**
12. Do you feel pretty worthless the way you are now? **Yes /** No
13. Do you feel full of energy? Yes **/ No**
14. Do you feel that your situation is hopeless? **Yes /** No
15. Do you think that most people are better off than you? **Yes /** No

Answers in **bold** indicate depression. Although differing sensitivities and specificities have been obtained across studies, for clinical purposes, a score higher than 5 points is suggestive of depression and should warrant a follow-up interview. Scores higher than 10 are almost always depression. (Adapted from Yesaviage JA, Brink TL, Rose TL, et al. Development and validation of a geriatric depression screening scale: a preliminary report. J Psychiatr Res 1983;17:37–49.)

Chapter 15

Neuropathic Pain

Theresa Hoskins Michel

The essential etiology of neuropathic pain is an insult to the nervous system. Nerve compression, immune-mediated damage, infectious damage, hereditary conditions, ischemia of neurons, metabolic abnormalities, toxic influences on nerves, and trauma to the nervous system may all cause neuropathic pain conditions. Patients with diabetes, postherpetic neuralgia, a cerebral vascular accident, a spinal cord injury, an amputation, or a gunshot wound or crush injury to the hand may all have neuropathic pain. The normal pathways for pain sensation and perception no longer function normally, resulting in abnormal peripheral discharges and consequent central nervous system (CNS) alterations. In this chapter, only three conditions are discussed as examples of neuropathic pain seen in rehabilitation.

Many problems arise in trying to diagnose the source of the pain, including the problems that one mechanism can be responsible for many different symptoms, one symptom in two different patients may be caused by different mechanisms, and several mechanisms can operate in one patient, and these mechanisms can change with time (Woolf and Mannion 1999).

Multiple treatments are needed to treat neuropathic pain conditions, including pre-emptive treatment, when possible, as in amputations using opiates and anti-inflammatory drugs to produce an effective blockade of afferent input. Without this, nociceptive information creates a memory of past inputs that affects membrane excitability and induces new gene expression, ultimately leading to brain changes and the encoding of "pain memories" (Katz and Melzack 1990).

Physical therapy approaches to the treatment of neuropathic pain states include the use of transcutaneous electrical nerve stimulation (TENS) as a means of restoring inhibitory afferent input to the dorsal horn. TENS can provide A-delta fiber stimulation along nerve pathways that are intact. Alternative forms of stimulation, such as light touch (massage, slow stroking), proprioception, vibration, or gentle heat (neutral warmth), may also be beneficial through this mechanism.

The pain of neuralgia is described as *constant*, *searing*, and *burning*, with accompanying allodynia. There may be *shooting* or *lancinating* pain, as well. These sensations may be the result of ectopic nervous system activity. TENS can be especially useful in these cases, because the stimulus can be selected to stimulate only large fiber-A-myelinated fibers using the appropriate strength-duration curves for those fibers and avoid the stimulation of C and A-delta fibers. This approach is based on the notion that TENS treatment can restore the usual inhibitory influence to the dorsal horn of these A-delta fiber inputs. Postoperative incisions with neuralgias respond especially well to TENS (Frampton 1994). Deep massage techniques or heat may simply result in allodynia and not be tolerated.

Patients sometimes prefer to wear tight clothing or no clothing on a painful part to prevent the summation of stimuli from increasing their already significant pain. Patients with hyperalgesia or allodynia may be helped by protecting the painful area from this summation by wearing elastic stockings, gloves, or even tape. Creams that numb the area or provide local anesthesia, such as lidocaine or capsaicin, may be helpful (Cheshire and Snyder 1990).

The patient with phantom limb pain represents the "pain memory" situation, in which the extremity was painful before amputation (Melzack 1990). Pre-emptive analgesia, in which the preamputation pain is abolished with effective analgesia, results in a much lower incidence of phantom limb pain. In the treatment of phantom limb pain, there may be two types of pain: local pain at the stump from a neuroma caused by the sprouting of axons from severed nerve endings, and a central pain from dorsal horn sensitization, resulting from the deafferentation of peripheral sources of sensation. Restoration of peripheral afferent input to the dorsal horn with stump stimulation procedures is sometimes helpful (Bach et al. 1988).

COMPLEX REGIONAL PAIN SYNDROMES

Complex regional pain syndrome (CRPS) types I and II are two clinical entities described within the number of sympathetically maintained pain syndromes. The pain of CRPS is typically persistent, and it affects the extremities or, occasionally, the face. Pain exists at a magnitude much beyond that expected based on the level of tissue damage. CRPS type I was formerly called *reflex sympathetic dystrophy* (RSD), and CRPS type II was known as *causalgia*. Nerve axons, which are subjected to nerve growth factors during a peripheral inflammatory reaction, often sprout and develop α-adrenergic receptors along these new axons (Sato and Perl 1991). Sometimes injury induces sprouting of sympathetic axons into the dorsal root ganglia, where they form "baskets" around the cell bodies of sensory neurons. Thus, there may be some interlinkages between the sensory neurons and the sympathetic neurons of the two nervous systems (van der Laan and Goris 2000). When this occurs, sympathetically maintained pain may result.

Severance or crush injury to peripheral nerves can cause the cessation of all input from that part of the periphery to the dorsal horn. This is called *deafferentation* and results in the spontaneous firing of dorsal horn neurons (Davar and Maciewicz 1989). The frequency of these spontaneous firings increases over time. Dorsal horn transmission interneurons have been found to be firing almost continuously 3 weeks after an injury (Loeser and Ward 1967), apparently owing to the loss of inhibitory input from the periphery. In addition, there may be a reduced descending inhibitory control of pain from a peripheral nerve injury, as a result of the down-regulation of γ-aminobutyric acid and opioid receptors in the dorsal horn, which occurs when there is a reduction in axonal input after the nerve is injured. Drugs such as gabapentin capsules (Neurontin) are used to attempt to mimic the action of γ-aminobutyric acid (Woolf and Mannion 1999).

In the acute phase of sympathetically maintained pain (CRPS with sympathetic involvement), the initial injury that precipitates the condition is often quite trivial and does not always involve nerve damage (Schwartzman 1993). For this reason, it may be ignored by health care providers or treated with icing, taping, protective covering, or casting, depending on whether it involves fracture, soft tissue damage, hematoma, or inflammation. There is typically a constellation of signs and symptoms indicating involvement of the sympathetic nervous system. At least four of the following limb symptoms must be present for a diagnosis of CRPS to be made: temperature and color change, edema, trophic skin, hair or nail growth abnormalities, impaired motor function, allodynia, and sudomotor changes (Galer et al. 2001). As the tissues begin to heal, the patient continues to protect the injured body part by nonuse and splinting. The pain of the acute injury is altered by time and becomes characterized by exquisite sensitivity to touch. Patients refuse to use their body part, because any light touch stimulus causes dramatic pain. A hand or a foot held in a protective posture and not used will exhibit shortened muscles and tendons and weakening of these functional units. Thus, the presence of a sympathetically maintained pain condition becomes more obvious the longer the patient has it, and diagnosis is often delayed owing to nonrecognition by a clinician.

CRPS appears initially as discoloration, trophic changes with shiny skin surface, and growth of hair on extensor surfaces. In stage I, the acute phase, the pain and hyperalgesia are localized to a peripheral nerve distribution or body segment. The skin is dry, red, and warm. Within approximately 3 months, it becomes cold, cyanotic, and sweaty. There is usually some local edema and muscle spasm. In stage II, which lasts a variable amount of time, muscles atrophy and there is x-ray evidence of osteopenia. Pain is described as diffuse and deep and is usually felt in a distal extremity rather than being localized to a single nerve. Movement, anxiety, and distress make pain worse. Stage III, the atrophic stage, involves severe contractures and osteoporosis. There may be edema, hypothermia, and increased hair growth with thickened nails. Muscle spasm, dystonia, and even pathologic fractures are characteristic. As the problem progresses, the pain spreads, leading to hyperalgesia, allodynia, and hyperpathia in a wider, more generalized pattern. At this stage of illness, a movement disorder is usually seen, characterized by difficulty initiating movement and by weakness, tremor, spasms, dystonia, and increased reflexes, which are amplified beyond the expected responses to disuse alone. Fascia become thickened, and atrophy of muscle, cartilage, and soft tissue becomes evident (Raja and Hendler 1990).

The earlier the diagnosis and intervention, the more likely the success. The goals of treatment are to (1) help the patient to reduce or control pain; (2) reduce or control edema; (3) increase range of motion (ROM) of the body part; (4) increase weight-bearing function; (5) decrease anxiety, frustration, anger, and depression; and (6) promote more beneficial coping mechanisms.

Pain control or reduction can be approached pharmacologically or nonpharmacologically, or both. It seems likely that no functional gains can be made until pain is controlled. Sympathetic blockade will interrupt the abnormal reflex arc between nociceptor afferent neurons and sympathetic efferent neurons. It can be done with local or regional pharmacologic blockade or surgical sympathectomy. Usually, repeated blocks are necessary in the lumbar paravertebral sympathetic chain. Epidural spinal cord stimulation and intrathecal infusion of morphine sulfate may be effective in some patients. Temporary blockade can be used as a diagnostic procedure with injection of procaine hydrochloride, as well as saline, to determine the effectiveness of sympathectomy. The current indication for surgical sympathectomy is a diagnosis of RSD in patients who have had partial but short-lived relief from regional sympathetic blockade and who have had four such blocks without effecting a permanent cure (Stanton-Hicks 1990). However, the use of sympathectomies is controversial. Many physicians in pain management clinics perform placebo blocks first to provide an indication for sympathetic block, which is based on more than placebo response (Verdugo and Ochoa 1994). In some cases of CRPS type I, even temporary relief of pain is the key to overcoming the extreme loss of function and breaking the cycle of loss of function with ever-increasing pain. If there is a successful period of pain relief, the physical and occupational therapists can seize the window of opportunity to normalize afferent input and build strength and normal ROM at the same time.

In some cases, corticosteroid therapy has been helpful. The mechanism of action seems unclear, as there are several possible explanations for its occasional success. Corticosteroids have potent anti-inflammatory effects, and there is an immunologic basis to their actions, as well. Corticosteroids stabilize basement membranes, which reduces capillary permeability and decreases extravasation of plasma, thus reducing edema. Another approach is the use of adrenergic blockade systemically. Propranolol is a beta blocker that blocks adrenergic receptors in blood vessels, heart, and lungs. It also has an anxiolytic effect, which may permit patients to cooperate with physical and occupational therapy. However, it does not influence the γ-adrenergic responses.

In refractory pain, patients may be given tricyclic antidepressants, anticonvulsants, and oral local anesthetics. Alternative drugs might be useful, such as clonazepam (Klonopin) for its antineuropathic pain properties, and diltiazem HCl (Cardizem), a calcium channel blocker, for its inhibition of vascular smooth muscle contraction or vasospasm.

RSD affects all aspects of a patient's life, and for this reason, a referral to an interdisciplinary pain clinic may be most useful. It is most important that CRPS patients receive the support of family, friends, and all members of the health care team in their efforts to become better from this devastating syndrome. Effective communication is essential.

The specific plan of care for the physical therapist and for all other members of the team to reinforce may be as follows:

- Stress loading exercises: Watson and Carlson (1988) recommend this program for upper-extremity RSD patients. The essence of this approach is to avoid performing ROM exercises that present a proprioceptive barrage, which perpetuates the pain (via A-delta input). They advocate isometric forces and axial loading with traction and compression. For the lower extremity, this means progressive weight bearing, supplemented by loading the foot with external weights of increasing amounts. Then, functional activities should be used, such as stepping, walking, and balancing. Use of the balance board (Baps) enhances motor reflex activation of intrinsic foot joints and joint structures, as well as muscles. For patients to tolerate any stress loading, they need desensitization.
- Desensitization program: This has been well described in the occupational therapy literature. Use of Coban wrap (3M, St. Paul, MN) and compression stockings may be effective in reducing edema and also in promoting habituation of the nervous system to the constant afferent input of the tight-fitting stocking. Massage to the skin (and eventually to deeper soft tissue), which is soothing, gentle, and continuously repetitive, should aid in desensitization. Alternative sensory stimulation, using fluidotherapy, cotton wool, beans, or marbles for patients to use themselves at home, may help the body part accommodate to more afferent input. Neutral warmth, or the application of a woolen stocking to maintain heat, in the foot can be helpful, especially if the painful part feels cold. If, on the other hand, it is red and hot, ice can be more helpful. Active ROM exercises should help to desensitize the foot and will also promote muscle pumping action to help reduce edema and promote better circulation. Elevation of the body part at least some of the time can be helpful.
- Muscle strengthening: Proximal musculature must all be affected by a distal painful situation. Specific muscle group strengthening exercise, with progression to resisted exercise, should be done. Careful work with ankle and foot ROM and muscle strengthening can be done and can be taught to the patient and the family. One of the fundamental questions in applying exercise approaches is *to touch or not to touch*? Patients are hypersensitive to touch, but they may be able or willing to learn to perform if left to their own methods and coping mechanisms. Patients with RSD usually demonstrate abnormal movement patterns, including spasm, dystonia, various jerks, and tremor. These have been well described by Verdugo and Ochoa (2000). Galer et al. (1995) have proposed that changes within the CNS may occur after persistent abnormal activation of the peripheral and autonomic nervous systems, which then can result in a neglect-like syndrome. Functional use patterns need to be programmed and reorganized in the nervous system in a therapeutic way. Examples of ways to do this include mental rehearsal and mental practice (data entry to the CNS) and repetition and sensory retraining (playing dominos blindfolded, reading Braille, matching pictures of keys to palpation of keys, feeling shapes and putting them into matched holes, working raised puzzles without vision, and using different postures or body positions with mirrors). These tasks help to restore the healthy image of self and the use of the involved limb in mental tasks and actual tasks. They help to educate the patient so that he or she is in control. Body-awareness training, such as that advocated by Feldenkreis or the Alexander technique, may become a useful adjunct to these approaches.

Attempts to quiet the sympathetic nervous system's activity with relaxation techniques may be helpful. The use of Jacobson's progressive relaxation, imagery, meditation techniques, t'ai chi, gentle rocking on a Swiss ball or in a rocking chair, deep diaphragmatic breathing, and massage may be considered. Biofeedback, hypnosis, acupuncture, stress management, behavioral modification, and TENS can also be helpful in specific cases.

Aerobic conditioning exercises, over time, produce an enhancement of balance between sympathetic and parasympathetic activity. For this reason, it has been shown to be beneficial for those with hypertension and other forms of heart disease (see Chapter 6). There is no current evidence showing that this is a benefit directly influencing the sympathetic dysfunction of patients with CRPS type I. However, owing to the health benefits of conditioning, it is a reasonable hypothesis to suggest that aerobic exercise will be useful to those patients with complex regional pain syndromes.

Case Example

The patient is a 25-year-old man who complains of severe left foot pain and sensitivity. His leg was initially injured at work when a tree rolled onto it. This resulted in an unstable, comminuted, closed fracture of the left distal tibia and fibula. He underwent a closed reduction the day of the accident, and he had surgery 2 days later for placement of an intermedullary nail in the left tibia. He was hospitalized for 1 week and discharged with instructions to bear no weight on the injured extremity. He began physical therapy 1 month later for progressive gait training, ROM improvement, and exercise. After five visits, he was able to bear normal weight on the leg without an assistive device. His doctor approved his return to light-duty work approximately 2.5 months after the injury. He was informed that light-duty work was unavailable. He continued his rehabilitation for an additional 17 visits, with a progressive increase in complaints of left lower leg, ankle, and knee pain. His gait became increasingly antalgic. His frustration and anger increased, and he was discharged to pursue a home exercise program, because no signs of progress were evident.

X-rays indicated incomplete union, and he had an autogenous bone graft approximately 7 months after the injury. Physician follow-ups over 3 weeks revealed decreased sensation of the foot; decreased active movement of the toes; and complaints of difficulty sleeping, ankle swelling, and donor site inflammation.

He is referred again to physical therapy 1 month after the bone graft.

Impairments: Pain in left foot, with marked hyperalgesia on palpation of foot and great toe. Pain rating is 9/10 when touched. Also, pain in left ankle and left knee with motion or attempted weight bearing. Multidimensional Pain Inventory profile is "dysfunctional." He exhibits extreme muscle guarding behaviors and grimacing with touch or movement. Other impairments include the following:

Decreased sensation of left foot with hypersensitivity of surgical scar
Hyperalgesia and allodynia of dorsal, lateral, medial, and plantar surfaces of foot
Decreased active movement of toes and ankle
Decreased passive and active ROM of ankle
Decreased strength of all ankle motions
Moderate aerobic fitness for his age

Functional limitations:

Sitting tolerance limited to 15 minutes
Walking with crutches, non–weight-bearing gait
Unable to wear socks or shoes on left foot
Unable to carry objects owing to crutch walking
Tries to keep his left foot elevated

Disability:

Unable to work since his injury
Unable to perform recreational activities (hunting, fishing, and hiking)
Diminished quantity and quality of social life

Evaluation, diagnosis, and prognosis (including plan of care): The patient is a thin, pale young man with chronic neuropathic pain and signs of sympathetically maintained pain. He exhibits loss of muscle strength, shortened muscles, and tight joint structures in the foot and ankle, with dystonic posture and fear of touch and movement. He has remarkable activity intolerance.

The treatment plan will focus on increasing weight-bearing activities of the foot and ankle without touching the painful part. Desensitization will be used, if helpful, to decrease the sensitivity of the foot and toes. A functional restoration session will be attended three times a week for 8 weeks. The patient will fulfill homework assignments to perform mental practice of weight-bearing activities and to apply desensitization and weight-bearing activities on his own. A treatment contract will be developed and signed by the patient to participate in a behavioral therapy approach to group and individual treatment. If available, an aquatic exercise program will be instituted for weight-bearing activities.

Treatment contract goals

1. Decrease behaviors that communicate to others that you are in pain, such as not wearing a sock

and shoe, and not placing foot on ground, guarding, and grimacing.
2. Formulate a plan for returning to work, and talk to your employer.
3. Learn self-desensitization through massage, tapping, and use of textured fabrics.
4. Perform closed-chain activities, such as stepping on scale or balance board.
5. Bear weight on compliant surfaces while sitting or standing in front of a mirror.
6. Lift 80 lb from the floor to your chest for 20 repetitions.
7. Walk for 30 minutes.
8. Bike for 30 minutes.

Home program

1. Education includes self-management of pain; desensitization with self-massage, using tennis balls or textured substances; and information on pacing.
2. Instruction is given in foot-stretching exercises and a walking program.
3. The patient lifts weights and rides a bicycle for general reconditioning, using proper lifting techniques and full weight bearing on both feet.

All physical therapy goals are met by the eighth week.

POSTHERPETIC NEURALGIA

After an acute inflammatory process to peripheral nerves, in which the chickenpox virus (varicella or herpes zoster) attacks cutaneous nerve endings, a prolonged pain syndrome usually appears, which is referred to as *postherpetic neuralgia* (PHN). Some authors have painstakingly studied many series of PHN patients, and Rowbotham and his group have described three general types: (1) those with irritable nociceptors experiencing allodynia but with minimal deafferentation, (2) those with deafferentation and marked sensory loss with allodynia, (3) those with deafferentation with marked sensory loss but experiencing no allodynia (Rowbotham and Fields 1989). The pathophysiologies of these three types differ, which explains their different symptom experiences. The first type, with irritable nociceptors, experiences peripheral sensitization, and allodynia is attributed to peripheral nociceptor input. This is likely owing to chronic inflammation of the affected peripheral nerve. The second and third types represent central sensitization with the loss of myelinated type A sensory fibers, resulting in the loss of central inhibitory effects of these afferent inputs on dorsal horn pain transmission interneurons. Those with allodynia may have interneuronal sprouting from deeper laminas' sprouting into the substantia gelatinosa (lamina II), which provides new direct connections to the pain transmission cells. This would result in non-nociceptive afferent input's being interpreted as pain (Shortland and Woolf 1993). Approximately 40% of all PHN patients experience intractable pain with allodynia. Those without allodynia (fewer than 15% of all studied PHN patients) but with profound sensory loss of all modalities may represent profound deafferentation without interneuronal sprouting (Rowbotham and Fields 1989).

Acute herpes infection typically affects patients older than 50 years of age, and its course involves the experience of pain for 2 or 3 days, followed by the appearance of an angry rash confined to a single dermatome. Within 72 hours of the appearance of the rash, a very acute and severe pain appears and persists with the rash. The most common sites for this infection are thoracic: paraspinal or axillary, corresponding to areas of intercostal nerve innervation of skin; trigeminal nerve facial skin distribution unilaterally; and the lateral cutaneous branch of the femoral nerve on one side. The rash gradually subsides with the appearance of vesicles in the same area, which persist for up to 1 month. Often, there is scarring of the skin surface from the rash or vesicles. By 3 months, the pain becomes spontaneous, constant, and may be burning, lancinating, and often intractable. PHN is one of the chronic pain conditions that has been associated with a high incidence of suicide.

The acute infection has been demonstrated to involve inflammation of the dorsal root ganglion with hemorrhagic necrosis and loss of neurons. Peripheral axons remain inflamed for months and lead to demyelination of all fibers with wallerian degeneration and sclerosis. The skin ultimately becomes denervated. In the dorsal horn, the acute zoster stage results in unilateral segmental myelitis and leptomeningitis at spinal segments adjacent to affected skin areas. At autopsy in patients who have had PHN, there is atrophy of the dorsal horn, whereas in patients who have not had PHN but did have the acute infection, no atrophy was seen (Watson et al. 1993, Kost and Straus 1996). In patients with PHN, the surviving cutaneous primary afferent nociceptors become sensitized and are spontaneously active, thus contributing to hyperalgesia and allodynia, leading to central sensitization.

These findings have led to a preventive approach to the treatment of patients with acute zoster infection. If PHN can be prevented, the neuropathic pain states, which appear later and plague the patient and the health care providers for many years, may be attenuated. Corticosteroids have been shown to have no effect on PHN, although they were effective in reducing the inflammation of the acute infection. Treating the infective virus with the antiviral agent acyclovir was effective in lowering the pain, but this was a short-lived benefit. However, there was a 42% reduction in the numbers of patients who went on to develop PHN (Whitley et al. 1995).

N-methyl-D-aspartate (NMDA) antagonists have been used to reduce the facilitated state of the CNS and act as antihyperalgesic and antiallodynic agents. Dextromethorphan hydrobromide is an example of one NMDA antagonist that was tried in both diabetic neuropathy patients and PHN. It was found to be much more effective in the diabetic group and no better than placebo in the PHN group (Nelson et al. 1997). Another NMDA antagonist, called *memantine*, gave a somewhat better response for PHN patients, but it was still insignificantly different from placebo. There are probably additional pain transmitter pathways besides the NMDA pathway that are involved, which accounts for the poor response to this single antagonist (Sang et al. 1997). In acute zoster, there may be a huge surge of nociceptive input at the time of the inflammation of the nerve endings, which may result in the destruction of inhibitory neurons. In diabetic neuropathy, there is a slow, prolonged nociceptive barrage, which damages but does not necessarily destroy the inhibitory neurons. It is this difference that may explain why NMDA antagonists work better with diabetic neuropathic pain.

Topical agents, such as the lidocaine patch or gel and capsaicin, are more successful than oral or IV administration. This suggests that the cutaneous nerves are responsible for the generation of the pain in PHN, and they lie within a few millimeters of the skin (Rowbotham et al. 1996). Iontophoresis of various substances, such as dextromethorphan hydrobromide, has proven to show some efficacy, as it penetrates the active agent to a depth perhaps more relevant to the source of this type of pain (Schiffman et al. 1996). Longer-term follow-up after iontophoresis using lidocaine and methylprednisolone revealed that 90% of patients reported an improvement in pain after 4 years of treatment, and almost all of these patients were taking care of themselves (Ozawa et al. 1999). Another topical approach is the use of capsaicin, which is not always tolerated, as it has been known to result in intolerable burning pain, which has resulted in 33% early dropout in several studies of its effect (Watson et al. 1991). Therefore, capsaicin shows mixed results with PHN, whereas topical lidocaine seems especially good for those patients with deafferentation pain with allodynia. New trials seem promising in the use of topical nonsteroidal anti-inflammatory drugs during the acute zoster infection.

Tricyclic antidepressants and serotonin reuptake inhibitors have shown some efficacy in PHN, as the usual range for some pain relief is 44–67%. Some patients with PHN also show sensitivity to norepinephrine when their skin is infiltrated with this sympathetic neurotransmitter. This can happen when central sensitization results in sympathetic postganglionic fibers of blood vessels sprouting to form baskets of terminals around primary afferent cell bodies in the dorsal root ganglia, similar to patients with other forms of sympathetically maintained pain (Rowbotham et al. 1999).

Patients with PHN, like many neuropathic pain patients, end up in our multidisciplinary pain programs, where a variety of treatment approaches may be helpful. Besides the pharmacologic approaches, hypnosis, biofeedback, and other cognitive and behavioral therapies may be tried. Some patients have benefited from TENS, on the theory that electrical stimulation of large A-fiber input reintroduces the normal inhibition of small fibers in the dorsal horn. This relies on normal sensory afferents, however, which may not be present in some of our patients. A new form of TENS, percutaneous electrical nerve stimulation (PENS), has been tested in a variety of chronic pain patients, including those with acute herpes zoster, to determine its effectiveness in prevention of PHN (Ahmed et al. 1998). This technique requires bipolar electrical stimulation to acupuncture needles placed in the soft tissue surrounding the area of dermatomal pain. Stimulation via PENS proved to be comparable to acyclovir therapy in healing of lesions and reducing pain, and patients were somewhat more improved with respect to the impact of the infection on sleep, physical activity, and the incidence and severity of PHN.

PHN, as with most other neuropathic pain conditions, is not well treated by neurosurgical approaches. Topical treatments, iontophoresis, and TENS and PENS offer the best relief to date, but all of these approaches require further controlled trials of efficacy and of optimal treatment parameters. These treatments fall into the realm of physical therapy approaches and should be studied by physical therapists.

PHANTOM LIMB PAIN

Eighty percent of all amputees experience pain in an absent body part. It is far more likely that *phantom sensation* will appear than *phantom pain*, and pain is more likely if the preamputated limb had pain, in which case the phantom pain is similar to the pain experienced before the amputation (Nikolajsen et al. 2000). Most phantom limb pain can be characterized as being of two types: peripheral and central. The *peripheral pain* is generally a cramping and squeezing sensation in the remnant muscles of the stump (Sherman 1997). In addition, there may be a neuroma formation as the cut end of peripheral nerves, under the influence of nerve growth factors and stimulated to become active by the surgical cut, begin to sprout. Sprouting axons form loose bundles of fibers called *neuromas*, which generate ectopic discharges, which may be spontaneous or provoked by pressure or cold to the stump (Devor 1997). The dorsal root ganglia, which contain the cell bodies of the cut axons, also begin to spontaneously discharge, with impulses moving into the dorsal horn from nerve bodies that once innervated now-missing body parts and impulses moving antidromically toward the cut endings of the neurons. Direction of impulse traffic will exaggerate the central dorsal horn response to afferent neural impulses coming in from the stump and may provoke nearby neurons to depolarize (Flor et al. 2000a).

Central sources of pain exist from the reorganization of the primary somatosensory cortex after an amputation or a deafferentation. Central reorganization occurs with the loss of a body part that once had a full representation on the somatosensory cortex. With loss of afferent information from the missing limb, the cortex derepresents that body part, unless the phantom sensations are being maintained by peripheral input (Ramachandram and Rogers-Ramachandram 2000). The reorganization of the somatosensory cortex can be prevented by pre-emptive analgesia, which also eliminates phantom limb pain in approximately half of the human subjects who receive it (Wiech et al. 2000). Therefore, approximately half of patients with phantom pain may experience their pain owing to its maintenance by peripheral input, and the other half may have intracortical changes that maintain their phantom pain. It is clear that deafferentation results in axonal sprouting in central as well as peripheral neurons, which will result in thalamic reorganization, as well as cortical and dorsal horn alterations (Jones 2000).

The temperature of the stump of amputees with phantom pain is altered compared to those patients without phantom pain (Flor et al. 2000). When the pain is described as *burning*, *throbbing*, and *tingling*, the temperature of the residual limb is inversely related to the intensity of the pain. Thermography shows a decrease in blood flow in these patients that is localized to the amputation side. For this reason, and also because the cramping sensations appear to represent muscle tension in residual muscles, both temperature and muscle-tension biofeedback can help some patients with phantom pain. A recent study of upper-extremity amputees who use myoelectric prostheses suggests that the training to use a prosthesis with motor units in the stump helps to reprogram the somatosensory cortex, which diminishes the experience of phantom pain (Lotze et al. 1999). Perhaps training to discriminate different residual muscle groups using electromyography, electrical stimulation, and biofeedback would help to prevent the loss of somatosensory representation of the missing body part or help to decrease the pain by a reversal of cortical reorganization, which occurs after amputation (Flor et al. 2000b).

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http://www.consult.iperweb.com Last accessed on: December 7, 2001.

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Chapter 16

Pain Management in Human Immunodeficiency Virus and Acquired Immunodeficiency Syndrome

Roberto Sandoval and Maureen J. Simmonds

In the early 1980s, an increased incidence of rare immunosuppressant infections was observed in major metropolitan areas in North America. The alarming growth in infections, such as *Pneumocystis carinii* pneumonia (PCP) and Kaposi's sarcoma (KS), was initially concentrated in the homosexual subpopulation within these cities. The Centers for Disease Control and Prevention (CDC) began gathering data regarding the rate of infection and population affected and infected, and a multitude of other variables needed to narrow down the possible etiology and pathophysiology involved in this new and emerging epidemic. The collection of symptoms observed was initially labeled as *gay-related immune deficiency* (GRID). A mixed pattern of bloodborne and sexually transmitted infections began to surface. By 1983, 33 countries reported similar infection patterns; 3,000 Americans were known to have had GRID, half of whom were reported to have died. This period was marked by an overwhelming fear of the unknown new disease and the means by which it was transmitted to other human beings. The Pasteur Institute in France isolated the human immunodeficiency virus (HIV) in 1983.

In the early 1980s, the scientific community at large proposed the notion of opportunistic infections (OIs) being related to a depressed immune response. OIs are the manifestation of commonly controlled organisms or infectious agents left to proliferate in an immunosuppressed environment (Cybulska 1997). They occur in disease processes that directly affect the immune system and in patients whose immune systems are compromised indirectly through chemotherapy or after organ transplant procedures. The severity and likelihood of contracting these OIs increase in an inversely proportionate relationship to the number of available T cells in the host's system. The relationship between the immune system suppression and OIs observed in persons with HIV infection and their absolute number of helper T cells, otherwise known as *CD4 cells*, became increasingly clear.

The number of CD4 cells and presence of OI due to severe immunosuppression forms the basis for the distinction between HIV and acquired immunodeficiency syndrome (AIDS). The current accepted definition of AIDS was drafted in 1991 by the CDC, taking into account the relative strength of the immune system of the affected individual as measured by the total number of CD4 cells present as well as the presence of OI associated with severe immunosuppression. Thus, the commonly accepted clinical definition for AIDS proposed in 1991 by the CDC is *CD4 blood level counts at or below 200 cells/µl (normal values range between 400 and 1,200 cells/µl in healthy individuals).*

Since then, we have witnessed the development of treatments aimed at slowing the replication of HIV. The latest statistics reflect a grim progression of the epidemic to a worldwide pandemic. The CDC, in its latest report (Centers for Disease Control and Prevention 2000), notes that in America, more than 750,000 individuals are living with HIV. Recorded deaths associated with HIV and AIDS totaled 438,000 in the United States in the year 2000. The United Nations AIDS committee estimates that the number of infected individuals currently living with HIV and AIDS is 33 million worldwide. A relatively high concentration of HIV and AIDS cases is located in sub-Saharan African countries (HIV/AIDS 2000).

The financial costs of HIV and AIDS are tremendous. Hellinger (1993) reported that the medical and pharmacologic management cost of treating an HIV-positive individual in the United States ranged from $260 to $2,760 per month. The specific costs depend on several factors, including the relative strength of the immune system. Furthermore, an early estimate of the cost of treating an individual with HIV in the United States was approximately $120,000 during an expected lifetime of 7 years with the disease. This estimate is based on the assumption that an individual maintains T-cell levels greater than 500 cells/mm^3. With the development of new medications against HIV, these preliminary estimates have been revised and updated. Moore and Chaisson (1997) reported that the average total monthly cost of treating people living with HIV and AIDS (PLWA) in their U.S.-based practice ranged from $1,015 to $2,436 per month. These estimates included inpatient and outpatient care, as well as medication-related expenses. Direct costs related to medical management are relatively easy to compute, although they are influenced by policies and politics as well as disease characteristics. Finally, it should be remembered that the economic cost pales in comparison to the human cost that this worldwide pandemic has caused.

PATHOPHYSIOLOGY

The human immune system is a complex network. Multiple levels of defense are in place to neutralize and eradicate foreign substances and organisms. Lymphocyte T-cell activity plays a major role in immunodefense against disease. The role of T cells, among other roles, is to identify foreign substances and organisms and produce antibodies to reveal the presence of foreign substances to other lymphocytes. This, in turn, initiates further defense responses against foreign substances and organisms.

HIV belongs to a family of ribonucleic acid (RNA) lentiviruses, characterized by a long latency period of incubation post infection. These RNA lentiviruses have an affinity for the immune and neurologic systems of the affected host. The HIV virion has the capacity and is attracted to infiltrate the cell wall of the host's CD4 cells. The infiltrating virion proceeds to overtake the normal function of its newly infected host cell to replicate its own RNA within the infected cell's nucleus. The propagation of the virion's progeny is transported via the blood stream, as well as the lymphatic system, attacking other CD4 cells and replicating its RNA. Within hours of initial exposure, billions of virions are traveling in and ravaging the host's immune system, further compromising normal immune function (Klatt 2000).

This initial period of rapid replication is followed by a period of homeostasis, in which the virion replication is somewhat controlled by a limited immune response to HIV. This period of homeostasis varies in length in PLWAs and is influenced by many factors. Identified factors that influence immune response range from genetic to environmental. This period of relative homeostasis can stress the host's immune system, gradually but increasingly compromising immune function. The overall number of T cells in the host's system decreases as virion numbers increase. This change in immune efficiency leads to an increased vulnerability to infections that would normally be resisted (Volberding and Deeks 1998).

PLWAs often experience weight loss manifested by a loss of body cell mass (BCM). The causes of HIV-related wasting are still unknown, but multiple mechanisms, such as anorexia, malabsorption, and altered metabolism of nutrients, are probably involved. Malabsorption and diarrhea may result from gastrointestinal tract OIs or from direct effects of HIV on the gastrointestinal tract. Infection with HIV may produce a metabolic derangement that alters nutrient use, resulting in loss of BCM (Nemechek et al. 2000). Loss of BCM is an important prognostic indicator of disease progression, survival, and death (Ott et al. 1995, Schwenk et al. 2000).

Anemia is also a commonly observed problem in PLWA and appears to influence physical function and perceived fatigue. Prolonged, untreated anemia has been identified in the literature as an independent risk factor of death in PLWAs by many authors (Coyle 1997, Henry 1998, Hester and Peacock 1998, Iacono et al. 1997, Kreuzer and Rockstroh 1997, Miles 1995, Moore 1999, Moore et al. 1998, Sullivan et al. 1998). Moore et al. (1998) surveyed 2,348 patients to determine the relative incidence of anemia in PLWAs between 1989 and 1996. They reported that 593 of all participants had at least grade 1 anemia (hemoglobin levels below 9.4 g/dl), whereas 95 participants had grade 4 anemia (hemoglobin levels below 6.9 g/dl). Unfortunately, a relatively high death rate was observed for patients who underwent blood transfusions. Whether this was owing to the relatively poor health of those receiving transfusions or whether the transfused blood provided a "new" fertile ground for virion reproduction is not clear. The latter was postulated by Moore et al. (1998) and further supported by Sullivan et al. (1998) and Moore et al. (1999). As with many complications observed in PLWAs, the etiology of anemia is not totally clear and is probably multifactorial (Kreuzer and Rockstroh 1997).

The number of available antiretroviral medications has increased from a single medication (zidovudine, also known as *AZT*) in 1989 to a growing combination of available regimens, which may require patients to take as many as 18 different medications at one time. The medications available can be subdivided into three major classes of antiretroviral regimens:

1. Nucleoside reverse transcriptase inhibitors (NRTIs)
2. Non-nucleoside reverse transcriptase inhibitors (NNRTIs)
3. Protease inhibitors (PIs)

NRTIs and NNRTIs inhibit virion replication before assimilation of the nucleus in the HIV-infected CD4 cell. PIs directly impact the propagation of virions by rendering inactive the replicated RNA (Klatt 2000). The use of antiretrovirals is relatively new in the management of HIV and AIDS. Further discussion of the specific pharmacokinetics of the HIV regimens available is beyond the scope of this chapter; for more detailed information, please refer to the *Textbook of AIDS Pathology* by E. Klatt (2000) and see this chapter's reference list for the online URL.

PAIN IN HUMAN IMMUNODEFICIENCY VIRUS AND ACQUIRED IMMUNODEFICIENCY SYNDROME

Pain is a common symptom in the HIV population (Laschinger and Fothergill-Bourbonnais 1999, Yermal 2000). Between 40% and 60% of PLWAs experience pain in one or more body locations (Breitbart et al. 1996a, 1996b, 1997). In a cohort of 504 patients, Vogl et al. (1999), noted that the most commonly reported distress symptoms were worrying (86%), fatigue (85%), sadness (82%), and pain (76%). Furthermore, when HIV transmission was associated with intravenous drug use (IDU), participants reported more symptoms and higher overall physical symptom distress than those who had non–IDU-associated HIV (Vogl et al. 1999). Multiple concomitant stressors influence the overall perception of pain in this population, as they do in any other.

The etiology of pain in HIV and AIDS is multifactorial and complex. In a retrospective study of pain in patients with HIV or AIDS, Breitbart et al. (1996a) reported that 50–80% of patients with AIDS had pain or painful episodes within the last 6 months, whereas 25–38% of HIV patients had pain at present or during the same time frame. To date, the most commonly reported pain syndromes include painful peripheral sensory neuropathy, pain due to extensive Kaposi's sarcoma, headache, pharyngeal and abdominal pain, arthralgias and myalgias, and some dermatologic conditions (Laschinger and Fothergill-Bourbonnais 1999, Martin et al. 1999, Pitagoras de Mattos 1999, Yermal 2000). Abdominal pain associated with *Mycobacterium avium* complex infection is commonly observed in this population. The abdominal discomfort is attributed to liver and spleen hypertrophy and overall distention of the abdominal wall muscles. Lower-extremity spasms are also observed in clients with *M. avium* complex–induced encephalopathy (Breitbart et al. 1996b).

TREATMENT OF PAIN IN HUMAN IMMUNODEFICIENCY VIRUS AND ACQUIRED IMMUNODEFICIENCY SYNDROME

The World Health Organization has proposed a pain treatment ladder to guide clinicians who are treating individuals with chronic pain in cancer and HIV and AIDS. It is a progressive ladder of interventions designed to maximize pain management (Rokach 2000). In addition, the treatment must be individualized, and active participation from the client should be encouraged. As a general guideline, the least-invasive and least-disruptive effective treatment intervention should be implemented at the beginning of the pain management program. Its effectiveness should be closely monitored using standardized outcome measures. Pain and the impact of pain (e.g., physical dysfunction) should be measured. Unfortunately, practitioners' exaggerated fears of addiction, inadequate knowledge of pain and pain management, and the social biases regarding minorities and illicit drug users' use and abuse of analgesic medication led to an environment in which pain was inadequately assessed and undertreated (Martin et al. 1999, Rotheram-Borus 2000). Breibart et al. (1997) followed 516 patients with clinical AIDS to determine if the presence of a history of drug abuse influenced the management of pain. The authors determined that, although the history of or active IDU does not influence the reported pain experience, the participants with a history of IDU reported significantly higher levels of depression and psychological distress, poorer overall quality of life, and had less social support than non-IDU participants. It should be noted that the results from this study suggest that the undertreatment of pain is not restricted to IDU patients but extends to PLWAs in general (Breitbart et al. 1997).

Physical therapy intervention in HIV and AIDS is one of adjunctive therapy to support medical and educational interventions. Physical therapy interventions in HIV were initially seen in a palliative care environment, in which the main aim was to maintain function and ameliorate pain and distress at the end of life. Pharmacologic advances, however, have led to improved survival times, such that HIV is now regarded as a chronic disease. Quality, as well as quantity, of life becomes a more important concern as patients deal with HIV problems that may be due to the disease or its treatment, or both (e.g., high cholesterol levels, diabetes, renal insufficiencies, and avascular necrosis of the hip) (Centers for Disease Control and Prevention 2000).

Physical therapists have a low risk for exposure to HIV, except in practice settings that include direct wound care. The U.S. Department of Labor, Occupational Safety and Health Administration standards for occupational exposure represent the best protection against exposure to HIV. Immediate medical attention is advised in case of exposure. Initiating highly active anti-retroviral therapy, or "cocktail" therapy, within hours of exposure has been shown to significantly decrease the chances of seroconversion (Klatt 2000).

EVALUATION OF PATIENTS WITH HUMAN IMMUNODEFICIENCY VIRUS AND ACQUIRED IMMUNODEFICIENCY SYNDROME

The basic principles of assessment and treatment of pain in PLWAs are not essentially different from any other painful condition. However, much like any other population facing a potentially life-threatening condition, it is ethically and morally imperative to maximize the amount of pain relief by addressing painful conditions, such as peripheral neuropathy, and by preventing or reducing BCM depletion through exercise and conditioning prescriptions. A thorough review of the patient's medical history is very important. Particular attention should be paid to the latest CD4 levels available, viral load (VL) present, history of OI, and any other abnormal laboratory values (glucose, lipids). VL levels obtained via hematologic studies are helpful in tracking the disease progression. The test became available in the early 1990s and measures the number of virions present. VL tests typically yield values between 400 and 750,000 virions. A more sensitive test, measuring VL as low as 50 virions, is also available; however, this test is primarily used in pharmacokinetic studies. VL values are tracked on a logarithmic chart and are significant when an increase of a factor of 10 is noted. Increases in VL and decreases in CD4 values are often associated with disease progression or the presence of a medication-resistant HIV strain, or both (Klatt 2000). Extreme care should be exercised when treating a patient who has severe immunosuppression (CD4 less than 50 cells/mm^3, VL greater than 300,000 virions) because of his or her increased vulnerability to potentially life-threatening infections.

A comprehensive pain interview should be conducted to differentiate pain related to OI, disease progress, or trauma, or all three. Clients must be constantly reassured that it is appropriate to seek relief from pain, as many clients are often overwhelmed by the loss of income, health, and social status.

Outcome measures are available to measure the effectiveness of clinical interventions. Extensive attention has been paid to the construction of quality of life in PLWAs (Cella et al. 1996, Cohen et al. 1996, Wu et al. 1997). Multiple tools are available to measure the different aspects of perceived quality of life. Most tools are multidimensional and address pain, physical and emotional well-being, and social support (Tsasis 2000). The Functional Assessment of Human Immunodeficiency Virus Infection (available at http://www.facit.org/facit_questionnair.htm), the Medical Outcomes Study-HIV (Wu et al. 1997, Wu et al. 1991, Revicki et al. 1998), and the Short-Form 36 General Health Survey (Ware and Sherbourne 1992) are the most commonly used health-related quality of life measures in HIV and AIDS. Some authors recommend the use of more than one measure (Hughes et al. 1997), because different questionnaires can provide slightly different information. However, this recommendation must be balanced against the need to avoid imposing an unnecessary data burden on patients or clinicians. Redundant data collection and the use of assessment and outcome measures that have limited or unknown levels of reliability and validity should be avoided.

Self-report questionnaires of function are valuable, as they reveal the global impact of the disease on the person. However, questionnaires need to be complemented with standardized and performed tests of physical function (Lee et al. 2001). Standardized tests of physical function help therapists to identify and manage movement difficulties and also measure the effectiveness of treatment. The use of simple physical performance tests is gaining interest as an evaluative method across disease groups. Basic activities that can easily be sampled and need minimal testing equipment include such tasks as reaching, walking, rising from sitting, picking up small or large objects, and dressing.

It is known that individuals with functional difficulties tend to move more slowly and with less force and less efficiency than their nonimpaired cohorts. Thus, task performance easily can be measured using the time taken or the distance walked or reached in a set time. Some investigators have developed and tested standardized performance-based tests in patients with back pain or chronic pain, and in cancer populations (Harding et al. 1994, Simmonds et al. 1998, 2000). The reliabilities (test-retest and inter-rater) of these simple tests are generally good to excellent (intraclass correlation coefficient [ICC] or r values ≥ 0.7), and validities (face, discriminative, and construct) are well established. We have recently tested a physical performance test in 100 patients with HIV and AIDS. The performance battery comprises a series of measures that challenge upper-limb movements and total-body movements in both seated and standing positions. Patients are timed as they walk 50 ft as fast as they can and at their preferred speed, complete a repeated sit-to-stand and a repeated reach-up task (Figure 16.1), don a sock (Figure 16.2), tie a belt (Figure 16.3), pick up coins from a table (Figure 16.4), and pick up a pen from the floor. The measured-distance tasks include a functional reach (Figure 16.5), a loaded forward reach (Figure 16.6), and a 6-minute walk.

The ease of application and ability to quantify a point of reference for individual patients make these physical performance tests adaptable and useful for clinicians in a wide range of practice fields (Simmonds et al. 1998). It is not necessary to assess the patient using the whole task battery; one or several tasks can be selected and used depending on the patient's problem.

A commonly used tool in HIV and AIDS care is a body impedance analysis, a noninvasive procedure that involves the transmission of a microcurrent through a set of electrodes placed on the right hand

A **B**

Figure 16.1. Timed reach-up task. **A.** Starting position. **B.** End position.

A **B**

Figure 16.2. Timed sock test. **A.** Starting position. **B.** End position.

Figure 16.3. Timed belt-tie test.

Figure 16.4. Timed coin pick-up test.

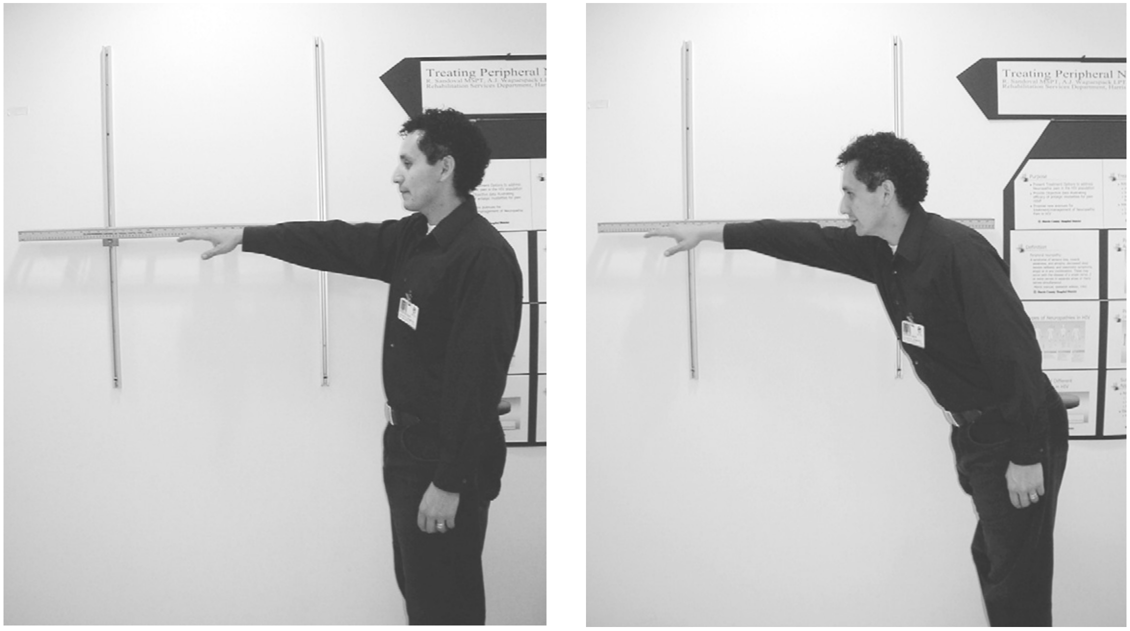
and right foot while the subject is supine. An algorithm uses the subject's impedance measurements (age, height, weight, and gender) to compute the percentage of body weight to allocate to BCM, fat, and extra-cellular mass (Ott et al. 1995). The use of body impedance analysis results is particularly helpful to track disease progression and efficacy of treatment interventions to prevent loss of BCM.

TREATMENT OF PATIENTS WITH HUMAN IMMUNODEFICIENCY VIRUS AND ACQUIRED IMMUNODEFICIENCY SYNDROME

The aims of physical therapy interventions are to minimize pain and BCM loss and improve function and quality of life. Treatment plans should be formulated to consider the patient's problems in a comprehensive manner. For example, patients are unlikely to fully participate in an exercise intervention aimed at improving function and preventing BCM loss if their pain is inadequately managed or if the exercise intervention does not accommodate their lifestyles. The physical therapist's expertise in the area of equipment recommendation can also reduce the burden of care in cases of late disease progression by improving the patient's overall function at home.

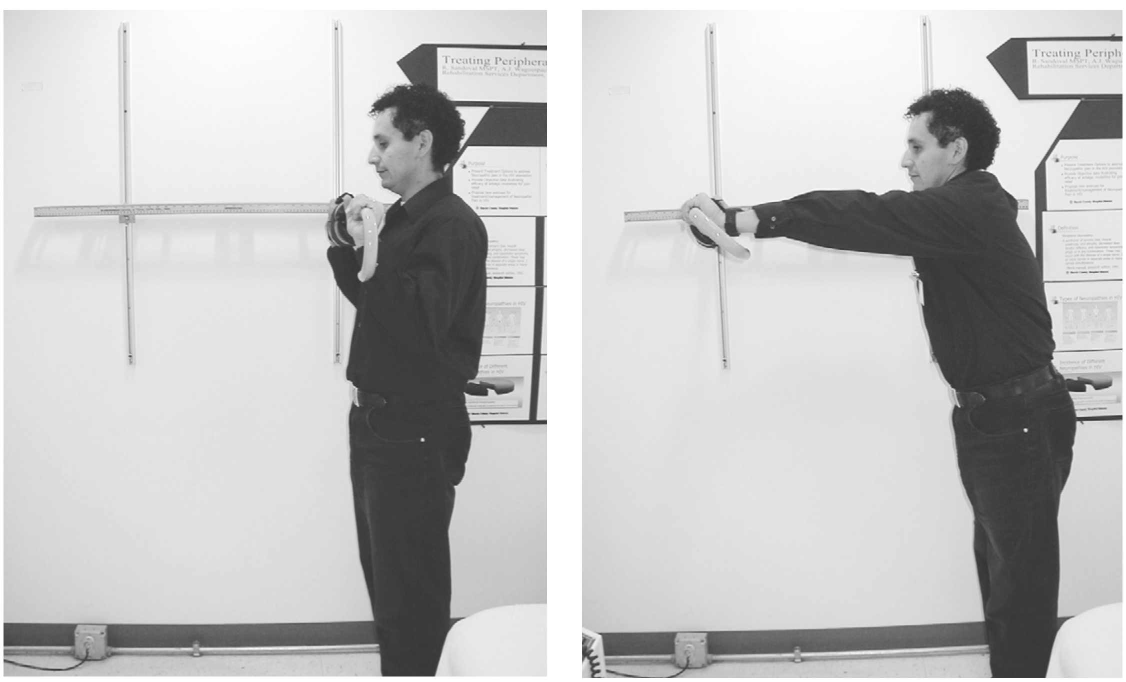
To comprehensively address the metabolic complications commonly seen in PLWAs, the interdisciplinary model should be applied in place of conventional rehabilitation settings. Research evidence supports the notion that close monitoring and mentoring of PLWAs regarding overall health management are beneficial in reducing the distress symptoms reported by PLWAs (Gifford et al. 1998). For instance, the use of massage as a therapeutic intervention, in conjunction with stress management, appears to lead to a decrease in health care resource use and improved perceived quality of life by PLWAs (Birk et al. 2000).

BCM can be improved by the use of resistive exercise alone or in conjunction with anabolic steroids, human growth hormone, and nutritional supplements. Schambelan et al. (1996) showed



A **B**

Figure 16.5. Functional reach. **A.** Starting position. **B.** End position.



A **B**

Figure 16.6. Loaded forward reach, 3 kg. **A.** Starting position. **B.** End position.

significant BCM (3-kg) increases in PLWAs when using human growth hormone in conjunction with treadmill exercise over a period of 12 weeks' intervention. Similar increases are shown with the use of anabolic steroids and exercise (Schambelan et al. 1996). The increase in BCM achieved appears to dissipate on discontinuing the use of either anabolic steroids or human growth hormone (Mulligan et al. 1999).

In a recent systematic Cochrane review of randomized controlled trials of aerobic training in PLWAs, Nixon et al. (2001) reported that exercising aerobically for at least 20 minutes and at least three times per week for a period of 4 weeks may lead to an increase in CD4 counts, improved cardiopulmonary fitness, and improved psychological status. The authors concluded that aerobic exercise is not only safe but also may be beneficial for PLWAs. In addition, there is mounting evidence of the benefits of regular exercise to improve the metabolism of medications, improve self-esteem, and prevent loss of BCM in this population (Mustafa et al. 1999, Nixon et al. 2001, Perna et al. 1999, Shephard 1998, Strawford et al. 1999, Wagner et al. 1998).

Case Example

The patient is a 35-year-old man with clinical manifestations of AIDS (CD4 less than 200 with presence of recent OI). He reports a recent onset of severe and bilateral foot pain concentrated at the metatarsal heads, as well as continuous lack of sensation (numbness) in his feet and severe pins and needles when walking barefoot. He also complains of occasional sharp pains when walking on uneven surfaces. He has night cramps severe enough to interfere with his normal sleeping pattern, resulting in an inability to sleep continuously for more than 3 hours at a time. He does not report any significant difference between the pain perceived in either foot, either in quality or intensity.

Pain On a 10-point scale, the patient rates the pain as 9, on average, during the day. We further requested that he rate the degree to which the pain bothered him (pain affect) on a scale of 0–10. This was also rated as a 9.

Function The patient is unemployed and has been unable to work for the past 3 years, as he is too fatigued to work since seroconverting. He was able to walk a 50-ft (15.2-m) distance at a preferred pace in 19.4 seconds. He was able to rise from sit to stand five times in 18.6 seconds and, finally, was able to reach forward an average of 9.5 in. (14.25 cm). The specific functional tests were selected for their ease of administration and because they directly tested and forced the client to bear weight at the forefoot during their execution.

Physical examination The posture is marked by an aversion to bear weight at the forefoot in standing, with marked flexion at the hips and excessive heel weight bearing in quiet standing. He has sufficient dorsiflexion to not interfere with his gait pattern. He exhibits slight swelling at both lower extremities, with a greater concentration of fluid at the ankles. He has not adjusted to a larger shoe size to accommodate the swelling at the extremities. Palpation reveals acute forefoot tenderness, particularly at the metatarsal heads, with normal fatty deposits. Weinstein monofilament test revealed a state of reduced protective sensation, as the patient's lowest detectable level was to the 2-g monofilament.

Aerobic fitness Unable to accurately assess owing to constant complaints of pain at his feet. He reports a marked loss in activity and exercise tolerance since the inception of pain at the feet.

Pain attitude and pharmacologic management The patient reports feeling resigned to being in pain, as previous multiple pharmacologic attempts at pain management have failed. Currently, patient reports intake of 25 mg of morphine sulfate (MS Contin) every 4 hours to assist with pain.

Assessment This client has severe and constant pain that is usually associated with neuropathy. The pain interferes with multiple aspects of daily life and appears to deprive the client of needed rest at night. Mild swelling with impaired sensation to light touch at the ankles was noted at initial evaluation. Finally, activity intolerance is of concern, as he is unable to exercise owing to the pain experienced.

Plan Develop and implement a comprehensive, problem-based program to address the patient's concerns. The program will include aerobic conditioning in conjunction with a general conditioning program aimed at improving his level of fitness and thus his tolerance to physical activities.

Treatment contract goals

1. Maximize pain relief experienced at the lower extremities with stretching strategies and instructions for home management.
2. Walk to and from the bus stop (approximately 180 m) initially, with a goal to be able to walk to and from all clinic appointments.

Treatment

1. The patient was fitted with a night splint to decrease the intensity of night cramps and provide a low-load stretch at the plantar flexors. He was shown and was able to independently demonstrate stretches of the plantar flexors and intrinsic feet muscles. He was instructed to perform 10 repetitions of each movement and to hold a stretch for a period of 20–30 seconds each trial.
2. The patient began an aerobic program consisting of 10–15 minutes of riding a stationary bicycle. The use of a treadmill to desensitize the feet to normal walking was gradually introduced.
3. The patient's home stretching program was reviewed and demonstrated by the patient at each return visit to the clinic.
4. The original functional markers of 50-ft walk test, sit to stand, forward reach, pain level, and pain affect were recorded.

At the completion of the program, the client's reported pain had decreased from 9/10 to 3/10, with a similar decrease in affect reported from an initial 9/10 to a 3/10 at discharge. The client reported 0/10 affect at the 6 weeks' follow-up session, with the pain level remaining at 3/10. An improvement was also observed in all functional markers tracked throughout the program and continued to improve post discharge. The client continued with the post-discharge recommendation to incorporate a walking program and his range-of-motion program in his daily routine.

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Chapter 17

Living with Chronic Pain: Exploration of Complementary Therapies and Impact on Quality of Life

Mary Lou Galantino and Sandra L. Lucci

Before modern science, traditional systems of medicine made healing available to the world population with a surprising degree of sophistication. In the twentieth century, there were great strides in developing Western medicine. Countless diseases were eliminated or controlled through advances in immunology and the discovery of antibiotic drugs and vitamins. However, conventional medicine does not offer a definitive cure for those challenged with back pain, arthritis, the effects of stress, cancer, and acquired immunodeficiency syndrome.

Consequently, the techniques to lessen chronic pain are shifting (Vickers 2000). Many people are turning to alternative healing arts for an answer. There is an increasing sense that certain ancient and esoteric healing practices, long ignored by Western science, may, in fact, represent insights into the nature of well-being. In the 1970s and 1980s, these disciplines were mainly provided as an alternative to conventional health care and hence became known collectively as *alternative medicine* (Vickers and Zollman 1999a). Vickers and Zollman wrote, "Over the years, 'complementary' has changed from describing the relation between unconventional healthcare disciplines and conventional care to defining the group of disciplines itself" (Vickers and Zollman 1999b, 693).

Alternative therapies are forms of practice that are outside the realm of conventional modern medicine. Most of these medical interventions and health care practices are neither widely taught in United States medical schools nor generally available in doctors' offices or hospitals. Alternative medicine covers a broad range of healing philosophies, approaches, and therapies.

Complementary medicine refers to a group of therapeutic and diagnostic disciplines that exists largely outside the institutions where conventional health care is taught and provided (Vickers and Zollman 1999a). If alternative medicine or therapy is used alone or instead of conventional medicine, it is called *alternative medicine.* If the treatment or therapy is done along with or in addition to conventional medicine, it is referred to as *complementary medicine,* as the two practices complement each other.

There are many forms of complementary and alternative medicines and therapies (Vickers and Zollman 1999a). In the minds of many conventional health caregivers, they have no significant value in managing disease. However, others recognize the value of using these techniques as a complement to conventional care. Vickers and Zollman wrote, "The past 10 years has seen a significant increase in the amount of complementary medicine" (Vickers and Zollman 1999a). Worldwide, conventional, biomedically oriented practitioners deliver an estimated 10–30% of human health care. The remaining 70–90% percent ranges from self-care according to folk principles to care given in an organized health care system based on an alternative tradition or practice.

Studies indicate that 40% of Americans used alternative medicine in 1997. Visits to practitioners of alternative medicine have increased by almost 50% since 1990 and have exceeded the number of visits to all primary care doctors, with 629 million visits to alternative medicine practitioners compared to 386 million visits to primary care doctors. Forty percent used alternative medicine to treat an illness. Chronic conditions, such as back and neck problems, anxiety, arthritis, and headaches, were the most prevalent reasons given for using alternative medicine (Vickers 2000, Vickers and Zollman 1999a, Vickers and Zollman 1999b).

A survey by Eisenberg et al. (1998) suggested that the 1-year prevalence of complementary and alternative medicine use was 34%. The survey also showed that, on average, each user made 19 visits a year to complementary and alternative practitioners, involving costs exceeding $500 per person, and 72% of the users did not inform their physicians regarding their use of alternative therapy. It was deduced that visits to complementary and alternative practitioners amounted to around $14 billion and outnumbered visits to primary care physicians.

More than 20% of primary health care teams provide some form of complementary therapy (Vickers and Zollman 1999a), which requires no special funding arrangements. Advantages of this system are that it requires minimal financial investment and that complementary treatments are usually offered only after conventional assessment and diagnosis. However, general practitioners cannot claim item-of-service payments for complementary treatments they give to their own patients. Since 1991, health authorities can only reimburse general practitioner principals who employ a complementary therapist, although the staff budget is limited, and a complementary practitioner is therefore employed at the expense of another member of the staff. Therefore, funds from voluntary sectors or charities may also be sought. Otherwise, the patients must pay out of pocket. Total 1997 out-of-pocket expenditures relating to alternative therapies were conservatively estimated at $27.0 billion, which is comparable with the projected out-of-pocket expenditures for all U.S. physicians services (Eisenberg et al. 1998).

New branches of established disciplines are continually being developed. What is thought to be conventional treatment varies between countries and changes over time. The boundary between complementary and conventional medicine is therefore blurred and constantly shifting. However, the most frequently used complementary and alternative interventions include the use of massage, acupuncture, herbal medication, various forms of exercise, chiropractic care, prayer and spirituality, the Feldenkrais method, t'ai chi, yoga, visualization, hypnosis, relaxation, and biofeedback.

MASSAGE THERAPY

Massage therapy is one of the oldest and most widely used alternative therapies. It is the systematized manipulation of soft tissues. Practitioners use a variety of physical methods, including applying fixed or movable pressure, holding or facilitating movement of the body, and using deep tissue and neuromuscular massage (Cronin-Stubbs et al. 2000). The effect of massage therapy on pain reduction and sense of well-being may include the following mechanisms of action: (1) stimulation of arterial and venous blood flow and lymphatic drainage, which maximizes the supply of oxygen and nutrients to sites of pain; (2) reduction of the excitability of neurons within the lower motor neuron pool, which results in relaxation of the muscle; (3) passive stretching and elongation of connective and muscular tissue, with a decrease in muscular tightness and tension; and (4) systematic release of endorphins and opiates in the brain and periphery, which results in pain reduction and a greater sense of well-being (Cronin-Stubbs et al. 2000). The latter is thought to be beneficial for relieving pain associated with arthritis, injuries, or recent surgery. The basic goal of massage therapy is to help the body heal itself and to increase health and well-being.

Massage is an effective technique for controlling pain. Head, neck, and shoulder pain can benefit from massage (Cronin-Stubbs et al. 2000). Massage can help pain originating from muscle tension in these areas by reducing spasms with prolonged stretches (Cronin-Stubbs et al. 2000). Massage improves circulation, which increases blood flow, bringing fresh oxygen to body tissues. This can assist in the elimination of waste products, speed healing after injury, and enhance recovery from disease (Cronin-Stubbs et al. 2000). Changes in pressure gradients between interstitial spaces and blood vessels are posited to explain massage's effects on promoting circulation and removing by-products of inflammation and infection (Cronin-Stubbs et al. 2000).

ACUPUNCTURE

As part of the holistic health movement of the last 25 years, acupuncture has become a well-known, reasonably available treatment in developed and developing countries (Beal 2000). For the last 5,000 years, however, acupuncture has been a major part of primary health care in China. Acupuncture is an ancient Chinese practice based on the premise that vital energy fields, called *Qi*, are blocked in disease (Newland 1999). Needles are placed along these pathways, or meridians, to redirect the flow of Qi through the body (Kolasinski 2001). Qi is the energy that flows through the body in predictable patterns along meridians. It is determined, in part, by the balancing of yin and yang (Pearl and Schillinger 1999). Disruption of this flow is thought to cause disease; manipulation of the flow of Qi with acupuncture re-establishes the balance of yin and yang and, therefore, a healthy state (Pearl and Schillinger 1999). Diagnosis and treatment are based on measuring and adjusting the flow of energy (Pearl and Schillinger 1999).

Acupuncture is used extensively for a variety of medical purposes, ranging from the prevention and treatment of disease to relieving pain and anesthetizing patients for surgery. As in many Oriental medicine practices, the emphasis of acupuncture is on prevention. In traditional Chinese medicine, the highest form of acupuncture was given to enable an individual to live a long, healthy life. Western explanations of acupuncture's efficacy in pain control are based on experimental data indicating that peripheral stimulation of high-threshold, small-diameter nerve fibers blocks the transmission of pain signals to higher centers in the brain (Kolasinski 2001).

Acupuncture is a treatment for pain, nausea and vomiting, neurologic rehabilitation, asthma, and addiction (Pearl and Schillinger 1999). Acupuncture involves penetration of the skin by fine needles at specific anatomic points in the body (Cronin-Stubbs et al. 2000). The placement of 6–12 needles on certain points of the body releases endorphins, enkephalins, and other neuropeptides (Newland 1999). Along with the usual method of puncturing the skin with the fine needles, the practitioners also use heat, pressure, friction, suction, or impulses of electromagnetic energy to stimulate the points (Vickers and Zollman 1999a, Pearl and Schillinger 1999). This increases circulation, decreases muscle spasm and anxiety, and increases energy. In addition to endorphin release, acupuncture triggers the release of adrenocorticotropin hormone from the pituitary gland. Adrenocorticotropin stimulates the adrenal gland to produce cortisol. Because cortisol is known to have anti-inflammatory properties, acupuncture's efficacy in treating inflammatory conditions may also be explained by this mechanism (Vickers and Zollman 1999a, Cronin-Stubbs et al. 2000, Pearl and Schillinger 1999).

Acupuncture is best known for the control of pain. However, acupuncture can treat a wide variety of common and uncommon disorders. The 1997 National Institutes of Health Office of Alternative Medicine Consensus Panel reviewed the scientific acupuncture literature and concluded that acupuncture may be useful alone or in combination with other therapy for addiction, dysmenorrhea, lateral epicondylitis, stroke rehabilitation, chronic pharyngitis, fibromyalgia, low back pain, carpal tunnel syndrome, asthma, ulcers, colitis, paralytic ileus, headaches and migraines, intercostal neuralgia (pain in the ribs), sciatica, and osteoarthritis. In the United States, acupuncture is used frequently for the treatment of chronic pain conditions, such as arthritis, bursitis, headache, and athletic injuries. It is also used for treating chronic pain associated with immune dysfunction, such as psoriasis (skin disorders), allergies, and asthma. Acupuncture is also found to be effective for the treatment of mind-body disorders, such as anxiety, chronic fatigue, irritable bowel syndrome, hypertension, and depression (Cronin-Stubbs et al. 2000, Newland 1999, Pearl and Schillinger 1999). Acupuncture affects circulation, blood pressure, rhythm and stroke volume of the heart, secretion of gastric acid, and production of red and white blood cells (Cronin-Stubbs et al. 2000, Newland 1999, Pearl and Schillinger 1999).

Acupuncture is used as a treatment for these conditions because it stimulates the release of a variety of hormones that help the body respond to injury and stress, and it stimulates the release of endogenous opioids, which have known analgesic effects (Cronin-Stubbs et al. 2000). Acupuncture can also affect pathways in the central nervous system that are involved in pain perception. In magnetic resonance imaging studies of healthy human volunteers, stimulation of acupoints has been associated with activation of descending antinociceptive pathways and deactivation of limbic structures, which are thought to be involved in cognitive-affective aspects of pain perception.

The use of acupuncture is prevalent around the world, yet there are few clinical trials of it (Fassler and Lopez-Bushnell 2001). The few clinical trials that have been completed indicated that acupuncture is effective for neck and low back pain (Fassler and Lopez-Bushnell 2001). In one study, a 5-year trial of 43 patients with low back pain showed significant relief of pain by acupuncture (Fassler and Lopez-Bushnell 2001). Three research studies reported that acupuncture reduces back pain in 88% of the subjects (Fassler and Lopez-Bushnell 2001). There is evidence that acupuncture may be of benefit to individuals who have back pain, even when they have shown no response to treatments of drugs, bed rest, epidural injection, physiotherapy, osteotherapy, chiropractic therapy, and surgery (Fassler and Lopez-Bushnell 2001). The benefits that have been reported in small-scale studies include reduction in medication, faster return to work, and a decrease in the need for more-invasive forms of treatment, including surgery (Fassler and Lopez-Bushnell 2001). The research available on acupuncture and back pain seems to indicate that the best results with acupuncture are from treatments that start as soon as possible after the onset of symptoms (Fassler and Lopez-Bushnell 2001).

The National Institutes of Health Acupuncture Consensus Development Panel concluded that acupuncture is promising for control of postoperative pain, chemotherapy-associated nausea and vomiting, low back pain, headache, and carpal tunnel syndrome. In the National Institutes of Health Acupuncture Consensus Development Panel Program and Abstracts, studies that examined the effect of acupuncture on headaches were reviewed (Birch 1997). Although the studies are heterogeneous in experimental design and type of headache examined (tension, migraine), there were three design types: those using sham or placebo controls (nine studies), those using biomedical treatment or no-treatment controls (five studies), and those with more complex designs (two studies). Of six studies using a sham needle control, two studies found acupuncture to be more effective than sham needles in reducing self-reported pain (Mayer 2000), and one of these two found a reduction in medication use (Mayer 2000). None of the three studies using placebo controls found acupuncture to be more effective than placebo (Mayer 2000). Eight of the nine studies using sham or placebo controls found the acupuncture treatment to be more effective than the control treatment (Mayer 2000). In addition, all five studies using biomedical or no-treatment controls found acupuncture to be approximately equal in efficacy to standard treatment. Taken together, studies on the effect of acupuncture on headache suggest that it may prove useful, but a definitive conclusion awaits the results of experiments designed with more specific hypotheses and larger sample sizes (Mayer 2000).

In a study by Galantino et al. (1999), seven persons with human immunodeficiency virus–related peripheral neuropathy completed a 30-day trial of daily noninvasive electroacupuncture. *Noninvasive electroacupuncture* involves the administration of electrical current through surface electrodes placed over acupuncture points. Participants self-administered the treatment at home for 20 minutes each day. At the end of the 30-day treatment period, significant differences in pain intensity and functional activity were reported by five and six participants, respectively. In a study conducted by Kemper et al. (2000), 47 families agreed to acupuncture treatment. The patients had a median age of 16 years, 79% were women, and 96% were white. The most common three diagnoses were migraine headache, endometriosis, and reflex sympathetic dystrophy (Kemper et al. 2000). Patients received a median of eight treatments within 3 months (Kemper et al. 2000). Acupuncture therapies included needle insertion (98%), heat and moxibustion (85%), magnets (26%), and cupping (26%) (Kemper et al. 2000).

Most patients rated the therapy as pleasant (67%), and most believed that the treatment had helped their symptoms (70%) (Kemper et al. 2000).

Through the results of research conducted by (Berde et al. 1999), it was concluded that the average visit length for an initial visit to an acupuncturist was 80 minutes and 57 minutes for follow-up visits; charges averaged $78 for initial and $54 for follow-up visits. Only 5% of fees were covered by insurance, and these tended to be worker's compensation or automobile accident claims. Most practitioners (64%) offered sliding scales, but only 21% saw Medicaid patients. Fees for acupuncture services are comparable to office visit fees for physicians. However, almost all (95% median) acupuncture fees are paid by patients.

HERBAL MEDICINE

Herbal medicine, sometimes referred to as *herbalism* or *botanical medicine*, is defined as the use of herbs for their therapeutic or medicinal value. An herb is a plant or plant part valued for its medicinal, aromatic, or savory qualities. Herbs produce and contain a variety of chemical substances that act on the body.

Herbal therapy is thought to be a more natural way to heal the body (Newland 1999). Herbal medicine can be broadly classified into various basic systems: traditional Chinese herbalism, which is part of traditional Oriental medicine; Ayurvedic herbalism, which is derived from traditional Hindu religion; and Western herbalism, which emphasizes the effects of herbs on individual body systems (Vickers and Zollman 1999c). Herbs have been used by all cultures throughout history. Herbalism is an integral part of the development of modern civilization. Originally confined to health food shops, herbal remedies are now marketed in many conventional pharmacies (Vickers and Zollman 1999c). The herbal remedies are usually taken as tinctures (alcoholic extracts) or teas, syrups, pills, capsules, ointments, or compresses.

Many medications commonly used are of herbal origin. Approximately 25% of the prescription medications dispensed in the United States contain at least one active ingredient derived from plant material. Some are made from plant extracts; others are synthesized to mimic a natural plant compound. Substances derived from the plants remain the basis for a large proportion of the commercial medications used today for the treatment of heart disease, high blood pressure, pain, asthma, and other problems. For example, ephedra is an herb that has been used in traditional Chinese medicine for more than 2,000 years to treat asthma and other respiratory problems. Ephedrine, the active ingredient in ephedra, is used in the commercial pharmaceutical preparations for the relief of asthma symptoms and other respiratory problems.

Although herbal preparations are widely used as self-medication for acute conditions, practitioners of herbal medicine tend to concentrate on treating chronic conditions, such as asthma, eczema, premenstrual syndrome, rheumatoid arthritis, migraine, menopausal symptoms, chronic fatigue, and irritable bowel syndrome (Vickers and Zollman 1999c). Herbs may be used for their anti-inflammatory, expectorant, antispasmodic, or immunostimulatory properties. The herbs most frequently used in the United States for multiple sclerosis are astragalus (milk vetch root) and ginseng to treat fatigue, chamomile as an antispasmodic, kava and St. John's wort (*Hypericum perforatum*) as antidepressants, and valerian as an anti-anxiety and antispasmodic (Newland 1999). In southern China, an herb called *Tripterygium wilfordii* hook F is used to suppress the immune response and helps suppress multiple sclerosis.

The aim of herbal treatment is usually to produce persisting improvements and wellness (Vickers and Zollman 1999c). In laboratory settings, plant extracts have been shown to have a variety of pharmacologic effects, including anti-inflammatory, vasodilatory, antimicrobial, anticonvulsant, sedative, and antipyretic effects (Newland 1999, Vickers and Zollman 1999c). Human studies also confirm the specific therapeutic effects of particular herbs; randomized controlled trials support the use of ginger for treating nausea and vomiting (Newland 1999, Vickers and Zollman 1999c), feverfew for migraine prophylaxis, and ginkgo for cerebral insufficiency and dementia (Newland 1999, Vickers and Zollman, 1999c). The best-known evidence regarding an herbal product concerns St. John's wort for treating mild to moderate depression. A systematic review of 23 randomized, controlled trials found the herb to be significantly superior to placebo and therapeutically equivalent to antidepressants, such as amitriptyline, but with fewer side effects (Vickers and Zollman 1999c).

In another study of traditional Chinese herbal treatment, eczema was studied in depth (Vickers and Zollman 1999c). As prescriptions depend on patients' exact presentations, only those with widespread, nonexudative eczema were included. Eighty-seven adults and children with refractory to conventional first- and second-line treatment were randomized to a crossover study that compared a preparation of approximately 10 Chinese herbs with a placebo consisting of herbs thought to be ineffective for eczema. Highly significant reductions in eczema scores were associated with active treatment but not with a placebo. At long-term follow up, more than half of the adults (12 of 21) and more than 75% of the children (18 of 23) who continued treatment had a greater than 90% reduction in eczema scores.

Because of the reported success stories, the interest in herbal medicine has been growing rapidly since the early 1990s. The 1997 annual U.S. sales of botanical products have been estimated at $5.1 billion, with future growth projected at 15% per year (Eisenberg et al. 1998). In the United States, the total market for medicinal botanicals was worth $3.87 billion in 1998, and alternative medicine treatments collectively were worth $27 billion. One survey, by Eisenberg et al. (1998), was based on a sample from across the United States by random telephone dialing. It suggested that the 1-year prevalence of complementary and alternative medicine use was 34%. Medical herbalism was the therapy showing the largest increase (380%) (Ernst 2000).

MANIPULATIVE THERAPIES: CHIROPRACTIC CARE AND OSTEOPATHY

Chiropractic care and osteopathy are therapies of the musculoskeletal system that were systematized in the late nineteenth century. These practitioners work with bones, muscles, and connective tissue, using their hands to diagnose and treat abnormalities of structure and function (Vickers and Zollman 1999d). Chiropractors are more likely to push on vertebrae with their hands, whereas osteopaths tend to use the limbs to make levered thrusts. Some osteopaths also practice a technique known as *cranial osteopathy* or *craniosacral therapy* (CST). Practitioners place their hands on the cranium and sacrum and gently handle the bones of the skull. The practitioners say that by feeling for and working with subtle rhythmic pulsations of the cerebrospinal fluid, they can correct disturbances in the neuromuscular system (Vickers and Zollman 1999d). Cranial osteopathy also has a reputation for treating children with such conditions as infantile colic, constant crying, and behavioral problems.

Treatment for the persistence of neuromusculoskeletal disorders, especially low back pain, into the subacute and chronic stages, includes using more than only passive modalities and manipulation (Mizel 1999). The most widely used technique is the "high-velocity thrust," a short motion usually applied to the spine (Vickers and Zollman 1999d). This maneuver is designed to release structures with a restricted range of movement. Practitioners also use a range of soft tissue techniques that do not involve high-velocity thrusts. For example, the "muscle energy techniques" make use of a "contract-relax cycle" to increase restricted ranges of movement.

Low back pain is the most common complaint seen by chiropractic and osteopathic practitioners (Vickers and Zollman 1999d). Other conditions often seen include neck and shoulder pain, sports injuries, repetitive strain disorders, headaches, and arthritis. Although they cannot affect disease pathology or progression, the practitioners claim to be able to treat secondary symptoms, such as pain from associated muscle spasm. Several randomized, controlled trials of the effectiveness of spinal manipulation for back and neck pain were conducted. In one trial, 741 patients with low back pain were randomized to chiropractic or hospital outpatient care. In addition to effects on back and neck pain, this randomized trial also indicated that manipulative treatment is beneficial for headache, including migraines (Vickers and Zollman 1999d).

A typical treatment session lasts approximately 15–30 minutes, although the first consultation may take longer. A course of chiropractic treatment for back pain might consist of six sessions, initially frequent and then at weekly intervals (Vickers and Zollman 1999d). Osteopathy and chiropractic care are almost exclusively based in the community and private sector. Some independent manipulative practitioners have established contracts with health authorities, fund holding practices, or primary care groups. Most health insurers offer some coverage for manipulative treatment.

CRANIOSACRAL THERAPY

CST is a gentle, noninvasive treatment approach that relies primarily on hands-on evaluation and treatment. It focuses on the normalization of bodily functions that are either part of or related to a semiclosed hydraulic physiologic system, which has been named the *craniosacral system*. The anatomy of the craniosacral system includes (1) a watertight compartment formed by the dura mater membrane, (2) the cerebrospinal fluid (CSF) within this compartment, (3) the inflow and outflow systems that regulate the amount of pressure on the cranial bones to which the dura mater attaches, (4) the joints or sutures that interconnect the cranial bones and other bones not anatomically connected to the dura mater. The bones of the cranium, as well as the second and third cervical vertebrae, the sacrum, and the coccyx, are also included in the structures of the craniosacral system (Upledger 1983, 1987).

The semiclosed hydraulic system includes the dural sleeves, as they invest the spinal nerve roots outside of the vertebral canal as far as the intervertebral foramina, and the caudal end of the dural tube, which ultimately becomes the cauda equina and blends with the coccygeal periosteum. The fluid within the semiclosed hydraulic system is CSF. The choroid plexuses within the brain's ventricular system and arachnoid granulation bodies regulate the inflow and outflow (respectively) of the CSF. CSF outflow is not rhythmically interrupted, but its rate may be adjusted by intracranial membrane tension patterns, which are broadcast primarily via the falx cerebri and tentorium cerebelli to the anterior end of the straight venous sinus, where an aggregation of arachnoid granulation bodies is located. This concentration of arachnoid granulation bodies is known to effect venous backpressure, which has an effect on the rate of reabsorption of CSF into the blood-vascular system (Retzlaff et al. 1978, Retzlaff et al. 1976, Kostopoulos 1992).

In combination with the message sent to the patient through the intentioned touch of the therapist is the corrective work that is done on a basic physiologic level, in which the fluid is gently moved by gentle hands-on manipulations applied directly and indirectly to the craniosacral system. More information on CST can be found at http://www.cranio.co.uk/about.htm.

The inter-rater reliability of experienced craniosacral therapists of palpating the craniosacral rhythm was intraclass correlation coefficient = 0.02 (Wirth-Pattullo and Hayes 1994).

The therapist, after mobilizing bony restrictions, focuses on the correction of abnormal dural membrane restrictions, perceived CSF activities, and energy patterns and fluctuations as they relate to the craniosacral system.

It is during this time that the patient often moves from a phase of being corrected and having obstacles removed to a phase of self-healing, with the therapist serving as a facilitator to the process. The tenants of CST include the concept that the dura mater membrane within the vertebral canal (dural tube) has the freedom to glide up and down within that canal for a range of 0.5–2.0 cm. This movement is allowed by the slackness and directionality of the dural sleeve as it departs the dural tube and attaches to the intertransverse foramina of the spinal column (Upledger 1987, Kostopoulos 1992). Ill health may manifest as sites of inertia or loss of smooth motions within the dural sleeve, according to the CST philosophy.

A basic assumption in CST, as it has evolved, is that the patient's body contains the necessary information for the discovery of the cause of any health problem. The treatment relies primarily on hands-on evaluation and treatment. The hands-on contact is accompanied by sincere intention to assist the patient in any way possible. In short, the therapist serves primarily as a facilitator to the patient's own healing process. The rapport that develops during the patient-therapist interaction lends itself powerfully to the positive therapeutic effect that many patients experience.

MYOFASCIAL RELEASE

Myofascial release is a highly specialized stretching technique used to treat patients with a variety of soft tissue problems (Talmage et al. 1999). When muscle fibers are injured, the fibers and the fascia that surround them become short and tight. As fascia has a tensile strength of 140 kg/cm^2 (2,000 $lb/in.^2$), this uneven stress can be transmitted through the fascia to other parts of the body, causing pain. Myofascial release treats these symptoms by releasing the uneven tightness in injured fascia (Travell and Simons 1992, Barnes 1990, Ramsey 1999).

Myofascial release is a manual therapy that can be used effectively with patients who have diminished hydration of tissue, myofascial shortening, and cross-linked collagen restrictions in their bones (Talmage et al. 1999, Barnes 1990, Ramsey 1999). The therapist trained in this technique places his or her hands on the patient and performs longitudinal stretching of the tissue, from distal to proximal, while using passive or active positioning of the tissue (Talmage et al. 1999). The therapist waits until the tissue responds under the surface of the practitioner's hand (Barnes 1990, Bottomley 2001). This feedback tells the therapist how much force to use, the direction of the stretch, and how long to stretch. Within 90–120 seconds, the tissue begins to move in a three-dimensional flowing manner, and the practitioner follows the flow of tissue to increase the length of this tissue with the softening of the myofascia underneath the hands (Barnes 1990).

A 2000 (Hanten et al.) study evaluated the efficacy of the use of ischemic compression followed by stretching and found this to be beneficial in managing myofascial trigger points, a common problem in our elderly population. Fascial restrictions released in this way over time result in improved balance and strength, helping to eliminate pain and poor posture.

PRAYER AND SPIRITUALITY

Since 1990, a growing body of research has examined both religious and spiritual concepts and their relationships to health (Chandler and Meisenhelder 2000). There are many ways to connect with one's spirituality, such as meditation, prayer, contemplation, silence, chanting, service, worship, ritual, acknowledgment, and gratitude; however, the two most widely researched and popular are prayer and spirituality.

Prayer is most often defined as a form of communion with a deity or creator and has been classified as a complementary or alternative therapy. Types of prayer include (1) contemplative-meditative prayer (which involves an intimate and personal relationship with a deity), (2) ritualistic prayer (repetition from printed material or memory), (3) petitionary prayer (asking God to meet specific personal needs or significant needs of others), (4) colloquial prayer (having conversations with God), and (5) intercessory prayer (praying for others) (Chandler and Meisenhelder 2000).

Spirituality can assist individuals facing uncertainty with chronic disease. Spirituality can be helpful in the management of rheumatoid arthritis and in helping individuals attain positive health perception (Potter and Zauszniewski 2000). Spiritual well-being was found to be important in helping individuals diagnosed with diabetes mellitus adapt to the uncertainty that accompanies chronic disease (Potter and Zauszniewski 2000). It was also found that some individuals, despite being involved over an extended period of time with a chronic disease, maintain a positive psychological view of their health (Potter and Zauszniewski 2000). Further research posited that one's spiritual belief has an indirect effect on the mind, such as promoting a calming influence, which may allow an individual to function cognitively at a higher level (Potter and Zauszniewski 2000).

MOVEMENT THERAPIES: FELDENKRAIS, T'AI CHI, AND YOGA

The human body needs to move, particularly when one becomes older. Manual movements, such as reaching, grasping, transporting, or manipulating objects, are essential to everyday life. Movement contributes to quality of life in general as well as to some specific daily activities. Movement is pleasurable, stress reducing, stimulating to the cardiovascular and lymphatic systems, and strengthening. There are many types of movement therapies, and Feldenkrais, t'ai chi, and yoga are introduced here.

The Feldenkrais techniques impart a sense of exploration, experimentation, and innovation that allows each person to find his or her optimal style of movement (Birkel 1998). The Feldenkrais method involves movement sequences that address joint and muscle groups and aspects of human functioning. It is proven to be beneficial for orthopedic and neurologic problems (Birkel 1998). The Feldenkrais method includes two approaches: awareness through movement and functional integration. Awareness through movement stresses the use of nonhabitual movements that link with the nervous system and the ways an individual learns. It involves nonstrenuous and gentle sequences designed to replace old patterns of movement with new ones. The functional integration involves the practitioner's actively guiding the client's body through individualized movements.

T'ai chi has been widely practiced in China for centuries as an art form, religious ritual, relaxation technique, exercise, and method of self-defense (Chen and Snyder 1999). It is unique for its slow, smooth movements with low impact, low velocity, and minimal orthopedic complications. It is a suitable conditioning exercise, especially for the elderly. This is because t'ai chi is not a vigorous type of exercise. Among other things, t'ai chi is used to rehabilitate persons with rheumatoid arthritis and to reduce pain, stress, and nightmares. Research by Chen and Snyder (1999) revealed two studies that evaluated the safety and potential use of t'ai chi as a weight-bearing exercise for patients with rheumatoid arthritis. The two studies required rheumatoid arthritis patients to bear full weight on both legs. The patients received 1 hour of t'ai chi instruction once or twice a week for 10 consecutive weeks and were compared to controls. It was concluded that t'ai chi has various benefits, including balance improvement, fall prevention, cardiovascular enhancement, and stress reduction. A further analysis of both studies showed no deterioration in joint tenderness or joint swelling. These findings suggest that t'ai chi appears to be safe for patients with rheumatoid arthritis and may serve as an alternative form of exercise therapy in rehabilitation programs (Chen and Snyder 1999, Vickers and Zollman 1999e).

The practice and study of yoga helps bring about a natural balance of body and mind in which the state of health can manifest. It helps keep the spine flexible, muscles strong, and bones dense (Birkel 1998). Yoga creates an internal environment that allows an individual to come to his own state of dynamic balance or health. Yoga teaches that a healthy person is a harmoniously integrated unit of body, mind, and spirit. In research studies, it has been shown that with the practice of yoga, a person can learn to control blood pressure, heart rate, respiratory function, metabolic rate, skin resistance, brain waves, body temperature, and other bodily functions (Birkel 1998). This is perhaps because perception and management of pain are closely linked to the mind and body connection (Galantino et al. 2000). Yoga has been shown to decrease somatic complaints, such as carpal tunnel syndrome, arthritis, asthma, obsessive-compulsive disorder, and methadone maintenance (Birkel 1998). Kabat-Zinn reported using simple asana and meditation to produce a greater than 33% decrease in pain in 65% of the chronic pain subjects (Galantino et al. 2000).

HYPNOSIS, RELAXATION, AND GUIDED IMAGERY

The primary uses of hypnosis and relaxation techniques are in anxiety, disorders with a strong psychological component (e.g., asthma), conditions that can be modulated by levels of arousal (e.g., pain), and programs for stress management (Vickers and Zollman 1999e).

Hypnosis is the "induction of a deeply relaxed state, with increased suggestibility and suspension of critical faculties" (Vickers and Zollman 1999e). This state is often called a *hypnotic trance*. Once in this state, patients are given therapeutic suggestions to encourage changes in behavior or relief of symptoms, especially in patients with arthritis. Patients normally see hypnotic practitioners for a 1.0-hour or 0.5-hour treatment. However, some general practitioners follow a longer initial consultation with standard 10- to 15- minute follow-up appointments (Vickers and Zollman 1999e).

There is good evidence from controlled trials that hypnosis and relaxation techniques can reduce anxiety and pain, especially the pain that is associated with cancer (Vickers and Zollman 1999e).

Most relaxation techniques are taught over the course of eight 1-hour weekly classes and need to be practiced daily (Vickers and Zollman 1999e). Relaxation practitioners use conventional diagnoses as described by the patient to design an appropriate program for the patient.

Guided imagery, including visualization, acts as a mechanism for perceptional, emotional, and bodily changes (Norred 2000). Guided imagery, which brings the imagination process into the visual realm, is another tool to engage the mind in the healing process. This type of therapy uses pictures instead of words. It facilitates the healing process, controls chronic pain, and decreases anxiety (Norred 2000). Visualization and imagery techniques are similar to hypnosis. The main differences are that the suggestions are visual and usually generated by the patients themselves. This technique is particularly used in treating cancer patients (Vickers and Zollman 1999e).

BIOFEEDBACK

Biofeedback operates on the notion that we have the innate ability and potential to influence the automatic functions of our bodies through the exertion of will and mind. Several different types of biofeedback machines can provide information regarding the systems in the body that are affected by stress. A number of studies have been performed using the electromyogram (EMG), which measures muscle tension, and thermal biofeedback (Crary and Groher 2000). EMG and thermal biofeedback have been used for the treatment of tension headaches, backache, and neck pain, as well as in stress-related illnesses, such as asthma and ulcers (Martelli et al. 1999). In a study conducted by Ham and Packard (1994), the sites examined for the treatment of chronic post-traumatic headaches included the forehead, frontal-posterior neck, and neck. The study reported that combined EMG and thermal biofeedback resulted in at least moderate improvement of headache pain for 53% of 40 chronic post-traumatic headache patients.

EMG biofeedback and cognitive-behavioral therapy are another form of therapy. Their effectiveness has been demonstrated for the treatment of various pain disorders, including headaches and facial pain (Martelli et al. 1999) Preliminary reports suggest that EMG biofeedback and cognitive-behavioral therapy are helpful for the treatment of disorders with high physiologic reactivity components, including chronic head and neck pain, and disorders associated with strong anxiety (Martelli et al. 1999).

CONCLUSION

There is no one-size-fits-all approach in traditional medicine. Treatment plans are customized and then adjusted over time. Because many people who have chronic pain do not feel the need to wait for the results of research that has not yet been done, they may readily turn to the comfort and support provided by traditional therapies. Natural healing offers much to enhance day-to-day self-care, which often improves patients' attitudes toward their medications.

Considerable research suggests that strong social support improves medical outcomes. People who have partners or a strong social network are less likely to have illness and will recover more quickly. Possibilities for support do not end with friends, family, and environment. Social interventions have also been found to be an important adjunct to medical interventions in a number of studies on chronic pain, especially on rheumatoid arthritis (Potter and Zauszniewski 2000). In another study that was reviewed, researchers found that successfully coping with chronic pain included an individual sense of illness control and predictability, a self-evaluation of success in coping, and an expectation of future success in coping (Potter and Zauszniewski 2000). Individuals with chronic pain who identify a lack of family support perceive greater levels of pain, use more medications, and are more limited in their activities (Newland 1999, Potter and Zauszniewski 2000). Successful coping was also found to be an active process rather than a passive one; coping behaviors were viewed as purposeful, consciously chosen, and responsive to environmental factors.

Empowered patients can organize holistic approaches to their health care without piling up a stack of practitioners or going off their budgets. Although the field of complementary therapies is vast, one can make sense of it by simply identifying all the areas of self-care that contribute to well-being. Natural therapies offer people many opportunities to engage in their healing on a daily basis. An overview of the different categories of complementary care and how they work together to contribute to overall physical and emotional wellness will help individuals combine professional care and self-care to create a complementary program that meets their own needs and lifestyles.

RECOMMENDED WEB SITE

Enhancing the accountability of alternative care. Available online at: http://www.milbank.org/mraltmed.html#cost

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Chapter 18

Pain and the Placebo in Physiotherapy: A Benevolent Lie?*

Maureen J. Simmonds

Why is it that apparently similar (even simple) injuries are a minor inconvenience for some individuals yet lead to a downward spiral of distress and disability for others? Why does the same treatment, applied by the same therapist for apparently similar conditions, work for some patients but not for others? Why does the same treatment have a different outcome when applied by different therapists? Why do some treatments appear so successful for a wide variety of conditions when first introduced but gradually lose their effectiveness and go out of vogue?

These questions and many others are not answered within the traditional, disease-focused medical model. They highlight the complexity of health, healing, and the health care system. A plethora of factors, beyond disease or injury, influences individuals' responses to their health problems, the treatment encounter, and the specific treatment. These nonspecific influences on treatment outcome are the *placebo effect*.

To truly understand the mechanisms involved in the treatment and healing process, it is necessary to understand the disease and the person with the disease. It is just as important to understand the practitioner. Practitioners' experiences, biases, and beliefs regarding the effectiveness of specific treatments, the patient, and the patient's problem also influence assessment findings and expected outcome (Gracely 1985, Simmonds and Kumar 1996, Simmonds et al. 1996, Ashton et al. 1991). The specific effects of the treatment itself may have a minimal additive role in the actual outcome.

The purpose of this paper is to discuss the magnitude and mechanisms of the placebo effect, especially in regard to placebo analgesia. A secondary aim is to consider the ethical and moral implications involved in using the placebo in physiotherapy treatments.

HISTORICAL PERSPECTIVE

Placebo is a term with an ancient origin. The simple translation from Latin, "I will please," is the usually accepted derivation. Since the eighteenth century, the term *placebo* has been used in a generally derogatory manner for mock medicine or quackery. A placebo treatment was considered a "nontreatment." The denigration of the placebo corresponded with an increase in the "science" of medicine (the biomedical model) and a belief in the objectivity and omnipotence of this science. In such a context, a placebo treatment was used as a simplistic check on the veracity of organic symptoms. A positive placebo reaction was interpreted

*Simmonds MJ. Pain and placebo: the benevolent lie? Physiotherapy 2000;86:631–637. Reprinted with permission. This article is based on a paper delivered at the World Confederation of Physical Therapy. Yokohama, Japan, 1999.

as proof of a somatic hallucination. Today, the placebo effect is generally acknowledged as a component of all traditional and nontraditional treatments, and serious research efforts are under way to understand the mechanisms of the placebo effect and the factors that influence it.

It is interesting to consider that the healing power of the placebo is so great that its use is mandatory in clinical trials, yet it is generally regarded as unethical to use the placebo in clinical practice. The problem is that it is difficult to distinguish between treatments that are primarily placebo and those that have specific physiologic effects, because many commonly used clinical interventions have been inadequately researched. Although some treatments appear to have stronger biological plausibility than others, that plausibility is still based on our current understanding of biology, and that understanding is subject to change. For example, it wasn't long ago that the mature nervous system was thought to be a static, hard-wired system and that bed rest was good for back pain.

COMPONENTS OF TREATMENT EFFECTS: SPECIFIC AND PLACEBO

All treatments, traditional or otherwise, have specific and nonspecific effects. For convenience and by convention, specific treatment effects are defined in physiologic terms (an increase in blood flow, a decrease in nerve conduction velocity), whereas nonspecific effects are everything else; they are "noise." Because traditional health care is primarily based on physiology and pathophysiology, treatments are developed and targeted using a physiologic approach. Therefore, it is not surprising that this framework is used to explain specific treatment effects. In this context, nonphysiologic or placebo effects of treatment are regarded as artifact. However, this simple categorization of physiologic versus nonphysiologic effects is an oversimplification. Richardson (1989) argues that the use of a single term (*placebo*) to describe disparate phenomena is potentially misleading, because it creates a spurious impression of homogeneity and stability of response. It is now evident that this nonphysiologic "noise" has specific physiologic effects (Hashish et al. 1988).

For example, Hashish (1988) found that under certain conditions, ultrasound was effective not only in reducing pain, but also in reducing the swelling that occurred after wisdom tooth extraction. Clearly, reduction of swelling is an objectively measurable physiologic indicator. This suggests that ultrasound has a specific physiologic effect, which is a position argued in most electrotherapy texts. However, for the ultrasound to reduce swelling, in Hashish's study, it was necessary for both patient and practitioner to believe in its efficacy and for the machine to have no output.

VARIABILITY IN MAGNITUDE OF THE PLACEBO EFFECT

For many years, placebo effects of treatment were considered to contribute a fixed fraction (one-third) to any treatment. This commonly held clinical belief is erroneous. It stems from an oft- but incorrectly cited paper by Beecher (1959), who summarized the results of his own studies to obtain the average placebo effect, which happened to be 36%. However, the average placebo effect was rather meaningless and misleading even at the time of publication, because the magnitude of the placebo effect in Beecher's studies varied between 15% and 58%, depending on the treatment and the outcome measured.

In a controlled trial, the relative magnitudes of the placebo effect and the specific treatment effect on a particular outcome can be determined by examining the pre-treatment to post-treatment change in both experimental and control groups. The magnitude of change that occurs in the experimental group represents the total treatment effect (specific and placebo). The magnitude of change that occurs in the control group is the placebo effect. The difference between groups is the specific effect.

Simmonds and Kumar (1994) reviewed a series of experimental studies and computed the nonspecific effect of transcutaneous electrical nerve stimulation (TENS) and laser. Using published data from controlled trials, they calculated the change from baseline in the control groups to determine the magnitude of the placebo effect. They reported that the placebo effect of TENS ranged between 5% and 72%, depending on the outcome measured, whereas the placebo effect of laser was l00%. Thus, the specific effect of TENS ranged between 28% and 95%, whereas the specific effect of laser was zero.

In most studies, the investigator is interested in the effect of a particular treatment, so the focus is on change due to treatment in the experimental group. There is implicit acknowledgment of the placebo effect, evidenced by the use of a control group, and the requisite statistical tests are run to ensure that the experimental group changed significantly more than did the control group. The actual change that occurs in the control group is essentially ignored. Until recently, little consideration was given to the magnitude of the placebo effect or why it was of such magnitude.

Methodologic Factors and Placebo Magnitude

The magnitude of the placebo effect is likely to be influenced by many of the same factors that influence the magnitude of the specific treatment effect (e.g., number and condition of the subjects, experimental control, and specific outcomes used). The number of subjects influences the power of the study (Cohen 1988) and validity of the findings, and thus the relative magnitude of both specific and placebo effects. The condition of the subjects is important, because the natural history of many conditions is either not known or is known to improve spontaneously. Thus, the timing of the intervention, acuity of exacerbation, length of follow-up, and natural history of the condition together and separately influence the measured magnitude of total treatment effectiveness and the components of treatment effectiveness (placebo and specific). Finally, the degree of experimental control of research testers and subjects, characteristics of the treatment, and outcome measured all influence analgesic response (see Outcome and Placebo Magnitude).

Outcome and Placebo Magnitude

Placebo and specific effects together equal the total treatment effect on a given outcome. By convention, placebo effects are often reported as a percentage of total treatment. Thus, because total treatment effect for a given outcome is 100%, treatments with a large specific effect will appear to have a relatively small placebo effect, and vice versa. Unfortunately, percentage values of specific versus placebo effects within a treatment group can distort the absolute magnitude of change and its clinical significance, or lack thereof.

Mathematics can also distort the designation of treatment success and thus the apparent magnitude of placebo. For example, pain relief is frequently reported as percent change between pre- and post test, and the criterion for treatment success is a certain percentage reduction (e.g., 50%). Results of studies using such percent reductions are biased in favor of patients with low baseline levels of pain. A pain reduction of 50% is relatively easy to achieve when patients have low levels of pain. A baseline pain score of 2 on a 0–10 scale needs to be reduced by one level (i.e., to a score of 1) for the treatment to be touted as effective. Fairly innocuous treatments can appear miraculous. In contrast, this oft-used 50% pain reduction criterion of success is much harder to achieve when patients have relatively high levels of pain. A baseline pain score of 8 on a 0–10 scale must be reduced by four points to a score of 4 for the treatment to be designated as effective.

Measuring pain relief can also be problematic, because it relies on the patient's memory of pretreatment pain. Pain memory is not only inaccurate, but there is also a tendency toward exaggeration of past pain (Erskine et al. 1990). Therefore, the analgesic effect of treatment will appear greater if pain is tested retrospectively (Price et al. 1999). Whether there will be a disproportionate change in the relative magnitude of placebo and specific components is not clear.

In contrast, treatment effects can appear reduced with the use of measures that are insensitive or have poor reliability. Although four- or five-point categorical pain scales have been used as outcome measures for many studies, including those testing TENS (Thorsteinsson et al. 1978, Hansson and Ekbiom 1983, 1984), the measures are not precise and are unable to measure relatively small changes in pain (Marchand et al. 1993). Potentially, this means that neither specific nor placebo effects of treatment will be evident.

Poor reliability of an outcome measure suggests that the results will be subject to measurement error. Thus, similar studies could produce conflicting results regarding the magnitude of placebo and specific effects, simply owing to measurement error. Questionable outcomes are also problematic. For example, it is interesting to note that Deyo et al.'s (1990) influential study asserting that TENS was primarily placebo used outcomes that were primarily exercise related, rather than pain related. Yet, TENS is a treatment that is designed to modulate nociceptive input and pain, not activity.

Moreover, physical therapy treatments may have a differential effect on different components of the pain. Pain is a multidimensional phenomenon, and sensory and affective components of pain change differentially (Gracely et al. 1979, Price and Barrell 1984, Marchand et al. 1993). Therefore, unless sensory and affective components of pain are measured independently, treatments may appear to have neither specific nor placebo effects.

Experimental Control and Placebo Magnitude

One of the most important methodologic factors influencing the magnitude of specific and placebo effects is the degree of experimental control. A rigorous study should be double blind and include naïve subjects and experimenters. Subject and experimenter expectations of outcome must be controlled. The experimental treatment must be matched with a sham treatment that is almost equivalent and a no-treatment group.

The sensory characteristics of many therapies make blinding of patients and practitioners problematic. Research that compares different treatments is plagued by the problem that both may be placebo. Sensory characteristics of a treatment intervention and the perceptual interpretation of "sensation" provides a window of observation on the placebo effect. To illustrate this point, I'd like to relate a research experience that I found fascinating. An experiment was designed to determine whether TENS had a differential analgesic effect that was dependent on the quality of the evoked pain (Simmonds et al. 1992). In this experiment, subjects were required to sit with one arm behind a curtain. Pain threshold and tolerance to sharp and dull pain were measured on the subject's hand before an application of TENS. TENS was applied for 20 minutes at one of two intensities: on (experimental group) or off (control group). The "on TENS" was then applied at a "strong but comfortable" intensity. To maintain this intensity of TENS, every 5 minutes, subjects were asked to report the sensation they were feeling in their hands as a result of the treatment. Adjustments to TENS intensity were then made as necessary. To make the conditions between groups as similar as possible, subjects in the control group ("off TENS") were also asked to report the sensation they were feeling in their hands as a result of the "treatment." Feigned adjustments to TENS intensity were then made.

Predictably, subjects in the experimental group reported sensations of buzzing or tingling in their hands that only varied in the strength of sensation. Much less predictable were the reports from subjects in the control group. Subjects reported sensations of heat, cold, numbness, tingling, and tightness. One subject reported that he felt as if his hand was blue (his hand was behind a curtain). Clearly, the absence of strong, well-defined sensory input resulted in a perceptual judgment that relied as much on imagination as on sensory input. The responses may also reflect social desirability (i.e., the research subjects desire to provide a response to please the investigator).

Do patients attending treatment provide the socially desirable response that they are feeling better to please their therapists? In a recent review of physical therapy and physical modalities for the control of chronic pain of musculoskeletal origin, Feine and Lund (1997) found no evidence that any specific therapy was more effective in the long term than placebo treatment. Yet, they also reported that placebo treatments were usually more effective than no treatment. Patients who had more treatment did better than those who had less treatment. How is this "nontreatment" helpful, and what are the mechanisms of this effect?

MECHANISMS OF PLACEBO EFFECTS

Research testing the mechanisms of placebo analgesia has focused on the role of classical conditioning or psychological factors, such as anxiety, expectancy, faith, and hope (Price et al. 1999).

Conditioning

Several investigators have proposed that the placebo response is partially explained by classical conditioning (Wickramasekera 1985, Watkins and Mayer 1982). For example, in drug trials, placebo effects are stronger when the placebo is given after the true medication (Laska and Sunshine 1973). Also, the time course of saline injections strongly mimics that of morphine in morphine-experienced patients. The similarity goes beyond the conditioned response. If a placebo is given repeatedly, the effect declines. This has been shown in a variety of experiments in which pain stimuli, analgesics, and placebo creams have been used (Voudouris et al. 1989, 1990).

However, conditioning appears to be complemented by expectancies, and it is difficult to tease out the relative contributions of each. Placebo effects are influenced by context and suggestion, as well as by the conditioning effect of a specific treatment (Price 1999). For example, patients with pain have expectations of pain relief when they attend a clinic and are treated by a knowledgeable and empathetic medical professional.

Beliefs and Expectations

The most commonly accepted mechanism of the placebo effect is based on treatment expectation. Expectation is given a variety of names: belief, faith, hope, confidence, enthusiasm, bias, meaning, credibility, transference, and anticipation (Price et al. 1999, Price and Barrell 1984, Evans 1985, White et al. 1985, Montgomery and Kirsch 1996, Fields and Price 1997, Wall 1994). Essentially, whether an individual will react to a placebo treatment can be determined before a treatment trial. It simply requires asking each participant what he or she expects the treatment outcome to be. Those who expect positive outcomes tend to get positive outcomes, whereas those who don't expect positive outcomes tend not to get positive outcomes.

Expectation is a learned state and is based on experiences. This learning of expected treatment effects is influenced by such factors as culture, education, and experience. For example, individuals' beliefs regarding injury, disease, illness and wellness, and the implications of such states will guide their health-related behavior. Given the choice, individuals seek help from the practitioner, be it physician, physiotherapist, spiritual advisor, or faith healer, who has the skills, knowledge, and powers they believe can help. Experiences with a particular type of practitioner or a specific practitioner will have a profound effect on individuals' subsequent health care decisions and their expectations of treatment outcome.

Likewise, it is the health practitioner's beliefs regarding a specific treatment that determine which interventions are used and which are not. Evidence supporting or refuting treatment effectiveness does not necessarily influence those beliefs. A belief is a fact to a believer. The congruence between patient's and practitioner's beliefs regarding the problem and the treatment will potentially affect the patient's efforts, enthusiasm, and adherence to treatment, thereby further complicating efforts to distinguish between specific and placebo effects.

Reduction of Anxiety and Desire for Relief

Clearly, the encounter of two people, one unwell and one wanting to help, can lead to the former's feeling less unwell, and any treatment may have a minimal additive effect (Wall 1994). Interventions (including physical therapy) can have a differential effect on pain affect compared to pain intensity (Gracely et al. 1979, Marchand et al. 1993, Simmonds and Claveau 1997). It appears that, although pain intensity hasn't changed, the treatment has allowed the patient to be less bothered or worried about his or her pain. Part of the mechanism involved in decreasing pain affect may be through reduction in anxiety. However, it is not yet clear whether anxiety reduction is part of the placebo effect or the cause of it. However, reduction of anxiety does explain why placebo effects seem to be greater in clinical studies in which pain is more threatening than in studies using experimental pain (Price 1999). It also explains why nonsensical clinical treatments can appear to work.

ETHICAL CONSIDERATIONS AND THE PLACEBO

The placebo effect is clearly powerful and permeates all aspects of therapy. Although its use is mandatory in clinical trials, it is generally regarded as unethical to use the placebo in clinical practice, because its use can be seen as an example of deception or outright lying (Bok 1978, Wall 1994). However, a lie is an *intent* to deceive (Purtilo 1999), and given the state of evidence supporting many common clinical beliefs and practices, it is difficult to determine whether there is true intent to deceive.

How can one judge which treatments are primarily specific in effect and which are primarily placebo when so many interventions—conservative and surgical—have never been adequately researched? If there is deception in therapy, and it is still difficult to determine who is the deceiver, who is the deceived, and when does the deception take place? The relative magnitude of specific and placebo effects varies over time and across clinical environments. Therefore, the *intent* to deceive is somewhat muddled.

Moreover, does a practitioner's lack of knowledge of treatment effectiveness belie a lack of intent to deceive the patient? Perhaps it is the practitioner who is deceived. For example, if a practitioner pays an instructor to learn how to apply a specific untested treatment, is the practitioner deceived if the treatment is primarily placebo? Should the practitioner have been better informed and expected instructors to support their assertions with empirically derived evidence? If there is deception, is the deception by the instructor intentional, or is the instructor naïve in regard to the factors (patient and therapist factors) that influence the placebo effect and, therefore, apparent treatment effectiveness? If the instructor truly believes that the effectiveness of treatment is based on specific physiologic mechanisms that suggest that they do not have the intent to lie, are they merely naïve? Should instructors be expected to support their assertions of treatment or test effectiveness with empirically derived data using a control group research design and peer reviewed publication? The results would help to address some of the ethical concerns outlined herein.

That all treatments have a placebo component complicates the ethical issues and makes tests and treatments easily "sellable" to naïve practitioners by charismatic, authoritative, and naïve instructors. After all, most experienced clinicians can offer a clinical example to apparently support their assertion of clinical effectiveness for a particular treatment. Many of us can offer a clinical example to support or refute effectiveness of most treatments we have used. Clearly, factors beyond the specific effects of the treatment influence treatment outcome.

Regardless of the above discussion, does the mechanism of effectiveness matter if the treatment works? Even if the placebo is considered to be a lie, it would appear to be a benevolent lie, wouldn't it? I know I have kissed my sons' bruised heads and scraped knees and elbows innumerable times. I've sat by their beds and held their hands with great effect when they are sick, knowing that they will soon brush me off with "Oh Mum!" when they are well. Is it reasonable to use these healing powers in the clinic and in the short term until patients are well enough to resume their independence? Is it deceptive?

The problem is that placebo treatments are not bereft of effects, and these effects may be malevolent as well as benevolent. For example, the individual may feel worse, become more dependent on the therapist, and be financially exploited when at his or her most vulnerable. Moreover, repeated treatment failures or inappropriate treatments may compound the patient's distress and anxiety.

Wall (1994) argues that it is not appropriate to use placebo treatments. He suggests that when patients choose a faith healer, they expect treatments based on faith. If, however, they seek help from traditional medicine, they expect those treatments to have a rational, tested, scientific basis, regardless of whether it is true. Thus, if practitioners use placebo treatments, they are capitalizing on patients' expectations created by the reputation and successes of traditional medicine. Where does benevolence end and exploitation begin? When, and under what conditions, are placebo treatments acceptable? Should there be full disclosure? Is it a benevolent lie or fraud to use treatments that have only placebo effects or have been untested? The answers are not easy, but the questions still should be asked. And only further empirical research can help settle the issues (Richardson 1989).

SUMMARY

The aim of this paper is to discuss the mechanisms and magnitude of the placebo effect of treatment and consider the ethical and moral implications of using placebo physiotherapy. Placebo, or nonspecific treatment effects, was long considered to contribute a fixed fraction (one-third) to any treatment effect. Recent evidence has revealed this commonly held clinical belief to be erroneous. The placebo effect of any treatment is a highly variable and complex phenomenon that is influenced by a myriad of factors. The outcome may be positive (e.g., analgesia) or negative (e.g., increased dependency on health care practitioner). Although the mechanisms of the effect are not fully understood, evidence supports the influence of classical conditioning, anxiety reduction, and the expectations of both patient and practitioner. The relationship between patient and practitioner influences the magnitude of the placebo effect, as does the method of treatment presentation. A charismatic or caring practitioner can evoke analgesia with or without further treatment. Treatment presented with an air of "mystery," apparent sophistication, or positive expectation can evoke analgesia simply through the method of its presentation. Questions regarding the ethical use of treatments that are primarily placebo need to be addressed. When and under what conditions are placebo treatments acceptable in the short or long term? Is it a benevolent lie or a regular lie to use treatments that have only placebo effects? Perhaps more important, do we know what those treatments are?

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Chapter 19

Outcomes Assessment in Patients with Chronic Noncancer Pain

Harriët Wittink, Scott A. Strassels, and Daniel B. Carr

Health care providers treat patients to make them "better." How is *better* defined, and by whom? "Better" from the practitioner's point of view, the patient's, or that of society? Is "better" less pain, increased physical functioning, decreased disability (physical therapist), increased quality of life (patient), or decreased cost to society of workers, compensation and fewer health care visits (society)? Does the same intervention that benefits one patient benefit a group of patients with similar conditions? How do we know whether it does? These are questions that the outcomes assessment movement is trying to address. This chapter discusses common terminology used in outcomes assessment and gives a number of examples of assessment tools used in measuring outcomes during the treatment of patients with chronic noncancer pain.

RATIONALE FOR OUTCOMES ASSESSMENT

Patients and their families have always been concerned with the expertise and qualifications of the health care providers caring for them, as well as the likely outcomes of proposed treatments. This concern was known and heeded well over 2,000 years ago, as articulated in "Prognosis," within the Hippocratic corpus (Chadwick et al. 1983):

> It seems highly desirable that a physician should pay much attention to prognosis. If he is able to tell his patients when he visits them not only about their past and present symptoms, but also to tell them what is going to happen . . . he will increase his reputation as a medical practitioner and people will have no qualms putting themselves under his care. Moreover, he will better effect a cure if he can foretell, from the present symptoms, the future course of the disease.

In Hippocrates' day, and for many centuries after, the outcome of a proposed treatment was a rather private affair and was often defined in terms of life or death.

In the course of the twentieth century, the evolution of outcomes research has been shaped by numerous factors, which include technologic developments in health care, changing definitions and concepts of health, and an increased focus on controlling health care costs while maintaining or improving the quality of care (Pransky and Himmelstein 1996), as well as a shift of the emphasis on acute care to the treatment of chronic diseases.

In the first part of the twentieth century, *health* was defined as the absence of disease and was measured in terms of incidence and mortality. In 1948, the World Health Organization (WHO) expanded the concept of health, defining it as "A state of complete *physical*, *mental* and *social* well being and not merely the absence of disease or infirmity" (WHO 1948). This definition reflected the multidimensionality of the concept of health and considered not only biological markers, but also the ability of an individual to perform physically, psychologically, and socially in the everyday environment.

Dichotomous outcomes, such as life and death, were no longer sufficient to measure the outcomes of care. Owing to the discrepancy between seemingly objective biological or imaging data and patients' symptoms or functioning, conventional measures of physiologic status, such as heart rate, blood pressure, and laboratory values, proved inadequate to address the effectiveness of medical care on the patients' overall health. This recognition spurred the development of new instruments to assess patients' symptoms, ability to perform various tasks of daily life, and mood and perceptions of their own health and well-being. As the reliability, responsiveness to change across populations and conditions, and acceptability to patients in a variety of health care settings became clearer, instruments for outcomes assessment were increasingly used by researchers who accepted the WHO definition and sought to measure the impact of health care on the quality of life (Stewart et al. 1988).

Outcomes research studies the results of medical care (Foundation for Health Services Research 1994). It involves "the rigorous determination of what works in medical care and what does not" and states that "outcomes research, by informing the content of policy positions, payment rules, and practice guidelines, presumably both solves the problems of quality and cost that beset health care and does so by scientific rather than political means" (Tanenbaum 1993, 1268). Outcomes research is the foundation of evaluation of the quality and costs of health care delivery. The evidence-based approach to health care, exemplified by the Cochrane Collaboration (Sackett 1997, Mulrow 1997, Carr et al. 1999), has been accompanied by a shift toward emphasis on patient-centered health outcomes (Gerteis 1993). This broadened perspective has heightened the need for tools to monitor and adjust treatment and approach clinical decision making from a viewpoint that is evidence based and patient centered (Marvel 1999).

HEALTH STATUS ASSESSMENT

Health assessments focus on three broad categories of measures: traditional biological, general (or generic), and disease-specific (Ware 1995). Traditional biological measures may be primary, such as morbidity and mortality, or surrogate, such as the decrease in blood pressure seen in patients who are given an antihypertensive. Measures used for patient-centered outcomes generally estimate the person's health-related quality of life (HRQOL) and his or her ability to function and do the things he or she wants to do. These measures may be generic, evaluating overall health status, or they may be disease-specific, focusing on the effect of a given condition on a person's life.

HRQOL assessment is the measurement or evaluation of the health of an individual or patient. HRQOL may include biological markers, but it emphasizes indicators of physical functioning, mental health, social functioning, and other health-related concepts, such as pain, fatigue, and perceived well-being (Greenfield and Nelson 1992). For concepts commonly included in HRQOL measurements, see Table 19.1.

Quality of life includes HRQOL, but it is a broader term that includes nonmedical aspects of life that reflect the aggregate impact of food, shelter, safety, living standards, and social and physical environmental factors (Greenfield and Nelson 1992). Patrick and Chiang (2000) write, "Quality of life connotes inclusion of the environment outside the context of the person and of health care and may or may not be health related, depending on the evaluation context and the impact of disease and treatment."

Patient-based outcome measures are indicators of patients' evaluations of changes in their health statuses, including HRQOL and mortality and indicators of mortality, or patients' evaluations of the quality of health care (U.S. Congress 1988). The importance of patients' views has been increasingly recognized (Fischer et al. 1999). Clinicians' taking the patient's view into account is associated with greater patient satisfaction with care (Hall et al. 1988), better compliance with treatment programs (Becker 1985), and more likely maintenance of continuous relationships in health care (Kaplan et al. 1989).

The contrast between traditional, disease-based clinical investigation and patient-centered outcomes research is analogous to the contrast between measures of efficacy and effectiveness. In an ideal setting, such as a randomized, controlled

Table 19.1. Domains Used in Health-Related Quality of Life Measurements

Domains	QWB	SIP	NHP	QLI	COOP	EQ-5D	DUKE	MOS SF-36
Physical functioning	X	X	X	X	X	X	X	X
Social functioning	X	X	X	X	X	X	X	X
Role functioning	X	X	X	X	X	X	X	X
Psychological distress	—	X	X	X	X	X	X	X
Health perceptions (general)	—	—	X	X	X	X	X	X
Pain (bodily)	—	X	X	—	X	X	X	X
Energy/fatigue	X	—	X	—	—	—	X	X
Psychological well-being	—	—	—	—	—	—	X	X
Sleep	—	X	X	—	—	—	X	—
Cognitive functioning	—	X	—	—	—	—	X	—
Quality of life	—	—	—	—	X	—	—	—
Reported health transition	—	—	—	—	X	—	—	—

COOP = Dartmouth Primary Care Cooperative Information Project; DUKE = Duke Health Profile; EQ-5D = Euro Quality of Life Instrument; MOS SF-36 = Short Form-36 Medical Outcomes Study Questionnaire; NHP = Nottingham Health Profile; QLI = Quality of Life Index; QWB = Quality of Well-Being Scale; SIP = Sickness Impact Profile.
Source: Adapted from J Ware. The status of health assessment 1994. Annu Rev Public Health 1995;16:327–354.

clinical trial, the *efficacy* of a treatment describes the dose-response relationship under well-controlled circumstances. The outcomes of interest are usually biological measures, such as changes in blood glucose levels or blood pressure. However, what is more important to practitioners and patients is *effectiveness*, which refers to the results of treatments as applied in typical practice settings and measured over the course of treatment, including measures that matter most to patients (patient-centered outcomes) (Pransky and Himmelstein 1996). Outcomes research is more likely to be generalizable and relevant to typical medical practice than tightly controlled clinical trials.

PHYSICAL THERAPY, HEALTH STATUS, AND THE DISABLEMENT MODEL

In physical therapy, too, a paradigm shift has taken place from treating impairments to emphasizing physical functioning. Biology and functioning overlap, but they overlap incompletely. Pathophysiologic changes may or may not alter a person's ability to function. As discussed in Chapter 1, the relationship between pain, impairment, and physical functioning is poor in patients with chronic pain, and it is probably mediated by psychosocial variables, such as fear avoidance and catastrophizing. The main goals of physical therapy for patients with chronic pain are increased functioning, decreased disability, and increased self-efficacy (i.e., self-management skills). How do we measure whether these goals are attained? To quote Alan Jette (1994), "first we need to speak to each other," meaning that we need to use precise language to define what we mean by terms such as *functional limitation* and *disability.* The Nagi (1991) disablement model has long been proposed as a conceptual framework for physical therapy treatment and outcomes measurement by Jette (1994) and Guccione (1991). The terminology used within that framework is defined in Chapter 1. Pope and Tarlov (1991) adapted the Nagi framework to include HRQOL (Figure 19.1).

Pope and Tarlov (1991) define *HRQOL* as corresponding to general well-being and encompassing physical and psychosocial determinants. Components of HRQOL include the performance of social roles, physical status, emotional status, social interactions, intellectual functioning, economic status, and self-perceived or subjective health status.

Physical therapists are used in the measurement of impairments, and much research has been dedicated to the establishment of the reliability of such measures (Brosseau et al. 1997, Petersen et al. 1994,

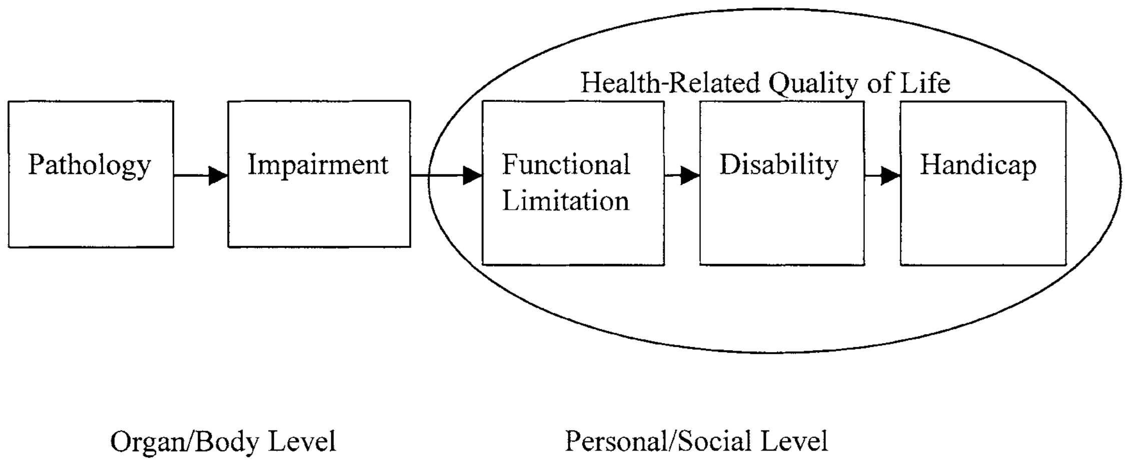

Figure 19.1. Integration of health-related quality of life (HRQOL) into the Nagi disablement framework. (Adapted from AM Pope, A Tarlov. Disability in America: Towards a National Agenda for Prevention. Washington, DC: National Academy Press, 1991.)

Christensen and Nilsson 1998, Nigg et al. 1995, Moreland et al. 1997). The goals of physical therapy intervention, however, include not just the elimination of impairments, if possible, but "remediation of functional limitation and disability, optimization of patient/client satisfaction, and primary or secondary prevention" (American Physical Therapy Association 1999). Functional limitation can be measured by physical capacity evaluations (King et al. 1998), performance tests (Simmonds et al. 1998, Harding et al. 1994, Wittink 1999), or by patient self-report through questionnaires.

Disability is defined by Nagi (1991) as "impaired normal overall role performance to such a degree that the individual's overall behavior is less than adequate to meet the expectations normal for one's age and gender as well as one's social and cultural environment." *Disability* thus refers to social rather than organismic functioning. In most of the literature, however, the term *disability* is used according to the WHO definition (World Health Organization 1980) that does not distinguish between physical and social functioning. For instance, the Oswestry Disability Index (ODI) is frequently used in back pain research to measure disability and is recommended as a disability measure in back pain (Deyo et al. 1998). The ODI, however, comprises measures of impairment (pain), functional limitations (sitting, standing), and disability (sex life, traveling) (Delitto 1994). Dionne et al. (1999) conducted a 2-year prospective study on 720 patients with low back pain in primary care to evaluate measures of pain, functional status, and work indices as measures of treatment outcome. They concluded that although pain, functional status, and work indices are related, they are not interchangeable. This finding supports the idea that distinctions should be made between the domains of pain, functional limitation, and disability.

Asking patients about their insurance status, as a proxy of work status, could simply assess work disability. Many patients, such as housewives, students, and the elderly, do not work, however. How should we then assess impairments in these roles and social performance? How should we assess patients who do work, but whose pain interferes with job duties? We try to answer some of these questions in the descriptions of outcomes tools.

GENERIC AND DISEASE-SPECIFIC MEASURES

An *item* is a single question (e.g., "In general, how would you say your health is?"). A *scale* contains the available categories for expressing the response to the question. A scale can be categoric (e.g., *excellent, very good, good, fair, poor*) or numeric,

Table 19.2. Selected Disease-Specific Health-Related Quality of Life Instruments

Arthritis Impact Measurement Scales (AIMS)	Neck Disability Index
Back Pain Classification Scale (BPCS)	Oswestry Low Back Pain Disability Questionnaire
Brief Pain Inventory (BPI, BPI-SF; formerly *Wisconsin Brief Pain Inventory*)	Pain and Distress Scale (PAD)
Biobehavioral Pain Profile	Pain Disability Index (PDI)
Catastrophizing Scale	Pain Distress Scales
Family Pain Questionnaire	Pain and Impairment Relationship Scale (PAIRS)
Fear-Avoidance Beliefs Questionnaire	Pain Perception Profile (PPP)
Graded Chronic Pain Scale	Patient Pain Questionnaire
Illness Behavior Questionnaire	Roland-Morris Disability Questionnaire
Low Back Pain Rating Scale	Somatic Input, Anxiety, and Depression (SAD) Index for the Clinical Assessment of Pain
McGill Pain Questionnaire (MPQ, MPQ-Short Form)	Treatment Outcomes in Pain Survey (TOPS)
Medical Outcomes Study Pain Measures	Visual Analog Pain Rating Scales
Multidimensional Pain Inventory (MPI; formerly *West Haven–Yale Multidimensional Pain Inventory*)	Work Limitations Questionnaire

or it can consist of a visual analog scale. A *domain* identifies a particular focus of attention (e.g., *physical functioning, mental or general health, patient satisfaction with care*) and may comprise the response to a single item or the responses to several related items. An *instrument* is the group of items used for the collection of desired data. An instrument may contain a single item or multiple items, which may or may not be categorized into separate domains (Gill and Feinstein 1994). A *domain* may consist of one scale (a collection of related items) or multiple scales. A one-scale instrument is called *domain specific*. The McGill Pain Questionnaire (MPQ) (Melzack 1975), for instance, asks about pain only. Scales can have a *ceiling* or *floor* effect, meaning that the instrument is unable to discriminate differences at the higher or lower end of the dimension being measured. A ceiling effect, for instance, may be a 10/10 pain intensity that is now reported as a 12/10 by a patient. A floor effect may occur when a patient's physical status worsens from being severely disabled to being bedridden. Selection of the outcomes tool will therefore depend on the population you wish to study (i.e., how sick your population is) and the ability of the measurement tool to detect changes at either end of the domain.

Patient-based outcomes measures can be subdivided into *generic* and *disease-specific* instruments. *Generic* HRQOL instruments estimate an individual's overall health status, whereas *disease* or *condition-specific* tools focus on the effect of a given condition on health status. For an overview of disease specific HRQOL measurements, see Table 19.2.

Generic and condition-specific HRQOL instruments can be used together to supplement the information collected (Ware 1991). For example, using a condition-specific survey or module together with a generic scale may provide more insight into aspects of health that are not well measured by either type of instrument (Wagner 1995, Rogers et al. 2000a, 2000b).

Generic HRQOL measures contain questions about physical and functional components, psychological dimensions, relational and social aspects, caregiver burdens, lifestyle changes, and spiritual beliefs (Berg 1976, Ferrell 1991a, Oleske 1990, Padilla 1990, Spilker 1990) that are related to health in general and can be used to compare HRQOL between groups of patients with different diseases. Stewart et al. (1989), for instance, showed that each of five chronic diseases (heart disease, diabetes, hypertension, myocardial infarction, and depression) had a unique health status "fingerprint" with distinct effects on physical functioning, mental health, social functioning, and perceived health status. Comparison of the impact of pain on health status to the impact of other chronic illnesses on general health status allows researchers to conduct trials of various treatments to make clinical decisions in medical practice and inform health care policy (Ware 1995).

Disease- or *condition-specific instruments* are sensitive and relevant to the disease that is treated

Table 19.3. Selected Mental Health Assessment Tools

Beck Depression Inventory	Millon Behavioral Health Inventory
Carroll Rating Scale for Depression	Minnesota Multiphasic Personality Inventory
Center for Epidemiologic Studies Depression Scale (CES-D)	Montgomery-Åsberg Depression Rating Scale
Coping Strategies Questionnaire	Multidimensional Health Locus of Control Scale
Depression Adjective Checklists	Pain Beliefs and Perception Inventory
Geriatric Depression Scale	Self-Rating Depression Scale (Zung)
Hamilton Rating Scale for Depression	Symptom Checklist-90 (SL-90)

or studied. Ren et al. (1998), for instance, demonstrated that generic measures of physical functioning and role limitations are more applicable in assessing a broad array of HRQOL issues, whereas disease-specific measures of physical functioning and role limitations are more useful in evaluating clinical management and limitations associated with specific disease conditions. For an overview of disease specific instruments, see Table 19.3.

Disease-specific outcome measures may be constructed and compared to the existing HRQOL instruments (Patrick and Deyo 1989). An alternative way to construct a disease-specific instrument has been to adopt the attribution approach suggested by Roland and Morris (1983), in which items from a previously validated generic instrument are rewritten with a specific disease attribution. Thus, a generic question, such as "Compared to 1 year ago, how would you rate your health in general now?" becomes a disease-specific question when rephrased: "Compared to 1 year ago, how would your rate your health because of your low back pain now?"

Many generic and condition-specific quality of life instruments have been constructed. More than a decade ago, Feinstein and colleagues (1986) identified 43 questionnaires concerning daily living. Instruments may be unidimensional or domain specific, meaning they measure only one aspect of HRQOL, such as physical functioning or mental health, or multidimensional, in which several measures of HRQOL are included. Some instruments are population specific, such as the Faces scale (see Figure 14.3), developed for the young and the elderly or those who do not speak English, and the geriatric assessment instruments (see Appendix 5.6 for an example).

CHOICE OF INSTRUMENTS

Instruments to measure HRQOL and other patient-centered outcomes are not easy to design. Some familiarity with the clinical epidemiology of the problem under investigation, biostatistics, and experimental psychology is needed. Because the purpose of this overview is to present a few widely applied quality of life instruments and the context in which they are used, we describe how to choose from available instruments rather than how to create a new questionnaire.

The selection of an instrument consists of two phases. The first has to do with the psychometric properties of the survey or questionnaire, and the second has to do with whether the investigator wants to use a generic or disease-specific instrument. The important psychometric properties to consider include the following (Jensen 1986, Wood-Dauphinee 1991, McDowell and Newell 1996):

- Test-retest reliability: the extent to which the measure generates consistent results. How close to each other are the results of repeated applications?
- Internal reliability (quantified by Cronbach's alpha): the sensitivity to the number of items that make up the measure and the degree of intercorrelation between the items. A Cronbach alpha of 0.9 or higher is generally preferred for measurement in a single person, whereas Cronbach alphas of 0.7 are preferred for group measurement (Nunnally 1978).
- Validity: the extent to which the instrument actually measures what it claims (i.e., the correspondence between what the instrument reports and reality).
- Responsiveness: the ability of an instrument to detect changes, particularly clinically important changes, over time in individuals or in groups of subjects.
- Applicability: the appropriateness of the instrument's use with the study population.

Table 19.4. Selected Generic Health-Related Quality of Life Instruments

COOP Charts for Primary Care Practice (Dartmouth COOP Charts)	Nottingham Health Profile (NHP)
Distress and Disability Scale (DDS)	Older Americans Resources and Services (OARS) Multidimensional Functional Assessment Questionnaire
Duke Health Profile (DUKE)	Physical and Mental Impairment-of-Function Evaluation (PAMIE)
Euro Quality of Life (EuroQoL or EQ-5) Instrument	Quality of Life Index (QLI)
Functional Assessment Inventory (FAI)	Quality of Well-Being (QWB; formerly *Index of Well-Being*)
Functional Living Index-Cancer (FLIC)	Self-Evaluation of Life Function Scale (SELF)
Functional Status Questionnaire (FSQ)	Short Form-12 Health Survey (SF-12)
Karnofsky Performance Status Scale	Short Form-20 Health Survey (SF-20)
McMaster Health Index Questionnaire (MHIQ)	Short Form-36 Health Survey (SF-36)
Multilevel Assessment Instrument (MAI)	Sickness Impact Profile (SIP)

COOP = Dartmouth Primary Care Cooperative Information Project.
Source: Adapted from I McDowell, C Newell. Measuring Health. A Guide to Rating Scales and Questionnaires. New York: Oxford University Press, 1996.

- Practicality: the likelihood that an instrument can be applied readily, without excessive burden to patient or investigator, and produce data that can be easily analyzed and applied.

DESCRIPTIONS OF SELECTED GENERIC HEALTH-RELATED QUALITY OF LIFE INSTRUMENTS

Of the many generic instruments available to assess HRQOL, four well-validated, widely used questionnaires stand out. Brief descriptions of each follow. For an overview of widely used generic HRQOL instruments, see Table 19.4.

Nottingham Health Profile

The Nottingham Health Profile (NHP) (Hunt and McEwen 1980) has been widely used in Europe, particularly before the advent of the Short Form-36 (McDowell and Newell 1996). The NHP resulted from a revision of the Nottingham Health Index (NHI), which was similar in design and content to the NHP. The NHP provides an estimate of physical, social, and health problems (Hunt et al. 1980, McDowell and Newell 1996). The NHP was influenced by the Sickness Impact Profile (SIP); however, the NHP asks about feelings and emotions, and the SIP examines changes in behavior. The NHP is a 37-item questionnaire with responses compiled into six domains: physical abilities, pain, sleep, social isolation, emotional reactions, and energy level. A second section includes optional questions about work, social and sex life, interests and hobbies, and holidays. The NHP takes approximately 10–15 minutes for patients to complete. Cronbach alphas were reported from 0.77 to 0.85 for the first section and from 0.44 to 0.86 for the second section in a sample of patients with osteoarthritis (Hunt et al. 1981). The NHP has been translated into a variety of European languages, as well as Arabic and Urdu.

Short Form-36 Medical Outcomes Study Questionnaire

One of the most widely used generic HRQOL instruments is the Short Form-36 Medical Outcomes Study Questionnaire (SF-36). Developed from data acquired by the RAND Corporation in the Medical Outcomes Study (Tarlov et al. 1989), the SF-36 contains eight scales of general health and functioning that are thought to be important to all people: physical functioning, role-physical (limitations in physical roles due to health problems), bodily pain, general health, vitality, social functioning, role-emotional (limitations in emotional roles due to health problems), and mental health (Stewart 1988, Ware 1992). All items are scored on scales from 0 to 100, such that a higher score indicates better health. Individual values are expressed as percentages of the total possible score.

The SF-36 can be administered quickly during a face-to-face interview, over the telephone, or by the patient. Its internal reliability in both general and chronic disease populations ranges from 0.78 to 0.93 (McHorney et al. 1994). Normative SF-36 scores for a variety of medical conditions have been published (Ware 1993). Several forms of the SF-36 are also available, including a 1-week recall version and the SF-12, a 12-item subset of the SF-36. The SF-12 may provide an opportunity to collect HRQOL information when time and resources are limited (Ware 1996). The SF-36 has been translated in more than 40 languages. Wagner et al. (1998) performed cross-cultural comparisons of the content of SF-36 translations across 10 countries and determined that "the translations are culturally appropriate and comparable in their content."

The SF-36 has been validated for use in many patient populations, of which we will only mention a few. The validity of using the SF-36 in the low back pain population is supported by its highly statistically significant ($p < .001$) correlations with the ODI and Low Back Pain disability domains (Grevitt et al. 1997). The SF-36 has also been validated for use in patients with alcohol dependence (Daeppen et al. 1998), osteoarthritis and rheumatoid arthritis (Kosinski et al. 1999), headache and migraine (Solomon 1997, Essink-Bot et al. 1997), sciatica (Patrick et al. 1995), neck pain (Riddle and Stratford 1998), and panic disorders (Candilis et al. 1999), and in euthymic and depressed patients with bipolar disorder (Gatchel et al. 1999) and functional restoration (Leidy et al. 1998).

A recent trial of percutaneous electrical nerve stimulation (PENS) compared to transcutaneous electrical nerve stimulation (TENS), exercise therapy, and placebo-PENS to treat people with low back pain secondary to degenerative disk disease included the SF-36 (Ghoname 1999). In addition to HRQOL, or health status, Ghoname (1999) uses analog scale scores for pain, physical activity, quality of sleep, daily analgesic use, and global assessment. Compared to the general population, pretreatment SF-36 scores indicated lower HRQOL scores. Post-treatment physical and mental composite scores for people who received PENS were significantly higher, reflecting better ability to function, compared to exercise and placebo PENS.

Becker (1997) studied HRQOL of 150 patients with chronic noncancer pain referred to a Danish multidisciplinary pain center by using the SF-36. The participants had no major mental disorders, nor did they use opioids illegally. Each of the SF-36 scale scores was lower than the normative values for a similar Danish population.

Gatchel et al. (1999) administered the SF-36 to 146 patients with chronic spinal disorders before entry into a functional restoration program and after completion of the program. Higher preprogram social functioning and bodily pain scores were associated with successful program completion. The 18 patients who did not complete the program had significantly lower bodily pain scores (more pain, $p < .003$) and lower social functioning scores ($p < .025$). The preprogram mental health score was positively associated with return to work, work retention, and lower surgery rates. Higher post-program SF-36 scores were significantly associated with return to work and less use of health care resources. Fanuele et al. (2000) used the Physical Component Summary scale of the SF-36 to quantify the effect spinal diagnoses have on patients' functional status compared to other common comorbidities and to quantify the effects of comorbidities on physical functional status in patients with spine disorders. They found that the Physical Component Summary score in patients with spinal problems was lower than or similar to that of patients with congestive heart failure, chronic obstructive disease, lupus, primary total hip replacement, total knee replacement, and glenohumeral joint disease.

Shortcomings of the SF-36 for use on its own (i.e., without the supplementation of a disease-specific tool) in the chronic pain population include the lack of sufficient upper-body functional items, the lack of differentiation between work disability and disability in other activities, and the lack of sensitivity of the Bodily Pain scale to change in an individual patient (Rogers et al. 2000a).

The RAND 36-Item Health Survey 1.0 includes the same questions as the SF-36 (http://www.qmetric.com/innohome/insf36.shtml), but is scored differently. Information on the RAND 36-Item Survey can be found at http://www.rand.org/health/toolsnav.html (tool, permission and scoring of the instrument (see Appendix 19.1).

Euro Quality of Life Instrument or EQ-5D

The EQ-5D is a generic health status measurement developed by the Euro Quality of Life (EuroQoL) group. The EuroQoL group is an international, multicenter, multidisciplinary organization that was founded in 1987. The EQ-5D consists of five dimensions: mobility, self-care, usual activities, pain and discomfort, and depression and anxiety. Each dimension is subdivided into three levels: 1 = no problems, 2 = some problems, and 3 = extreme problems. By combining the different levels of each of the dimensions, a total of 243 health states can be defined. The sixth item is a global evaluation of one's own health using a VAS of 0–100 (worst imaginable health to best imaginable health).

The descriptive data of the EQ-5D can be converted into values suitable for cost-effectiveness analysis by linking patient's health state descriptions to empirical valuations of health states from the general population (http://www.atsqol.org/sick.html). The EQ-5D has been translated in multiple languages, and a number of cultural adaptations of the EQ-5D are available.

Essink-Bot et al. (1997) compared the EQ-5D with the SF-36, the NHP, and the Dartmouth Primary Care Cooperative Information Project (COOP)/World Organization of National Colleges, Academies, and Academic Associations of General Practitioners/Family Physicians (WONCA) charts (van Weel 1993) in a sample of migraine patients and a matched control group. The SF-36 exhibited the best ability to discriminate between groups.

SICKNESS IMPACT PROFILE

The SIP is used to estimate behavioral changes due to illness (Bergner 1976a, 1976b). In this context, *sickness* encompasses the effects of being ill on a person's everyday activities, as well as on his or her feelings and attitudes (McDowell and Newell 1996). Thus, the SIP examines how sickness affects a person's behavior and the ability to carry out daily activities. The SIP contains 136 statements in 12 categories, and the patient completes the survey by checking the items that describe him or her on a particular day. It takes approximately 20–30 minutes to complete the SIP, and 5–10 minutes to score it. Test-retest reliability was shown to be high (r = 0.92), as was internal consistency (Cronbach alpha 0.94) (Bergner et al. 1981). Essink-Bot et al. (1996) found that the SIP emphasizes physical functioning, whereas the NHP emphasizes mental functioning.

The SIP has been used to measure HRQOL in persons with chronic noncancer pain. Among persons examined at least one year after having epidural electrodes implanted for spinal electrical stimulation, responders and nonresponders alike reported lower physical and psychosocial functioning compared to a control group (Augustinsson 1986). Persons with pain also had lower mental well-being scores than persons without pain. In another trial, the SIP was used along with the Millon Clinical Multiaxial Inventory (Marshall 1992). Persons who had amputations or chronic musculoskeletal pain did not differ on most SIP scales. Neither anxiety nor depression was thought by these authors to be particularly prevalent in persons with chronic pain. Among persons with chronic pain who participated in an inpatient cognitive-behavioral pain management program, individuals who were not working (an average of 4.3 years of unemployment) had significantly worse scores for depression, self-efficacy related to pain, pain-related distress, and the overall impact of pain when measured by the Beck Depression Inventory and the SIP (Richardson 1994).

HRQOL instruments have been used not only as individual assessment tools, but also to help describe groups of people with chronic pain. In one trial, the SIP was used with the Medical Examination and Diagnostic Information Coding System to try to identify subgroups of persons with chronic pain and evaluate responses to rehabilitation programs (Sanders 1993). In this study, four groups of patients were identified based on overall level of dysfunction and physical pathology. Individuals who were highly dysfunctional and had moderate or low levels of physical pathology were the most dysfunctional according to their SIP scores. They were also the most depressed, used more pain medications, and were less active and less likely to be working at the time of pretreatment. Further information on the SIP can be found at http://www.qlmed.org/mot/SIP.htm.

PAIN-SPECIFIC OUTCOMES MEASUREMENT

Routine measurement of health status variables during clinical care offers a rational, objective means to determine which therapies best help an individual to manage and cope with pain (Aaronson 1987, Padilla 1988). Chronic noncancer pain affects not only the patient, but also the patient's family, friends, and co-workers. Thus, individual selection, application, and titration of pain therapies is expected to benefit not only patients, but also the quality of life of other persons subject to stress and burnout (Charap 1978, Ferrell 1991b, 1993). Incorporating information about HRQOL into the treatment of persons with pain not only addresses issues of importance to patients and the people in their social structures, but is also useful to third-party payers, who are motivated to improve clinical outcomes and patient satisfaction, and employers, who are interested in improving productivity, reducing absenteeism, and controlling overall health care costs.

Pain, in general, and chronic and persistent pain disorders, specifically, are unique challenges to outcomes research owing to the importance of subjective information. Unlike the great majority of medical conditions, chronic pain does not involve one distinct organ system, pathophysiologic process, or specific discipline. Although pain is characterized as a symptom, it is, in fact, a subjective experience, a perception (Chapman and Gavrin 1999). This perception not only results from nociceptive sensations, but is also regulated or influenced by psychological, social, and other environmental factors (Brown et al. 1999). Physical functioning, work, and family and social relationships are usually impaired by chronic noncancer pain. Comorbidities that often accompany chronic pain are depression, anxiety, and social isolation (Rudy et al. 1988). For these reasons, it has been argued that the assessment of patients with chronic pain should be accomplished within a multidimensional framework (Lousberg et al. 1999b). This assessment should provide clinicians with relevant information to formulate a treatment plan, and also, it should allow for measurement of the outcome of treatment. The generic HRQOL instruments discussed earlier are epidemiologic tools and, as such, are able to measure change in large samples of patients. By their nature, they are not intended, nor are they sufficiently sensitive, to measure change in a single person. Furthermore, they lack information on items frequently assessed in pain treatment and management, such as solicitous responses (Kerns et al. 1985, Romano et al. 1995), coping ability (Tan et al. 2001, Nielson et al. 2001), fear avoidance (Waddell et al. 1993, Vlaeyen and Linton 2000, Al Obaidi et al. 2000), and the extent of disablement from pain.

Many instruments are used to assess the impact of pain on patients' lives. Ideally, the instrument should provide relevant information to all clinicians within an interdisciplinary (multidisciplinary) team, have a low respondent burden, and be sensitive enough to detect changes at both group and individual levels. Some widely used methods to assess pain and its influence are offered in the following.

Unidimensional Measurement

Pain Intensity

The three most commonly used methods to assess pain intensity are the verbal rating scales, VASs, and numeric rating scales. Von Korff et al. (VRSs 2000) caution that multiple factors, including time of day, influence patients' pain reports. Aggregated pain measures have therefore been shown to be more reliable and more sensitive to treatment effects than single items (Jensen and McFarland 1993). *Aggregated pain measures* are scores that are created from multiple measures. For instance, the average of three concurrent responses to a 100-mm VAS of pain intensity ratings of current, average, and best pain (Dworkin et al. 1990) can be taken. A composite measure that has shown high internal consistency (Cronbach alpha >0.8) consists of an average of 0–10/10 ratings of current, least, and average pain ratings in cancer pain patients (Serlin et al. 1995). Jensen et al. (1999) report that individual 0–10 pain intensity ratings have

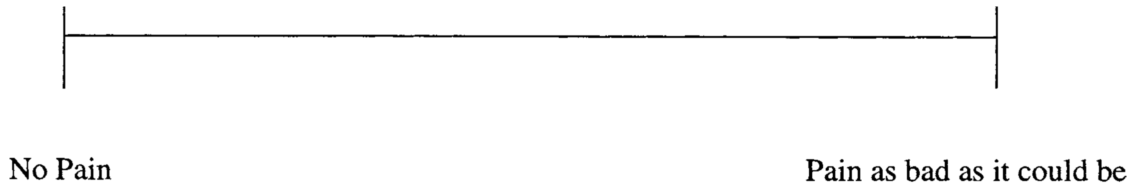

Figure 19.2. The visual analog scale.

sufficient psychometric strength to be used in chronic pain research, especially in studies with large sample sizes, but composites of 0–10 ratings may be more useful when maximal reliability is necessary (i.e., in studies with small sample sizes or in the monitoring of an individual patient).

Verbal Rating Scales. VRSs consist of a list of adjectives that describe different levels of pain intensity. An adequate VRS of pain intensity should include adjectives that reflect the extremes of this dimension and sufficient additional adjectives to capture the gradations of pain that may be experienced (Von Korff 2000) (e.g., 0 = no pain, 1 = slight pain, 2 = moderate pain, 3 = severe pain). Although criticized for its assumption that the interval between the scores is equal, this scale is easily administered and scored. VRSs are positively and significantly related to other measures of pain intensity (Jensen et al. 1986). Jensen et al. (2001) reported on the potential clinical use of classifying pain as mild, moderate, or severe based on the impact of pain on quality of life. There is a nonlinear relationship between pain intensity and pain interference. Pain intensity begins to have a serious impact on functioning when it reaches a certain threshold—approximately 5 on a 0–10 scale in patients with cancer pain (Serlin et al. 1995). To investigate whether this relationship held true for patients with noncancer pain, Serlin et al. (1995) asked 205 patients with acquired amputation and phantom limb pain, back pain, or both to rate their average pain intensity and degree of pain interference for each type of pain. The results supported a nonlinear relationship between pain intensity and pain interference, but the authors found that the optimal cutoffs for classifying mild (1–4/10), moderate (5–6/10), and severe pain (7–10/10) determined in patients with cancer pain were only true for those with back pain. Different cutoff scores were found for patients with phantom limb pain and general pain. Moreover, the degree of pain interference varied with the type of pain.

Visual Analog Scale. VASs (Figure 19.2) are simple tools to assess intensity and other dimensions of pain, such as anxiety, efficacy of treatment, and emotional responses. These scales are lines, which are usually 100 mm long, that represent the continuum of the symptom being rated, with labels at either end to represent the extremes of the symptom, such as "no pain" and "pain as bad as it could be" (McDowell and Newell 1996, Scott 1976, Huskisson 1974).

Patients mark the scale at a point that represents the severity of their pain. Variations of these techniques request that patients circle a number from 0 to 10 or place a mark through one of these numbers. VASs are more sensitive and precise than descriptive scales. They are also easy to use and interpret; however, they are limited to expressing only one dimension of the pain experience at a time. It may be difficult for someone to imagine what the worst pain imaginable is, or a person with chronic noncancer pain may report his or her pain as being outside the 0–10 limits—saying that his or her pain is a 20, for example.

The validity of VASs is supported by their positive relations to other measures of pain intensity (Jensen et al. 1986, Kremer et al. 1981). They are sensitive to treatment effect and are distinct from measures of other subjective components of pain (Von Korff 2000).

Numeric Rating Scales. Numeric rating scales involve asking the patient to rate the pain from 0 to 10 (11-point scale), 0 to 20 (21-point scale), or 0 to 100 (101-point scale). Jensen et al. (1994) showed that 11- and 21-point scales provide sufficient levels of discrimination for patients with chronic pain to describe their pain intensity. Like the VRS and the VAS, the numeric rating scales demonstrate positive and significant correlations with other measures of pain intensity (Kremer et al. 1981, Jensen et al. 1986).

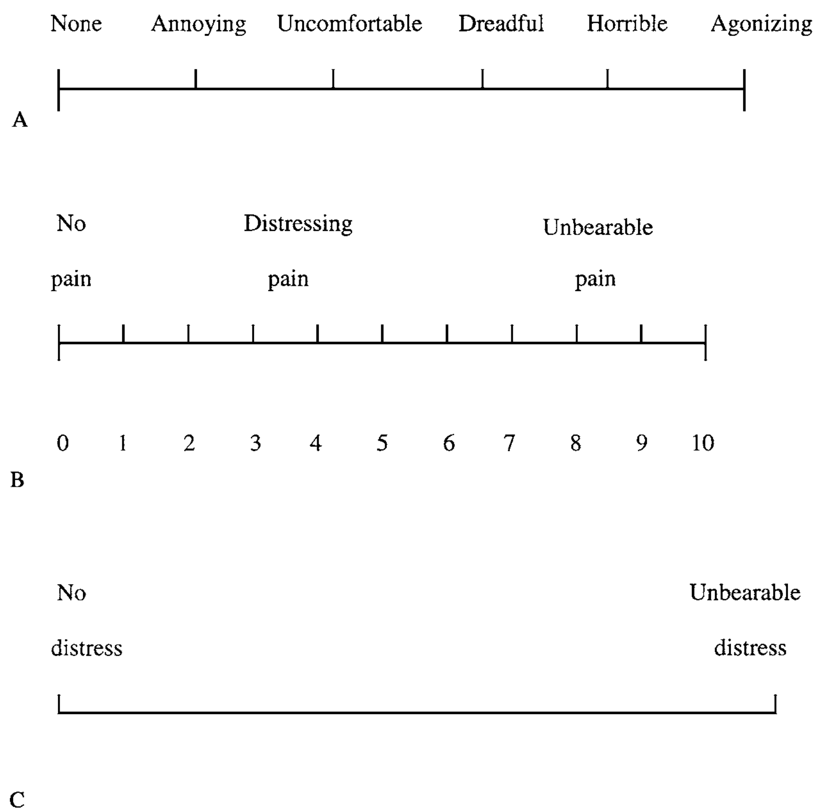

Figure 19.3. Pain distress scales recommended by the Acute Pain Management Guideline Panel. **A.** Simple Descriptive Pain Distress Scale. If used as a graphic rating scale, a 10-cm baseline is recommended. **B.** 0–10 Numeric Pain Distress Scale. If used as a graphic rating scale, a 10-cm baseline is recommended. **C.** Visual Analog Scale. A 10-cm baseline is recommended for VAS scales. (Carr DB, Jacox AK, Chapman CR, et al. Clinical Practice Guideline Number 1: Acute Pain Management: Operative or Medical Procedures and Trauma. Rockville, MD: Agency for Health Care Policy and Research, Public Health Service, U.S. Department of Health and Human Services; 1992. AHCPR publication 92-0032.)

Pain Affect

McGill Pain Questionnaire. The MPQ provides estimates of the sensory, affective, and evaluative dimensions of pain (Melzack 1975). It is one of the most frequently used instruments for pain measurement and is considered useful for evaluating pain treatments and as a diagnostic aid (Graham 1980, Keefe 1986, Melzack 1983, Sternbach 1974, McDowell and Newell 1996). In addition to collecting information about diagnosis, drug therapy, pain and medical history, and other symptoms and modifying features, the MPQ also contains a list of words that describe pain, divided into groups pertaining to the sensory, affective, and evaluative dimensions of the pain experience.

The MPQ is available in several languages, as well as extended (Dartmouth Pain Questionnaire, McGill Comprehensive Pain Questionnaire) and shortened versions, and components of the MPQ have been incorporated into other instruments (McDowell and Newell 1996). Although the MPQ is one of the leading pain assessment tools and is considered the gold standard of pain assessment tools, it does have some limitations (Turk 1992). For the purposes of this discussion, clinicians should keep in mind that it may be difficult to discriminate between types of pain syndromes in persons who are anxious or who have other psychological disturbances.

Pain Distress Scales. The Acute Pain Management Guideline Panel (Carr et al. 1992) recommends, among other tools, the use of the scales in Figure 19.3.

Graded Chronic Pain Scale. The Graded Chronic Pain Scale (GCPS) was developed to provide a brief, simple method of grading the severity of chronic or recurrent pain for use in general population surveys and studies of patients in primary care settings (Von Korff et al. 1992). The GCPS consists of seven questions, rated on a scale from 0 to 10, that ask about pain severity and pain interference with activities (work, school, or housework) that signify disability. Patients are classified into one of five grades (Appendix 19.2).

Chronic pain grade at baseline showed a highly statistically significant and monotonically increasing relationship with unemployment rate, pain-related limitations, depression, fair to poor self-rated health, frequent use of opioid analgesics, and frequent pain-related doctor visits, both at baseline and at 1-year follow-up (Von Korff et al. 1992). Internal consistency was Cronbach alpha 0.74 for patients with back pain, 0.67 for headache, and 0.71 for temporomandibular joint dysfunction (Von Korff et al. 1992).

Smith et al. (1997) undertook a postal survey (n = 400) in the United Kingdom to assess the reliability, validity, and acceptability of the GCPS. They found high internal consistency (Cronbach alpha 0.91). The validity of this instrument in this population was tested by comparing responses to each category within a concurrently administered SF-36 health survey, while reliability was estimated through internal consistency tests. Correlations with the SF-36 were highly significant (p <.001), with the strongest correlation being with the SF-36 Bodily Pain scale, confirming convergent validity. These investigators found the GCPS to be a valid and reliable tool to be used in mail surveys of persons with chronic pain. Equally, Elliott et al. (2000) found the GCPS responsive to change over time and significantly correlated with changes in the SF-36.

The GCPS questions were initially developed with a 6-month reporting period. Subsequently, they have been administered with 3- and 1-month reporting intervals (Von Korff et al. 2000).

Multidimensional Measurement

Brief Pain Inventory

The Brief Pain Inventory (BPI) was originally developed for use in persons with cancer, although it is also used to assess pain in people with other diseases (McDowell and Newell 1996). The purpose of the BPI is to assess the severity of pain and the impact of pain on daily functions. Assessment areas include severity of pain, impact of pain on daily function, location of pain, use of pain medications, and the amount of pain relief in the past 24 hours or week (Cleeland 1991). The internal consistency ranges from Cronbach alpha 0.77 to 0.91. The form takes approximately 10 minutes to complete. It is valid for use in Chinese (Mandarin) (Uki 1996), Filipino, French, Hindi (Saxena 1999), Italian (Caraceni 1996), Japanese, and Vietnamese, among others. It is also available in a shortened form, the BPI-SF (Cleeland 1994, Cleeland 1992), which takes 5 minutes to fill out. When applying the BPI to persons with chronic noncancer pain, the clinician should keep in mind that interpretation may be difficult if the questions asked do not reflect the patient's experience. Furthermore, questions about functioning are subject to both floor and ceiling effects. The BPI is copyrighted, but permission to use it is routinely granted at no cost by providing a short description of its intended use. Samples of the form, both the short and long versions, can be found at http://prg.mdanderson.org/bpicopy.htm.

Multidimensional Pain Inventory

The Multidimensional Pain Inventory (MPI; formerly the West Haven–Yale Multidimensional Pain Inventory [WHYMPI]) was developed by Kerns et al. (1985). It is a 64-item self-report questionnaire comprising three parts and 12 subscales. The first two parts are related to patients' appraisals of pain and the impact of pain on different domains of their lives and perceptions of the responses of significant others to their distress and suffering. The last part relates to how frequently patients perform 18 common daily activities. Internal consistency ranges from Cronbach alpha 0.70 for outdoor activities to 0.90 for interference.

Using cluster-analytic and multivariate classification methods, three homogeneous subgroups of chronic pain patients have been identified and replicated across a wide range of medical diagnoses (back pain, temporomandibular disorders, headache). The three groups' distinct profiles were labeled *dysfunctional*, *interpersonally distressed*, and *adaptive coper*. The percentages in each group for back pain patients were 62%, 18%, and 20% for the dysfunctional, interpersonally distressed, and adaptive coper profiles, respectively (Turk and Rudy 1988). Unfortunately, studies showed that a large number of patients could not be classified owing to missing responses to "significant other" questions. Okifuji et al. (1999) modified instructions on the MPI (MPI-M) to clarify the term *significant other*, which resulted in an almost two-thirds reduction in patients who could not be classified, without changing the distribution of the profiles.

The MPI has demonstrated reliability and validity in patients with chronic low back pain (Turk and Rudy 1990). The MPI is used widely and has been translated into Spanish, Portuguese, French, Swedish, Dutch, and Italian (Walter 1991, Bergström 1998, Lousberg et al. 1999). Information on how to license this instrument can be found at http://www.qlmed.org/WHYMPI/.

Treatment Outcomes in Pain Survey

The Treatment Outcomes in Pain Survey (TOPS) (Rogers et al. 2000a, 2000b) is a multidimensional tool that includes the SF-36 and was developed according to the Nagi disablement model (Nagi 1991) (Appendix 19.3).

In addition to the SF-36, this instrument contains demographic data and 14 scales, of which seven fit into the Nagi framework. The other seven scales are considered to be mediating factors between the domains of pain, functional limitation, and disability. The seven main scales include pain symptom, perceived and objective family disability, work limitations, objective work disability, and upper and lower body limitations. Cronbach alphas of these scales range from 0.70 for objective work disability to 0.92 for lower body functioning and 0.93 for perceived family and social disability. This high internal consistency allows for the measurement of change during treatment of an individual patient. The mediating scales include fear-avoidance, passive coping, life control, and solicitous responses. In addition, two scales measure patient satisfaction with care and outcomes. The final scale is the Total Pain Experience Scale, which is a composite of pain intensity, pain interference, physical functioning, and disability.

Pain clinic normative values were established based on a sample of 1,230 administrations of the tool in interdisciplinary pain clinics in Boston and Salt Lake City. The instrument was translated and validated in French Canadian (Ingham 2000). The instrument takes approximately 10–15 minutes to complete. The completed questionnaire is scanned using customized TOPS software that automatically loads the item responses into an Access database, from which the responses are scored into scales. A two-page report contains the RAND SF-36 and the TOPS scores. This process takes approximately 6 minutes to complete. Only the TOPS questions follow, as the SF-36 part of the questionnaire was shown earlier.

STANDARDIZED PSYCHOLOGICAL INSTRUMENTS

In addition to anxiety and depression, patients with chronic pain may develop a variety of psychological problems, including anxiety, depression, sleep disorders, and disruptions in family life. Because of this vulnerability, adding an assessment of mental health to generic and condition-specific HRQOL may help patients and health care providers work together more effectively toward their common goals of pain relief and improved functioning.

As it is outside the scope of physical therapy practice to assess patients' mental health, we will limit our discussion of psychological tools to a frequently used measure to assess depression. Depression has been associated with high health care use and costs (Engel et al. 1996) and is highly prevalent in patients with chronic pain. For an overview of commonly used psychological instruments, see Table 19.3.

Beck Depression Inventory

The Beck Depression Inventory (BDI) has been used for more than 30 years (Beck 1961). It was originally designed for use in measuring depth or intensity of depression in psychiatric patients but has since been used in screening efforts, clinical research, and clinical practice (Beck 1981, 1988). The BDI contains 21 items; each item is a list of four statements, arranged in order of increasing severity, about a particular symptom of depression. It is generally self-administered, and it takes approximately 5–10 minutes to complete. It is available in French, Spanish, German, Polish, Danish, Chinese, and Turkish language versions, and it has been adopted for administration for school-aged children, adolescents, and deaf persons (Beck 1988, Gallagher 1986, Steer 1986, Shek 1990, Karanci 1988). The BDI is a reliable and valid scale that is routinely used in psychological testing (McDowell and Newell 1996). The internal consistency of the BDI for psychiatric patients is 0.90 (Steer et al. 2000) and ranges from 0.85 to 0.88 in nonpsychiatric medical patients (Winter et al. 1999, Steer et al. 1999, Beck et al. 1997). It has been used to assess persons with chronic noncancer pain; however, because of the emphasis the BDI places on the somatic aspects of depression, it has been suggested that persons with chronic noncancer pain may have a higher level of false-positive scores (Williams and Richardson 1993). Wesley et al. (1999) administered the BDI to a sample of 101 nondepressed and 99 depressed patients with chronic back pain and found that the BDI was useful in generating important information on the interference posed by pain on the functioning of an individual while allowing for an independent evaluation of subjective indices of depression and somatic concern. The BDI is scored by adding the ratings for each of the 21 items. None or minimal depression is <10, mild to moderate depression is 18–29, and severe depression is 30–63.

PAIN-SPECIFIC PSYCHOLOGICAL INSTRUMENTS

A variety of other instruments are used to collect self-reported data from persons with chronic noncancer pain. These include questionnaires that address beliefs, such as the widely used Coping Strategies Questionnaire (CSQ) and the Pain Beliefs and Perceptions Inventory (PBPI). The CSQ was designed to help identify methods of coping used by persons with chronic low back pain (Rosenstiel 1983). It contains six types of cognitive strategies, two types of behavioral mechanisms, and two effectiveness ratings. The CSQ was found to be internally reliable when used to assess pain-coping strategies. The authors also found that praying, hoping, and coping self-statements were used frequently, whereas others, such as reinterpretation of pain sensations, were not. Overall, cognitive coping and suppression, helplessness, and diverting attention or praying explained much of the variance in coping strategies. The CSQ has been studied widely to better describe its factor structure, its use in persons with low back pain or cancer pain, and its use for prediction of patient and spouse ratings of patients' self-efficacy (Geisser 1994, Riley 1997, Robinson 1997, Swartzman 1994, Dozois 1996, Keefe 1997, Lin 1998).

The PBPI assesses three aspects of pain beliefs: self-blame, perception of pain as mysterious, and beliefs about pain duration (Williams and Thorn 1989). These authors found that the belief that pain will last is associated with greater intensity of pain and decreased compliance with psychological and physical therapies. It contains only 16 items; thus, respondent burden is low. Like the CSQ, the PBPI has also been used widely and has been translated for use in the United Kingdom (Williams 1991, Herda 1994, Morley 1995).

Although we cannot review other self-report instruments at length, two important instruments should be discussed: the fear-avoidance questionnaire and the pain catastrophizing scale.

Fear-Avoidance Beliefs Questionnaire

The Fear-Avoidance Beliefs Questionnaire is a 16-item instrument developed by Waddell et al. (1993). It contains two scales; seven items on fear-avoidance beliefs about the relationship between low back pain and work (internal consistency, Cronbach alpha 0.88), and four items on fear-avoidance beliefs about physical activity in general (internal consistency, Cronbach alpha 0.77). Test-retest reliability was kappa 0.74. Fear-avoidance beliefs correlated significantly with self-reported disability in activities of daily living and work loss (Waddell et al. 1993), as well as spinal isometric strength deficit (Al Obaidi et al. 2000).

Fear avoidance was shown to be a significant predictor of chronic pain 12 months after initial evaluation in a sample of 300 patients with acute low back pain (Klenerman et al. 1995). Vlayen and Linton (2000) support the notion that pain-related fear and fear-avoidance behaviors are strong predictors of the development of chronic pain in patients with musculoskeletal disorders. For the complete Fear-Avoidance Beliefs Questionnaire, see Appendix 5.3.

In our own research on the TOPS instrument, we rephrased all questions to be generic (i.e., "physical activity might harm my back" was rephrased to "physical activity makes me hurt more") to apply to patients with pain from any source. The work-related and physical-activity dimensions of the TOPS fear-avoidance scale had an internal consistency of 0.62 and 0.64, respectively. As the two dimensions correlated highly (r = 0.75 after correction for reliability of measurement), suggesting one dominant domain, we subsequently reduced the scale to five items that focus solely on beliefs (internal consistency = 0.70) (Rogers et al. 2000b) (see Question 23 in Appendix 19.3).

Pain Catastrophizing Scale

The Pain Catastrophizing Scale (PCS) is a 13-item instrument that was developed in 1995 at the Dalhousie University Pain Research Centre to facilitate research on the mechanisms by which catastrophizing impacts on the pain experience (Sullivan et al. 1995). The items on the PCS were drawn from previous experimental and clinical research on catastrophic thinking in relation to pain experience (Rosenstiel and Keefe 1983, Chaves and Brown 1987, Spanos et al. 1989) (Appendix 19.4).

The PCS yields a total score and three subscale scores assessing rumination ("I can't stop thinking about how much it hurts"), magnification ("I worry that something serious might happen"), and helplessness ("There is nothing I can do to reduce the intensity of the pain") (Sullivan 2000). Cronbach alpha for the total PCS is 0.87, rumination is 0.87, magnification is 0.66, and helplessness is 0.78. Test-retest reliability across a 6-week period was $r = 0.75$ (Sullivan et al. 1995). The PCS takes approximately 5 minutes to complete. Support for good internal consistency and validity of the PCS was provided by others (Osman et al. 1997, 2000).

A total PCS score of 38 represents a clinically relevant level of catastrophizing. In a study on patients with osteoarthritis, women were found to have higher levels of pain, physical disability, and pain behavior and to score significantly higher on measures of catastrophizing than men. Catastrophizing was found to mediate the relationship between gender and pain-related outcomes independent of depression (Keefe et al. 2000). Similar findings were reported in an experimental pain setting (Sullivan et al. 2000).

Catastrophizing was shown to predict depression (Turner et al. 2000, Keefe et al. 1989), perception of pain (Hassett et al. 2000, Geisser et al. 1994), lower self-efficacy for pain, lower spousal ratings of self-efficacy for control of fatigue or mood symptoms (Keefe et al. 1997), and disability (Martin et al. 1996).

In a study (Sullivan et al. 1998) of individuals who had sustained soft tissue injuries to the neck, shoulder, or back following work or motor vehicle accidents, catastrophizing was significantly correlated with patients' reported pain intensity, perceived disability, and employment status. Catastrophizing contributed to the prediction of disability over and above the variance accounted for by pain severity. The rumination subscale was the strongest predictor of pain and disability.

The PCS subscales are computed by summing the responses to the following items:

Rumination: sum of items 8, 9, 10, 11
Magnification: sum of items 6, 7, 13
Helplessness: sum of items 1, 2, 3, 4, 5, 12

DISEASE-SPECIFIC OUTCOMES MEASURES

Disease-specific instruments reflect particular limitations or restrictions associated with specific disease states. These instruments are designed to be sensitive in determining the effects of treatment on or the spontaneous longitudinal course of a single disease or condition. A large variety of disease-specific measures have been developed for almost every imaginable condition. Of interest to physical therapists treating patients with pain are instruments measuring the impact of

- Migraine (Patrick et al. 2000)
- Shoulder pain (Beaton and Richards 1996, Roddey et al. 2000, van der Heijden et al. 1998)
- Knee pain (Roos et al. 1998) (A knee injury, osteoarthritis, and foot and ankle outcome tool

can be found at http://www2.space2u.com/~d5067/, and Lysholm scales for the assessment of knee impairment and function can be found at http://data.orthonet.de/orthonet/v1/medi/sco019.htm [Lysholm and Gillquist 1982].)
- Arthritis pain (Arthritis Impact Measurement Scale, 2nd version) (Meenan et al. 1992)
- Neck pain (Vernon and Mior 1991)
- Back pain

Two of the most commonly used disease-specific tools for back pain are the ODI (Fairbank et al. 1980) and the Roland-Morris Disability Questionnaire (RDQ) (Roland and Morris 1983). The ODI and RDQ scores are highly correlated, with similar test-retest reliability and internal consistency. Floor and ceiling effects determine the choice of instruments. A greater proportion of patients score in the top half of the distribution of RDQ scores than in the top half of the ODI scores. The ODI is therefore recommended in patients who are likely to have persistent severe disability, and the RDQ is recommended in patients who are likely to have relatively little disability (Roland and Fairbank 2000).

Oswestry Disability Index

The ODI (Fairbank et al. 1980) is one of the most frequently used tools in back pain research. It has excellent test-retest reliability ($r = 0.99$, Fairbanks 1980; intraclass correlation coefficient = 0.83 Grönblad et al. 1993) and clinical face validity. The internal reliability, Cronbach alpha, was found to be 0.71 for version 1.0 (Strong et al. 1994), and, using version 2.0, Cronbach alpha was 0.76 (Fisher and Johnson 1992) and 0.87 (Kopec et al. 1996).

The ODQ consists of 10 sections that include pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sex, social life, and traveling. Each section is scored on a six-point scale (0–5), with 0 representing no limitation and 5 representing maximal limitation. The subscales combined add up to a maximum score of 50. The score is then doubled and interpreted as a percentage of patient-perceived disability (the higher the score, the greater the disability).

The ODQ has been correlated with impairments, such as pain, as scored on a VAS ($r = 0.62$) (Gronblad et al. 1993) and the presence or absence of relaxation in back muscles during flexion in chronic low back pain patients ($p < .001$) (Triano and Schultz 1987).

The ODQ was able to differentiate between employed and unemployed subjects in a sample of subjects with low back pain seeking workers' compensation (Sanderson et al. 1995). The ODQ was also able to differentiate between low back pain patients seeking or not seeking compensation (Greenough and Fraser 1992), confirming discriminant validity of this measure.

Correlations of the ODI with the Low Back Outcome Scale ($r = -0.87$) (Greenough and Fraser 1992) and the Pain Disability Index ($r = 0.83$) (Grönblad et al. 1993) are good. Correlations with the Waddell Disability Scores ($p < .001$) and the Waddell Impairment Rating ($p < .05$) were significant (or not reported) (Greenough and Fraser 1992). Thus, external validity of the ODQ was confirmed by good correlation with the Low Back Outcome Scale, Pain Disability Index, Waddell Disability Scores, and Waddell Impairment Rating. The ODI has been used to validate a number of back pain-specific outcomes tools (Gronblad et al. 1994, Gronblad et al. 1993, Ruta et al. 1994).

Significant correlations were reported between the SF-36 domains and the ODI (Grevitt et al. 1997), with the Mental Health scale having the lowest correlation. The copy of the instrument in this book is version 2.0, a modification of the original version. Version 2.0 is recommended for use by the original author (Fairbanks) over version 1.0, as it specifically asks for "pain today," a format that patients prefer (Fairbank and Pynsent 2000).

Roland-Morris Disability Questionnaire

The Roland-Morris Disability Questionnaire (Roland and Morris 1983) was derived from the SIP. The generic SIP was constructed to be disease specific by adding "because of my back pain" to each item. Twenty-four items were selected from the SIP by the original authors, because they related specifically to physical functions that were likely to be affected by low back pain. These items include walking, bending over, sitting, lying down, dressing, sleeping, self-care, and activities of daily living. Cronbach alpha for the scale has been estimated between 0.84 and 0.93 (Roland

and Fairbank 2000). The RDQ correlates well with the SF-36 physical subscales, SIP (Jensen et al. 1992), and pain ratings (Beurskens et al. 1996). It is available in 12 languages, and translations are available from the author, who can be reached at mroland@man.ac.uk.

Garratt et al. (2001) compared the Aberdeen Back Pain Scale (ABPS) (Ruta et al. 1994), RDQ, and EQ-5D in 187 patients with low back pain who were randomized either to an exercise program or to usual care. The ABPS and the RDQ were highly correlated (r = 0.70), and a good correlation was found between the EQ-5D and the RDQ (r = 0.50). The ABPS was more powerful than the EQ-5D and the RDQ at discriminating between groups of patients in relation to medication variables and between patients' abilities to perform housework and sports. The ABPS was also strongly associated with the presence of other medical conditions. The RDQ was more sensitive to differences between the two groups of patients. For the complete RDQ, see Appendix 5.7.

Neck Disability Index

The Neck Disability Index (NDI) is a tool derived from the ODI with permission from the original author (Fairbank et al. 1980). It contains 10 questions, each with six response items, which include pain intensity, personal care, lifting, reading, headaches, concentration, work, driving, sleeping, and recreation. The NDI is scored in the same way as the ODI, by summing the responses and multiplying by two. Test-retest reliability is r = 0.89, and the internal consistency of the entire instrument is alpha 0.80, with each of the questions having an alpha >0.75 (Vernon and Mior 1991). Hains et al. (1998) confirmed good psychometric properties (Cronbach alpha 0.92) of the instrument, as did Riddle and Stratford (1998). Face and content validity were demonstrated in several studies (Vernon and Mior 1991, Hains et al. 1998). The NDI can be found for clinical use on multiple Web sites.

Work Limitations Questionnaire

The Work Limitations Questionnaire (WLQ) was developed by Debra Lerner and Benjamin C. Amick III in 1998 at The Health Institute, with support from GlaxoWellcome, Inc.

The WLQ is a 25-item, self-administered questionnaire measuring the degree to which health problems interfere with ability to perform job roles. It was designed for assessing groups of individuals who are currently employed. The WLQ indicates the degree to which health problems interfere with specific aspects of job performance (on-the-job disability) and the impact on productivity of these work limitations (see Appendix 19.5).

The WLQ items ask respondents to rate the level of difficulty (or, on one scale, their level of ability) they have when performing 25 specific job demands. These demands have four defining features: (1) A wide range of jobs in the United States include these demands, (2) a wide variety of physical and emotional health problems can make it difficult to perform these demands effectively, (3) the demands are considered important to the job from the perspective of job incumbents, and (4) losses in individual work productivity are frequently related to the degree to which these demands are not met.

Responses to the 25 items are combined into four work limitation scales: the Time Management Scale (Question 1), the Physical Demands Scale (Question 2), the Mental/Interpersonal Demands Scale (Questions 3 and 4), and the Output Demands Scale (Question 5). Cronbach alpha ranged from 0.88 for Output Demands to 0.91 for Mental/Interpersonal Demands. The WQL was shown to have high reliability and validity (Lerner et al. 2001). The instrument takes 5–10 minutes to complete.

For more information, email wlq@lifespan.org.

EVIDENCE-BASED RESEARCH

The gold standard of current evidence-based research is the Cochrane Collaboration. The Cochrane Collaboration was developed in response to a call by Archie Cochrane, a British epidemiologist, for systematic, up-to-date reviews of all randomized controlled trials in health care. Its aim is to provide reliable, unbiased, up-to-date information to health care providers worldwide so they can make informed decisions about health care. A number of centers have been established throughout the world, and collaborative review groups prepare and maintain systematic reviews. At the beginning of 1997, the existing and planned review groups (more than 40) covered most of the important areas of health care. Relevant to this chapter, Cochrane Collaborative review groups have been formed to assess spine problems, musculoskeletal pathology, and pain, palliative, and supportive care (Carr et al. 1999).

Methods for scoring the quality of research reviewed have been established (Jadad and McQuay 1996). A meta-analysis can be performed in cases in which studies meet certain common criteria and can be statistically combined. A *meta-analysis* is a synthesis of the results of several studies (Sackett 1997). The precision of such a meta-analysis is greater than any one of its component studies because of the aggregation of patient numbers.

One meta-analysis published outside of the Cochrane library identified published studies of treatment in multidisciplinary pain clinics (MPCs) between 1960 and 1990 (Flor 1992). These authors identified 65 studies that met inclusion criteria. They concluded that multidisciplinary pain treatment resulted in large effect sizes that were maintained for more than 6 months, MPCs were efficacious, and the effects were not limited to patients' perceptions but also extended to objective behavior, such as return to work or decreased use of health care resources. One analysis evaluated whether return to work could be predicted after MPC treatment (Fishbain 1993). These authors concluded that, although prediction of return to work is an increasingly important topic, few of the studies they evaluated met appropriate design and statistical criteria. They were unable to clearly identify which variables were useful predictors of return to work.

One of the challenges unique to evaluating treatment at MPCs is that the criteria used to define success are often nonstandard (Turk 1996). Despite this problem, Turk and colleagues (1996) found that reported pain reduction ranged from 14% to 60%, and reductions appeared to be well maintained at follow-up, although some studies reported no improvement during treatment. Treatment was reported to result in decreased opioid use in nearly three-fourths of persons, whereas untreated people generally reported no change. Treatment was also noted to improve activity levels and return to work, lower use of the health care system (including hospitalization and surgery), and increase the percentage of disability claims that were settled. This last point suggests that many persons with chronic noncancer pain can return to work, even after an extended period of being disabled.

Finally, one group of researchers performed a meta-analysis of meta-analyses (Fishbain et al. 1999). These researchers concluded that MPC treatment is consistently effective for most outcomes, including return to work, although it was unclear what outcome variables or type of pain responded most to treatment. Meta-analytic results depend, however, on the studies included within the analysis. Thus, owing to a variety of methodologic problems that affect pain treatment studies, the results of this study should be interpreted cautiously.

Because Cochrane reviews are considered the gold standard, owing to their stringent research criteria, we have tried throughout this book to provide the reader with the available Cochrane reviews whenever possible. Many Cochrane reviews conclude that "there is insufficient evidence to conclude that [the] treatment is effective due to the poor quality of the studies reviewed." Physical therapists must establish treatment efficacy and efficiency through carefully asked questions and well-designed studies. Physical therapists are no exception from other health care providers; many common medical and surgical interventions are provided based on the clinician's training and beliefs. Evidence-based guidelines based on the available evidence are being established. Physical therapists need to heed these guidelines to improve the quality of care we deliver for the good of our patients and, ultimately, the future of our profession. Perhaps someday, physical therapists will be able to write their own guidelines based on the evidence they have collected through research and collaboration.

CONCLUSION

In this chapter, we have presented instruments used to assess HRQOL and examples of how these instruments have been used in clinical practice and research. The biomedical literature contains clear evidence that HRQOL data are useful to guide and evaluate treatment for a variety of medical conditions, including chronic noncancer pain.

Measures of HRQOL are useful, clinically significant means to incorporate patient preferences into front-line medical decision making. Doing so is expected to improve overall patient satisfaction with care (Marvel 1999). Furthermore, patients with chronic noncancer pain often believe that they have lost control over their condition and their care. Using patient-centered data may help affected individuals recognize not only that their opinion is important, but also that they do have some control over what happens to them.

No tool will be used if it is too burdensome (too long or difficult to understand). Instruments must be easily understood, administered, and interpreted by clinicians and patients. No instrument is ideal for all intended uses; questionnaires are available in a variety of forms, however, and many of these can be readily incorporated into clinical care and research.

Jaded et al. (2000) write that

> if the Internet and evidence-based decision making are to reach their full potential and contribute to improvements in health care, a powerful and efficient synergy must develop between them. The Internet could benefit evidence-based decision making by giving decision-makers cheap, fast and efficient access to up-to-date, valid and relevant knowledge at the right time, at the right place, in the right amount and in the right format. Conversely, the tools and principles of evidence-based medicine could be used to gain a better understanding of the role of the Internet in health care, helping us to anticipate opportunities and prevent potential problems.

We have attempted to provide you with useful Web addresses throughout this book in the hope that they will make the readers' search for information easier. Use the information on the Web. Try to practice your profession based on what the evidence shows us.

RECOMMENDED WEB SITES

All Web sites in this chapter were last accessed on: June 10, 2001.

Web Sites to Visit for Measurement Tools

http://www.qolid.org/url.htm
http://www.stat.washington.edu/TALARIA/talaria0/LS2.2.html. Measurement of pain in children and patients with cancer pain.
http://www.outcomes-trust.org/instruments/
http://www.york.ac.uk/inst/crd/welcome.htm
http://ericae.net/testcol.htm. Test locator site.

Web Sites to Visit for Evidence-Based Research

http://www.cochrane.org. Main site for the Cochrane Collaboration.
http://www.med.unr.edu/medlib/netting.html. Web site containing evidence-based Web sites.
http://www.herts.ac.uk/lis/subjects/health/ebm.htm. Web sites and databases.
http://www.jr2.ox.ac.uk/bandolier/. Bandolier Evidence Based Medicine.
http://www.jr2.ox.ac.uk/bandolier/painres/painres.html. Pain research at Bandolier Evidence Based Medicine.
http://www.medscout.com/guidelines/cochrane/. Cochrane Collaboration.
http://www.iwh.on.ca/home.htm. Institute for Work and Health, Canada.
http://www.ahcpr.gov/. Agency for Health Care Research and Quality.

Guidelines on Managing Pain

http://www.ampainsoc.org/pub/bulletin/nov00/clin1.htm
http://www.guideline.gov
http://www.nlm.nih.gov/nichsr/hsrsites.html. Research on health care in general.

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Appendix 19.1

RAND 36-Item Health Survey

1. In general, would you say your health is:	
Excellent	1
Very good	2
Good	3
Fair	4

2. **Compared to 1 year ago**, how would you rate your health in general **now**?	
Much better now than 1 year ago	1
Somewhat better now than 1 year ago	2
About the same	3
Somewhat worse now than 1 year ago	4
Much worse now than 1 year ago	5

The following items are about activities you might do during a typical day. Does **your health now limit you** in these activities? If so, how much?

(Circle One Number on Each Line)

	Yes, Limited a Lot	Yes, Limited a Little	No, Not Limited at All
3. **Vigorous activities**, such as running, lifting heavy objects, participating in strenuous sports	[1]	[2]	[3]

4. **Moderate activities**, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf.	[1]	[2]	[3]
5. Lifting or carrying groceries	[1]	[2]	[3]
6. Climbing **several** flights of stairs	[1]	[2]	[3]
7. Climbing **one** flight of stairs	[1]	[2]	[3]
8. Bending, kneeling, or stooping	[1]	[2]	[3]
9. Walking **more than a mile**	[1]	[2]	[3]
10. Walking **several blocks**	[1]	[2]	[3]
11. Walking **one block**	[1]	[2]	[3]
12. Bathing or dressing yourself	[1]	[2]	[3]

During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of your physical health**?

(Circle One Number on Each Line)

	Yes	No
13. Cut down the amount of time you spent on work or other activities	1	2
14. **Accomplished less** than you would like	1	2
15. Were limited in the **kind** of work or other activities	1	2
16. Had **difficulty** performing the work or other activities (for example, it took extra effort)	1	2

During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of any emotional problems** (such as feeling depressed or anxious)?

(Circle One Number on Each Line)

	Yes	No
17. Cut down the **amount of time** you spent on work or other activities	Yes	No
18. **Accomplished less** than you would like	1	2
19. Didn't do work or other activities as **carefully** as usual	1	2

20. During the **past 4 weeks**, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

(Circle One Number on Each Line)

Not at all	1
Slightly	2
Moderately	3
Quite a bit	4
Extremely	5

21. How much **bodily** pain have you had during the **past 4 weeks?**

(Circle One Number on Each Line)

None	1
Very mild	2
Mild	3
Moderate	4
Severe	5
Very severe	6

22. During the **past 4 weeks**, how much did **pain** interfere with your normal work (including both work outside the home and housework)?

(Circle One Number on Each Line)

Not at all	1
Slightly	2
Moderately	3
Quite a bit	4
Extremely	5

These questions are about how you feel and how things have been with you **during the past 4 weeks.** For each question, please give the one answer that comes closest to the way you have been feeling.

How much of the time during the **past 4 weeks…**

(Circle One Number on Each Line)

	All of the Time	Most of the Time	A Good Bit of the Time	Some of the Time	A Little of the Time
23. Did you feel full of pep?	1	2	3	4	5
24. Have you been a very nervous person?	1	2	3	4	5
25. Have you felt so down in the dumps that nothing could cheer you up?	1	2	3	4	5
26. Have you felt calm and peaceful?	1	2	3	4	5
27. Did you have a lot of energy?	1	2	3	4	5
28. Have you felt downhearted and blue?	1	2	3	4	5
29. Did you feel worn out?	1	2	3	4	5
30. Have you been a happy person?	1	2	3	4	5
31. Did you feel tired?	1	2	3	4	5

32. During the **past 4 weeks**, how much of the time has your **physical health or emotional problems** interfered with your social activities (like visiting with friends, relatives, etc.)?

(Circle One Number)

All of the time	1
Most of the time	2
Some of the time	3
A little of the time	4
None of the time	5

How TRUE or FALSE is each of the following statements for you?

(Circle One Number on Each Line)

	Definitely True	Mostly True	Don't Know	Mostly False	Definitely False
33. I seem to get sick a little easier than most people.	1	2	3	>4	5
34. I am as healthy as anybody I know.	1	2	3	4	5
35. I expect my health to get worse.	1	2	3	4	5
36. My health is excellent.	1	>2	3	4	5

RAND 36-ITEM HEALTH SURVEY (VERSION 1.0) SCORING RULES

Introduction

The RAND 36-Item Health Survey (Version 1.0) taps eight health concepts: physical functioning, bodily pain, role limitations due to physical health problems, role limitations due to personal or emotional problems, emotional well-being, social functioning, energy/fatigue, and general health perceptions. It also includes a single item that provides an indication of perceived change in health. These 36 items, presented here, are identical to the MOS-SF described in Ware and Sherbourne (1992). They were adapted from longer instruments completed by patients participating in the Medical Outcomes Study (MOS), an observational study of variations in physician practice styles and patient outcomes in different systems of health care delivery (Hays and Shapiro 1992, Stewart et al. 1992). A revised version of the RAND 36-Item Health Survey (Version 1.1) that differs slightly from Version 1.0 in terms of wording is currently in development.

Scoring Rules for the RAND 36-Item Health Survey (Version 1.0)

We recommend that responses be scored as described below. A somewhat different scoring procedure for the MOS SF-36 has been distributed by the international Resource Center for Health Care Assessment (located in Boston, MA). Because the scoring method described here (a simpler and more straightforward procedure) differs from that of the MOS SF-36, persons using this scoring method should refer to the instrument as the RAND 36-Item Health Survey 1.0.

Scoring the RAND 36-Item Health Survey is a two-step process. First, precoded numeric values are recoded per the scoring key given in Table 1. Note that all items are scored so that a high score defines a more favorable health state. In addition, each item is scored on a 0 to 100 range so that the lowest and highest possible scores are set at 0 and 100, respectively. Scores represent the percentage of total possible score achieved. In step 2, items in the same scale are averaged together to create the eight scale scores. Table 2 lists the items averaged together to create each scale. Items that are left blank (missing data) are not taken into account when calculating the scale scores. Hence, scale scores represent the average for all items in the scale that the respondent answered.

Example: Items 20 and 32 are used to score the measure of social functioning. Each of the two items has five response choices. However, a high score (response choice) on item 20 indicates extreme limitations in social functioning, whereas a high score (response choice 5) on item 32 indicates the absence of limitations in social functioning. To score both items in the same direction, Table 1 shows that responses 1 through 5 for item 20 should be recorded to values of 100, 75, 50, 25, and 0, respectively. Responses 1 through 5 for item 32 should be recorded to values of 0, 25, 50, 75, and 100, respectively. Table 2 shows that these two recoded items should be averaged together to form the social functioning scale. If the respondent is missing one of the two items, the person's score will be equal to that of the nonmissing item.

Table 3 presents information on the reliability, central tendency, and variability of the scales scored using this method.

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Table 1. Step 1: Recording Items

Item Numbers	Change original response category*	To recoded value of
1, 2, 20, 22, 34, 36	1 ---------------->	100
	2 ---------------->	75
	3 ---------------->	50
	4 ---------------->	25
	5 ---------------->	0
3, 4, 5, 6, 7, 8, 9, 10, 11, 12	1 ---------------->	0
	2 ---------------->	50
	3 ---------------->	100
13,14, 15, 16, 17, 18, 19	1 ---------------->	0
	2 ---------------->	100
21, 23, 26, 27, 30	1 ---------------->	100
	2 ---------------->	80
	3 ---------------->	60
	4 ---------------->	40
	5 ---------------->	20
	6 ---------------->	0
24, 25, 28, 29, 31	1 ---------------->	0
	2 ---------------->	20
	3 ---------------->	40
	4 ---------------->	60
	5 ---------------->	80
	6 ---------------->	100
32, 33, 35	1 ---------------->	0
	2 ---------------->	25
	3 ---------------->	50
	4 ---------------->	75
	5 ---------------->	100

*Precoded response choices as printed in the questionnaire.

Table 2. Step 2: Averaging Items to Form Scales

Scale	Number of Items	After Recoding Per Table 1, Average the Following Items
Physical functioning	10	3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Role limitations due to physical health	4	13, 14, 15, 16
Role limitations due to emotional problems	3	17, 18, 19
Energy/fatigue	4	23, 27, 29, 31
Emotional well-being	5	24, 25, 26, 28, 30
Social functioning	2	20, 32
Pain	2	21, 22
General health	5	1, 33, 34, 35, 36

Table 3. Reliability, Central Tendency, and Variability of Scales in the Medical Outcomes Study

Scale	**Number of Items**	**Alpha**	**Mean**	**SD**
Physical functioning	10	0.93	70.61	27.42
Role limitations due to physical health	4	0.84	52.97	40.78
Role limitations due to emotional problems	3	0.83	65.78	40.71
Energy/fatigue	4	0.88	52.15	22.39
Emotional well-being	5	0.90	70.38	21.97
Social functioning	2	0.85	78.77	25.43
Pain	2	0.78	70.77	25.46
General health	5	0.78	56.99	21.11
Health change	1	—	59.14	23.12

Note: Data are from baseline of the Medical Outcome Study (N = 2,471), except for health change, which was obtained 1 year later.

Appendix 19.2

Graded Chronic Pain Scale*

Questions Used to Grade Chronic Pain Status

Pain intensity items

1. How would you rate your back/headache/facial pain on a 0–10 scale at the present time, that is right now, where 0 is "no pain" and 10 is "pain as bad as could be"?

No Pain									Pain as bad as could be
1	2	3	4	5	6	7	8	9	10

2. In the past 6 months, how intense was your worst pain rated on a 0–10 scale where 0 is "no pain" and 10 is "pain as bad as could be"?

No Pain									Pain as bad as could be
1	2	3	4	5	6	7	8	9	10

3. In the past 6 months, on the average, how intense was your pain rated on a 0–10 scale where 0 is "no pain" and 10 is "pain as bad as could be"? (That is, your usual pain at times you were experiencing pain.)

No Pain									Pain as bad as could be
1	2	3	4	5	6	7	8	9	10

Disability items

4. Approximately how many days in the last 6 months have you been kept from your usual activities (work, school, or housework) because of back/headache/facial pain?

Disability Days: ____________________________

5. In the past 6 months, how much has back/headache/facial pain interfered with your daily activities rated on a 0–10 scale where 0 is "no interference" and 10 is "unable to carry on any activities"?

No interference									Unable to carry on any activities
1	2	3	4	5	6	7	8	9	10

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6. In the past 6 months, how much has back/headache/facial pain changed your ability to take part in recreational, social, and family activities where 0 is "no change" and 10 is "extreme change?

No change									Extreme change
1	2	3	4	5	6	7	8	9	10

7. In the past 6 months, how much has back/headache/facial pain changed your ability to work (including housework) where 0 is "no change" and 10 is "extreme change"?

No change									Extreme change
1	2	3	4	5	6	7	8	9	10

Method of Grading Chronic Pain Severity

Scoring

Characteristic pain intensity is a 0–100 score derived from questions 1–3:
Mean (pain right now, worst pain, average pain) × 10
Disability score is a 0–100 score derived from questions 5–7:
Mean (daily activities, social activities, work activities) × 10
Disability points: add the indicated points for disability days (question 4) and for disability score.

Disability Points			
Disability Days (0–180)		Disability Score (0–100)	
0–6 Days	0 Points	0–29	0 Points
7–14 Days	1 Point	30–49	1 Point
15–30 Days	2 Points	50–69	2 Points
31+ Days	3 Points	70 +	3 Points

Classification

Grade 0 Pain free	No pain problems (prior 6 months)
Grade I Low disability: low intensity	Characteristic pain intensity less than 50, and less than 3 disability points
Grade II Low disability: high intensity	Characteristic pain intensity of 50 or greater, and less than 3 disability points
Grade III High disability: moderate limiting	3–4 disability points, regardless of characteristic pain intensity
Grade IV High disability: severely limiting	5–6 disability points regardless of characteristic pain intensity

Appendix 19.3

Treatment Outcomes in Pain Survey

New England Medical Center

Name: ______________
DOB: ___ / ___ /___
MR #: ____ - ___ - ___

Treatment Outcomes in Pain Survey (TOPS)

This form completed on (month/day/year): _____ / _____ / _____

Instructions: An important part of your evaluation includes examination of pain from your perspective because you know your pain better than anyone else does. The following questions are designed to help us learn more about your pain and how it affects your life. This information will help keep track of how you feel and how well you are able to do your usual activities.

Please answer every question (unless you are asked to skip questions because they don't apply to you).

Answer the questions by marking in the appropriate oval. For example:

● or ⊗

There are no right or wrong answers. If you are not sure how to answer a question, please give the best answer you can. Thank you for completing this important questionnaire.

Your Health In General

1. In general, would you say your health is:

O	O	O	O	O
Excellent	Very good	Good	Fair	Poor
[1]	[2]	[3]	[4]	[5]

2. Compared to one year ago, how would you rate your health in general now?

O	O	O	O	O
Much better now than one year ago	**Somewhat better** now than one year ago	**About the same** as one year ago	**Somewhat worse** now than one year ago	**Much worse** now than one year ago
[1]	[2]	[3]	[4]	[5]

3. The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

(fill in one oval on each line)

	[1] Yes limited a lot	[2] Yes limited a little	[3] No not limited at all
a. **Vigorous activities**, such as running, lifting heavy objects, participating in strenuous sports	o	o	o
b. **Moderate activities**, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	o	o	o
c. Lifting or carrying groceries	o	o	o
d. Climbing **several** flights of stairs	o	o	o
e. Climbing **one** flight of stairs	o	o	o
f. Bending, kneeling, or stooping	o	o	o
g. Walking **more than a mile**	o	o	o
h. Walking **several blocks**	o	o	o
i. Walking **one block**	o	o	o
j. Bathing or dressing yourself	o	o	o
k. Combing your hair	o	o	o
l. Writing	o	o	o
m. Talking	o	o	o

4. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

(fill in one oval on each line)

	[1] Yes	[2] No
a. Cut down the **amount of time** you spent on work or other activities	o	o
b. **Accomplished less** than you would have liked	o	o
c. Were limited in the **kind** of work or other activities	o	o
d. Had **difficulty** performing the work or other activities (for example, it took extra effort)	o	o

5. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

(fill in one oval on each line)

	[1] Yes	[2] No
a. Cut down the **amount of time** you spent on work or other activities	o	o
b. **Accomplished less** than you would have liked	o	o
c. Didn't do work or other activities as **carefully** as usual	o	o

6. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

O	O	O	O	O
Not at all	Slightly	Moderately	Quite a bit	Extremely
[1]	[2]	[3]	[4]	[5]

7. How much bodily pain have you had during the past 4 weeks?

O	O	O	O	O	O
None	Very mild	Mild	Moderate	Severe	Very Severe
[1]	[2]	[3]	[4]	[5]	[6]

8. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

O	O	O	O	O
Not at all	Slightly	Moderately	Quite a bit	Extremely
[1]	[2]	[3]	[4]	[5]

9. These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks...

(fill in one oval on each line)

	[1] All of the time	[2] Most of the time	[3] A good bit of the time	[4] Some of the time	[5] A little of the time	[6] None of the time
a. Did you feel full of pep?	O	O	O	O	O	O
b. Have you been a very nervous person?	O	O	O	O	O	O
c. Have you felt so down in the dumps that nothing could cheer you up?	O	O	O	O	O	O
d. Have you felt calm and peaceful?	O	O	O	O	O	O
e. Did you have a lot of energy?	O	O	O	O	O	O
f. Have you felt downhearted and blue?	O	O	O	O	O	O
g. Did you feel worn out?	O	O	O	O	O	O
h. Have you been a happy person?	O	O	O	O	O	O
i. Did you feel tired?	O	O	O	O	O	O

10. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?

O	O	O	O	O
All of the time	Most of the time	Some of the time	A little of the time	None of the time
[1]	[2]	[3]	[4]	[5]

11. How TRUE or FALSE is each of the following statements for you?

(fill in one oval on each line)

	[1] Definitely True	[2] Mostly True	[3] Don't Know	[4] Mostly False	[5] Definitely False
a. I get sick a little easier than other people.	O	O	O	O	O
b. I am as healthy as anybody I know.	O	O	O	O	O
c. I expect my health to get worse.	O	O	O	O	O
d. My health is excellent.	O	O	O	O	O

Your Pain Problem

12. On a scale from 0 to 6 please rate:

(fill in one circle on each line)

	No pain						Worst possible
a. Your worst bodily pain in the past 4 weeks.	⓪	①	②	③	④	⑤	⑥
b. Your average pain in the past 4 weeks.	⓪	①	②	③	④	⑤	⑥
c. Your pain right now while filling out this form.	⓪	①	②	③	④	⑤	⑥
d. Your level of pain in the past week.	⓪	①	②	③	④	⑤	⑥

Your Social and Recreational Activities

13. How much does your pain get in the way of your daily activities (on a scale from 0 to 6):

⓪	①	②	③	④	⑤	⑥
Not at all						Completely

14. How much does your pain get in the way of:

(fill in one oval on each line)

	[1] Not at all	[2] A little bit	[3] Moderately	[4] Quite a bit	[5] Extremely
a. Enjoying your social activities or hobbies?	O	O	O	O	O
b. Doing any social activities or hobbies?	O	O	O	O	O
c. Getting along with your husband/ wife/ significant other/ family?	O	O	O	O	O
d. Getting along with friends outside of your family?	O	O	O	O	O
e. The pleasure you get from being with your family?	O	O	O	O	O
f. How well you can plan things?	O	O	O	O	O

15. How often do you:

(fill in one oval on each line)

	[1] Every Day	[2] 4-6 Times Per Week	[3] 2-3 Times Per Week	[4] Once a Week	[5] Never
a. Visit friends?	O	O	O	O	O
b. Get together with a group of people?	O	O	O	O	O
c. Enjoy your favorite hobby or activity?	O	O	O	O	O
d. Do things outside of the house?	O	O	O	O	O

Your Work

16. Are you currently:

(choose all that apply)

Working at a paying job full time .... ①
Working at a paying job part time .... ②
Retired .... ③
Laid-off or unemployed, but looking for work .... ④
Unemployed, not looking for work .... ⑤
A full-time homemaker .... ⑥
Student .... ⑦
Working at a volunteer job full time .... ⑧
Working at a volunteer job part time .... ⑨
In vocational rehabilitation or job training .... ⑩
Short-term disability .... ⑪
Disabled .... ⑫
Other .... ⑬
(Please specify)______________________

17. Which of the following disability supports do you receive? (choose all that apply)

O	O	O	O	O	O	O
Workers' comp	State disability	Private disability	SSDI	SSI	Other	No disability support
[1]	[2]	[3]	[4]	[5]	[6]	[7]

Your Satisfaction and Expectations

18. How satisfied are you with:

(fill in one oval on each line)

	[1] Completely Dissatisfied	[2] Very Dissatisfied	[3] Somewhat Dissatisfied	[4] Somewhat Satisfied	[5] Very Satisfied	[6] Completely Satisfied
a. Your current treatment of your pain?	o	o	o	o	o	o
b. Your physical ability to do what you want to?	o	o	o	o	o	o
c. The overall results of your treatment to date?	o	o	o	o	o	o

Control and Coping

19. On a scale from 0 to 6 please rate:

(fill in one circle on each line)

	None						Complete
a. Your control over your life in the past week.	⓪	①	②	③	④	⑤	⑥
b. Your ability to handle problems in the past week.	⓪	①	②	③	④	⑤	⑥
c. Your control over your pain.	⓪	①	②	③	④	⑤	⑥
d. Your success in coping with stressful situations in the past week.	⓪	①	②	③	④	⑤	⑥

20. How often have you done <u>each</u> of the following during the <u>past 6 months</u> in response to physical health or emotional problems? (If you have not had any problems, please indicate what you think you would be likely to do).

(fill in one oval on each line)

	[1] Never	[2] Rarely	[3] Sometimes	[4] Fairly Often	[5] Very Often
a. Hoped for a miracle.	o	o	o	o	o
b. Decided to spend more time alone.	o	o	o	o	o
c. Withdrew from other people.	o	o	o	o	o
d. Took it out on other people.	o	o	o	o	o

Your Husband / Wife / Significant Other / Closest Person

21. When you are in pain, how often does this person help you by:

(fill in one oval on each line)

	[1] Never	[2] Rarely	[3] Some-times	[4] Fairly often	[5] Very often
a. Doing your work or chores.	O	O	O	O	O
b. Telling you to take it easy.	O	O	O	O	O
c. Bringing you pain medicine.	O	O	O	O	O
d. Serving you food or drink.	O	O	O	O	O

Other Daily Activities

22. The following items are about activities you might do during a typical day. Does <u>your health now limit</u> you in these activities? If so, how much?

(fill in one oval on each line)

	[1] Yes Limited a lot	[2] Yes limited a little	[3] No not limited at all
a. Brushing your teeth.	O	O	O
b. Pulling a sweater or shirt over your head.	O	O	O
c. Opening a door handle.	O	O	O
d. Doing or undoing buttons.	O	O	O

23. The following statements are about how your everyday activities affect or might affect your pain.

(fill in one oval on each line)

	[1] Completely Disagree	[2]	[3] Unsure	[4]	[5] Completely Agree
a. Physical activity makes me hurt more.	O	O	O	O	O
b. Physical activity might make me feel better.	O	O	O	O	O
c. It is safe for a person with my condition to be physically active.	O	O	O	O	O
d. Work might hurt me.	O	O	O	O	O
e. I should do my normal work with my present pain.	O	O	O	O	O

Your Work

24. **DURING THE PAST TWO WORK WEEKS**, how much of the time did your physical health or emotional problems make it **difficult for you to do the following**?

(fill in one oval on each line)

	[0] Difficult None of the Time (0%)	[1] Difficult A Slight Bit of the Time	[2] Difficult Some of the Time (50%)	[3] Difficult Most of the Time	[4] Difficult All of the Time (100%)	[5] Does Not Apply To My Job
a. Think clearly when working . . .	O	O	O	O	O	O
b. Get going easily at the beginning of the work day . . .	O	O	O	O	O	O
c. Be near or around other people when working . . .	O	O	O	O	O	O
d. Do the same motions repeatedly while working . . .	O	O	O	O	O	O
e. Use hand-operated tools or equipment while working (for example, a pen, keyboard, computer mouse, drill, hairdryer or sander) . . .	O	O	O	O	O	O

Your Health Habits

25. How would you describe your smoking habits?

O Never smoked [1]
O Used to smoke [2]
O Less than 1 pack cigarettes per day [3]
O 1 to less than 2 packs cigarettes per day [4]
O 2 or more packs of cigarettes per day [5]
O Smoke cigars or a pipe [6]

26. Do you drink alcohol (beer, wine, or liquor)?

O Not at all [1]
O Occasionally a social drink [2]
O About 1 to 3 drinks per day [3]
O Four or more drinks per day [4]

27. Do you drink alcohol to relieve your pain?

O Regularly [1]
O Often [2]
O Seldom [3]
O Never [4]

Health Care

28. Thinking about your health care and the services you receive to treat your pain, how would you rate the following?

(fill in one oval on each line)

	[1] Poor	[2] Fair	[3] Good	[4] Very Good	[5] Excellent
a. Ease of making appointments for medical care by phone.	○	○	○	○	○
b. Thoroughness of treatment.	○	○	○	○	○
c. Attention given to what you have to say.	○	○	○	○	○
d. Amount of time you have with doctors and staff during a visit.	○	○	○	○	○
e. The outcomes of your medical care, how much you are helped.	○	○	○	○	○
f. How well your care meets your needs.	○	○	○	○	○
g. Overall quality of care and services.	○	○	○	○	○

About You

29. How old are you?

① Under 35 ② 35-39 ③ 40-44 ④ 45-49 ⑤ 50-54 ⑥ 55-59 ⑦ 60-64 ⑧ 65-69 ⑨ Over 69

30. Are you male or female?

① male ② female

31. Which of the following best describes your racial or ethnic background?

○ Hispanic or Latino [1]
○ White or Caucasian [2]
○ Black or African-American [3]
○ Asian [4]
○ Other [5]

32. How many persons live in your household, including yourself, other adults, and any children?

○ One person [1]
○ Two persons [2]
○ Three to five persons [3]
○ More than five persons [4]

33. What is your current marital status?

○ Married [1]	○ Living Together [2]	○ Separated [3]	○ Divorced [4]	○ Widowed [5]	○ Never Married [6]

34. What is the highest grade you completed in school?

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ Grade School

⑨ ⑩ ⑪ ⑫ High School

⑬ ⑭ ⑮ ⑯ College

⑰+ Post Grad

35. Approximately what was your household's **TOTAL INCOME** last year **before taxes**?

○ Less than $10,000 [0]	○ $10,000 - $19,999 [1]	○ $20,000 - $29,999 [2]	○ $30,000 - $39,999 [3]	○ $40,000 - $49,999 [4]	○ $50,000 - $59,999 [5]	○ $60,000 - $69,999 [6]	○ $70,000 - $79,999 [7]	○ $80,000 or more [8]

Thank you for completing this very important questionnaire!

With permission from DB Carr, W Rogers, HM Wittink. New England Medical Center and the Health Institute, Boston, MA.

Appendix 19.4

Pain Catastrophizing Scale*

*With permission from Michael Sullivan PhD, Pain Research Centre, Department of Psychology, Dalhousie University, Halifax, Nova Scotia. For further information about the tool or treatment of catastrophizing, contact sully@is.dal.ca.

Ψ

PCS

Name: ____________________ Age: ________ Gender: _________ Date: ____________

Everyone experiences painful situations at some point in their lives. Such experiences may include headaches, tooth pain, joint or muscle pain. People are often exposed to situations that may cause pain such as illness, injury, dental procedures or surgery.

We are interested in the types of thoughts and feelings that you have when you are in pain. Listed below are thirteen statements describing different thoughts and feelings that may be associated with pain. Using the following scale, please indicate the degree to which you have these thoughts and feelings when you are experiencing pain.

0 – not at all **1** – to a slight degree **2** – to a moderate degree **3** – to a great degree **4** – all the time

When I'm in pain ...

1 ☐ I worry all the time about whether the pain will end.

2 ☐ I feel I can't go on.

3 ☐ It's terrible and I think it's never going to get any better.

4 ☐ It's awful and I feel that it overwhelms me.

5 ☐ I feel I can't stand it anymore.

6 ☐ I become afraid that the pain will get worse.

7 ☐ I keep thinking of other painful events.

8 ☐ I anxiously want the pain to go away.

9 ☐ I can't seem to keep it out of my mind.

10 ☐ I keep thinking about how much it hurts.

11 ☐ I keep thinking about how badly I want the pain to stop.

12 ☐ There's nothing I can do to reduce the intensity of the pain.

13 ☐ I wonder whether something serious may happen.

____

...Total

Appendix 19.5

Work Limitations Questionnaire

In the past 2 weeks, how much of the time did your physical health or emotional problems make it difficult for you to do the following?

	All of the Time (100%)	Most of the Time	Some of the Time (About 50%)	A Slight Bit of the Time	None of the Time (0%)	Does Not Apply to My Job
a. do your work without stopping to take breaks or rests	☐1	☐2	☐3	☐4	☐5	☐0
b. stick to a routine or schedule	☐1	☐2	☐3	☐4	☐5	☐0
c. keep your mind on your work	☐1	☐2	☐3	☐4	☐5	☐0
d. speak with people in person, in meetings or on the phone	☐1	☐2	☐3	☐4	☐5	☐0
e. handle the workload.......	☐1	☐2	☐3	☐4	☐5	☐0

Note: Items a. and b. are from the Time Demands scale. Items c.and d. are from the Mental-Interpersonal Demands scale. Item e. is from the Output Demands scale.

In the past 2 weeks, how much of the time were you **ABLE TO DO** the following without difficulty caused by physical health or emotional problems?

	All of the Time (100%)	Most of the Time	Some of the Time (About 50%)	A Slight Bit of the Time	None of the Time (0%)	Does Not Apply to My Job
a. walk or move around different work locations (for example, go to meetings)	☐1	☐2	☐3	☐4	☐5	☐0
b. use hand-held tools or equipment (for example, a phone, pen, keyboard, computer mouse, drill, hairdryer, or sander)	☐1	☐2	☐3	☐4	☐5	☐0

Note: Items a. and b. are from the Physical Demands scale.

Source: Reprinted with permission from Dr. Debra Lerner.

Appendix I

Pain Curriculum for Students in Occupational Therapy or Physical Therapy*

INTRODUCTION

A. *Overview of roles and responsibilities of occupational therapists and physical therapists.* Pain is a common problem for many of the clients/patients seen by occupational therapists and physical therapists. For these clients/patients, the primary therapeutic objectives are reduction of pain and associated disability, promotion of optimal function in everyday living, and development of meaningful family and social relationships. Promotion of health and well-being through prevention of pain and disability or handicap resulting from pain is a fundamental concern. It is essential that occupational therapists and physical therapists take a holistic and collaborative view of the needs of the client/patient with pain. Therapists should be able to recognize the numerous misconceptions that prevail about pain and people with pain and be able to refute and challenge their existence.

The professions of occupational therapy and physical therapy vary in their underlying theoretical foundations and in their overall approach to pain.

Occupational therapists are primarily concerned with the psychosocial and environmental factors that contribute to pain and the impact of pain on the individual's everyday life. Their roles and responsibilities include the following:

1. Assessment of the impact of pain on occupational performance in the areas of self-care, paid and unpaid work, interests and leisure pursuits, customary habits and routines, and family relationships. Assessment will include evaluation of psychosocial and environmental factors aggravating pain in the home and workplace.
2. In collaboration with the client/patient, development of an occupational therapy program to increase self-esteem, restore self-efficacy, and promote optimal occupational function despite pain. Intervention strategies may include assistive devices and adaptive equipment; purposeful and productive occupations and activities; and vocational rehabilitation or work hardening to improve endurance and work skills and reestablish roles, habits, and routines of everyday life. Education about pain and supportive individual, family, or group counseling are utilized as needed.
3. Liaison and referral within an interdisciplinary team approach.

Physical therapists apply a wide range of physical and behavioral treatments to reduce pain and prevent dysfunction. Their roles and responsibilities include the following:

1. Assessment of the primary and secondary chemical (infection and inflammation), biomechanical (stress and strain), and behavioral factors that contribute to pain, the pain activity cycle, and overall function.

*Reprinted with permission from the International Association for the Study of Pain. Ad Hoc Subcommittee for Occupational Therapy/Physical Therapy Curriculum. Pain Curriculum for Students in Occupational Therapy or Physical Therapy. IASP Newsletter, 1994;3.

2. In collaboration with the client/patient, development of a physical therapy program directed at modification of the effect of primary and secondary contributors to pain, promotion of tissue healing, and reduction of the factors that may lead to the recurrence of pain and dysfunction. Intervention may include education; exercise; manual therapy; movement facilitation techniques; and application of electro/physical agents based on thermal, mechanical, electrical, or phototherapeutic modalities. Education is focused on understanding pain and on improved posture, body mechanics, and gait. Exercise is directed toward the strengthening of specific muscle groups as well as counteracting the effects of generalized deconditioning. Movement is used as a mechanism to control and decrease pain and to increase mobility.
3. Liaison and referral within an interdisciplinary team approach.

Cognitive-behavioral strategies and supportive/educational approaches for pain management may be implemented by occupational and physical therapists to reduce pain and improve function and overall quality of life. Therapists from either profession have a common commitment to person-centered care, the promotion of health and well-being, and the prevention of long-term disability and handicap resulting from pain. Family education is an integral component of therapeutic programs.

To carry out professional responsibilities for clients with pain, occupational therapists and physical therapists must have an understanding of the physiologic basis and the psychological and environmental components of pain and their impact on pain experience across the life span. Therapists should be familiar with pain assessment and measurement approaches and should be able to implement a broad variety of management strategies from their specific professional orientations. While neither occupational therapists nor physical therapists are responsible for pharmacologic management, they should have sufficient knowledge about pharmacologic agents and their side effects to act as advocates for optimal pharmacologic management and to support proper use of medication by clients/patients.

B. *Overview of the interdisciplinary pain curriculum for students in occupational therapy or physical therapy.* This pain curriculum is designed as an interdisciplinary course of study to support and encourage professional collaboration. The focus of the course is on the pain experience of clients/patients and the physiologic, psychosocial, and environmental components of that experience, with an application of profession-specific theoretical frameworks to assess and manage pain and the impact of pain on everyday life. In this respect, this course presents new knowledge that will be applicable to students in either occupational therapy or physical therapy. However, in some educational programs, it may not be feasible or practical to offer this course in an interdisciplinary framework.

Inclusion of specific management strategies, as detailed in this curriculum, may depend on whether these strategies have been previously examined in other course work. Review of interventions rather than detailed instruction of each management strategy is expected in this course. Course instructors should modify management strategies where necessary if this curriculum is presented as a profession-specific course.

Students should be familiar with the theoretical models behind interventions as well as the empirical evidence of effectiveness of any management strategies. Course instructors are encouraged to adopt a critical appraisal perspective as a basis for decision making when reviewing the benefits and limitations of interventions.

Occupational therapy and physical therapy programs have different clinical areas of priority for student education. A suggested list of common pain problems for discussion according to definition, prevalence, clinical features, and possible interventions is included. The relevance of these pain problems within the curriculum should be decided by individual course instructors. All pain terminology and definitions used in this course should be consistent with Merskey and Bogduk (1994), *Classification of Chronic Pain: Descriptions of Chronic Pain Syndromes and Definition of Pain Terms*.

Considerable variation exists from country to country in the academic structure of professional programs for occupational therapy or physical therapy and in the professional expectations of an entry-level therapist. Faculty in occupational therapy and physical therapy programs should incorporate the specific content of this pain curriculum within their programs using whatever structural and educational approaches would be the most appropriate to meet local professional and program needs. However, this curriculum is designed to be most appropriate for students who have previously completed courses in anatomy, physiology, kinesiology or movement, and the majority of their professional therapeutics courses. In a traditional curriculum format, completion of this curriculum as constructed would require two semesters in a senior year and would be the approximate equivalent of a four– to six–credit-hour course.

COURSE OBJECTIVES

On completion of this course, the occupational therapy or physical therapy student will

1. Understand the current theories of the anatomic, physiologic, and psychological bases of pain and pain relief.
2. Recognize how age, gender, family, culture, spirituality, and the environment contribute to the pain experience and must be considered in assessment and management of pain.
3. Be able to assess the pain experience and resulting therapeutic needs for an individual according to an occupational therapy or physical therapy framework.
4. Recognize the differences between acute and chronic pain and their implications for assessment and management of pain.
5. Emphasize performance of a comprehensive evaluation and treatment in the acute pain phase to prevent the onset of chronicity.
6. Be familiar with the reliability, validity, benefits, and limitations of self-report, behavioral, and physiologic measures to assess and measure pain, pain experience, and impact of pain on everyday life.
7. Use a person-centered perspective to formulate collaborative intervention strategies consistent with an occupational therapy or physical therapy perspective.
8. Adopt a critical appraisal perspective toward the use of assessment and intervention strategies and outcome measures.
9. Understand the prevention of pain problems in the home and workplace within a framework of health promotion and illness prevention.
10. Be familiar with the roles and responsibilities of other health care professionals in the area of pain management and the merits of interdisciplinary collaboration.
11. Recognize the changing nature of knowledge about underlying pain mechanisms and the importance of ongoing pain education.

COURSE OUTLINE

- I. Introduction
  - A. Definition of pain as a multidimensional experience
  - B. The epidemiology of pain as a public health problem with social, ethical, and economic considerations
  - C. Barriers to pain assessment and management
  - D. Role of occupational therapy and physical therapy in pain care (complementary roles)
- II. Nature of pain
  - A. Historical theories
    1. Descartes' theory of pain
    2. Gate control theory of pain
  - B. Physiologic basis of pain
    1. Peripheral and central mechanisms (including nociceptive events, ascending and descending pathways, effects of inflammation and tissue damage on nociceptors, nerve trauma and entrapment, central and peripheral sensitization)
    2. Biochemical and biomechanical nociception
    3. Sympathetic nervous system mechanisms in pain
    4. Tonic and phasic pain
    5. Referred pain (visceral and somatic pain)

6. Physiologic and pathologic effects of unrelieved pain
7. Trigger point mechanisms (e.g., myofascial pain)
8. Postural components (home and work)

C. Distinction among acute, recurrent, and chronic pains
1. Definitions and classifications of acute and chronic pains
2. Impact on physiology of pain
3. Impact on psychological response to pain
4. Specific pain definitions including pain threshold, pain tolerance, and pain endurance

D. Psychological and behavioral components of pain experience and relationship to acute or chronic nature of pain
1. Anxiety, fear, crisis reactions, stress
2. Impact on spirituality and meaningfulness, hope and hopelessness
3. Psychological effect of unrelieved pain on perceptions of control and self-efficacy
4. Depression, wish to die, suicidal risks
5. Impact of persistent pain on habits, roles, occupational performance, and future quality of life
6. Personality and gender influences on pain experience

E. Environmental components of pain experience
1. Family and social influences
2. Ethnic and cultural considerations

F. Interaction of physiologic basis of pain with psychological and environmental components and their impact on pain perception and pain response

III. Pain across the life span (physiologic and psychosocial factors, implications for assessment, measurement, and intervention)

A. Pain in infancy, childhood, and adolescence

B. Pain in the elderly

IV. Assessment and measurement of pain

A. Application of professional models to assessment of pain (e.g., in occupational therapy, the models of human occupation and occupational performance; in physical therapy, the orthopedic model, the acute pain model, and movement theory)

B. World Health Organization model of impairment, disability, and handicap

C. Utility, reliability, and validity of pain measures

D. Self-report measures as the gold standard of measurement for pain intensity, location, quality, temporal variation, chronology of pain, and factors that increase or decrease pain

E. Behavioral and physiologic measures

F. Benefits and limitations of measurement strategies for acute, recurrent, or chronic pain

G. Assessment of pain impact on daily life and quality of life
1. Using daily diary recording of pain, activity level (including self-care, work, leisure activities, exercise)
2. Changes in routines, roles, and skills

H. Meaning of pain behavior considering age of the individual, nature of pain, and contextual characteristics of the pain

I. Assessment and measurement of pain when the client has communication problems due to age, language, or physical/cognitive difficulties

J. Outcome measures

V. Management of pain and prevention of negative consequences of pain on everyday life occupations/activities

A. Person-centered intervention through collaborative goals using concepts and strategies from clinical reasoning to understand the experience and needs of a person with pain

B. Principles of critical research appraisal and application to clinical decision making

C. Principles of a therapeutic milieu to reduce pain and promote optimal function
1. Trust and honesty
2. Control and predictability
3. Anticipating when pain may occur
4. Using baseline and daily measures of pain and activity
5. Developing a daily routine to support readjustment of habits and roles according to individual capacity and life situation
6. Modification of physical and psychosocial factors that promote pain or neg-

ative consequences of pain on daily life
   7. Involvement of family members and significant others
   8. Encouragement of active over passive participation
   9. Communication and team process
D. Using an interdisciplinary team approach
   1. Roles and responsibilities of the health care team
E. Consideration of management strategies according to nature of pain (acute, recurrent, or chronic) and the client's statement of needs
F. Group approaches for education, support, and encouragement
G. Cognitive-behavioral interventions
   1. Setting short- and long-term goals
   2. Developing a daily routine
   3. Pacing of activities
   4. Coping strategies and appraisals
   5. Distraction
   6. Relaxation
   7. Visual imagery
   8. Play and art
   9. Use of meaningful occupations/activities
H. Operant strategies to support effective coping strategies
I. Physical interventions
   1. Movement to control pain
   2. Exercise to correct posture and improve strength
   3. Movement and exercise to improve self-esteem, restore self-efficacy, normalize body awareness, and promote optimal function
   4. Heat and cold
   5. Massage
   6. Mobilizations/manipulation
   7. Transcutaneous electrical nerve stimulation and other electrical protocols
   8. Biofeedback
   9. Laser
   10. Acupuncture
   11. Spray and stretch
   12. Biomechanical therapies
   13. Other interventions (ultrasound, rolfing, shiatsu, pulsed electromagnetic fields, McKenzie's techniques, Alexander techniques, trager, muscle energies, myofascial release and craniosacral techniques, mobilization of the nervous system)
J. Assistive devices and adaptive equipment
   1. Benefits and limitations
K. Reintegration into work (paid and unpaid employment)
   1. Work assessment, work hardening
   2. Application of ergonomic principles
   3. Reducing pain-producing hazards
   4. Work simplification
   5. Using groups to support reintegration to work
   6. Litigation and compensation and possible medicolegal implications for clients/patients and therapists
L. Back care
   1. Reducing hazards to good back care
   2. Posture in standing, sitting, and sleeping
   3. Strategies for bending, lifting, and reaching
   4. Building exercise and relaxation into daily life
M. Sleep
   1. Alternatives to medication
   2. Creating a sleep environment for restorative sleep
   3. Readjusting the biological clock
   4. Sleep problems and relationship to somaticovisceral pain
N. Role of pharmacologic approaches
   1. Principles of administration
   2. Nonsteroidal anti-inflammatory drugs, opioids, adjunctive medications, and other alternatives
   3. Modes of administration
   4. Side effects
   5. Tolerance, physical dependence, psychological dependence, and drug-seeking behavior
   6. Addiction risks
   7. Patient-controlled analgesia
   8. Role of occupational therapy and physical therapy in supporting optimal pharmacologic strategies
O. Nutrition and diet
P. Intimacy and sexuality
Q. Placebo effect of management strategies

VI. Common pain problems (definition, prevalence, clinical features, possible interventions)

A. Migraine and headache
B. Back and neck pain
C. Musculoskeletal pains (arthritis, fibromyalgia, myofascial pain, reflex sympathetic dystrophy, temporomandibular dysfunction)
D. Neuralgias
E. Pain associated with burns
F. Pain associated with progressive disease, terminal illness (cancer), palliative care
G. Pain and psychiatric illness
H. Pain in acquired immunodeficiency syndrome
I. Pain due to health care procedures

VII. Service delivery
A. Traditional pain management model, multidisciplinary pain treatment clinics and facilities, modality-specific practice
B. Ethical and legal standards of pain management

Appendix II

Support Groups

AIDS Action Council
Westlund House
16 Gordon Street
Acton, ACT 2601
GPO Box 229
Canberra, ACT 2601
(02) 6257-2855
http://www.aidsaction.org.au/

AIDS Action
1906 Sunderland Place NW
Washington, DC 20036
(202) 530-8030
http://www.aidsaction.org/

American Cancer Society
http://www.cancer.org/

American Chronic Pain Association
P.O. Box 850
Rockin, CA 95677
(916) 632-0922
http://www.theacpa.org/

American Fibromyalgia Syndrome Association
6380 E. Tanque Verde, Suite D
Tucson, AZ 85715
(520) 733-1570
http://www.afsafund.org/

American Pain Society
4700 W. Lake Avenue
Glenview, IL 60025
(847) 375-4715
http://www.ampainsoc.org/

American Spinal Injury Association
2020 Peachtree Road NW
Atlanta, GA 30309-1402
(404) 355-9772
http://www.asia-spinalinjury.org/

Arachnoiditis Information and Support Network
Jean Lonergan
3825 Chatham Road
Louisville, KY 40218
http://hometown.aol.com/Ddzevie/index.html
Australia: http://www.redback.org.au/

Arthritis Foundation
P.O. Box 7669
Atlanta, GA 30357-0669
(404) 872-7100
http://www.arthritis.org/

Cancer Care Inc.
National Office
275 Seventh Avenue
New York, NY 10001
(212) 302-2400
(800) 813-HOPE (4673)
http://www.cancercare.org/

Candlelighters Childhood Cancer Foundation
3910 Warner Street
Kensington, MD 20895
(800) 366-2223
http://www.candlelighters.org/

Endometriosis Association
8585 N. Seventy-sixth Place
Milwaukee, WI 53223
(414) 355-2200
http://www.endo-online.org/

International Association for the Study of Pain
909 NE Forty-third Street, Suite 306
Seattle, WA 98105
(206) 547-6409
http://www.iasp-pain.org

Interstitial Cystitis Association
51 Monroe Street, Suite 1402
Rockville, MD 20850
(800) HELP-ICA (435-7422)
http://www.ichelp.org/

Mayday Pain Project
http://www.painandhealth.org/

National Institute of Arthritis and Musculoskeletal and Skin Diseases
1 AMS Circle
Bethesda, MD 20892-3675
(301) 495-4484
http://www.niams.nih.gov

National Association for Sickle Cell Disease
National Headquarters
200 Corporate Pointe, Suite 495
Culver City, CA 90230-8727
(310) 216-6363
http://www.sicklecelldisease.org/

National Chronic Pain Outreach Association
7979 Old Georgetown Road, Suite 100
Bethesda, MD 20814-2429
(301) 652-4948

National Coalition for Cancer Survivorship
1010 Wayne Avenue, Suite 770
Silver Spring, MD 20910-5600
(301) 650-9127
(877) NCCS-YES (622-7937)
http://www.cansearch.org/

National Headache Foundation
(888) NHF-5552 (643-5552)
http://www.headaches.org

National Multiple Sclerosis Society
733 Third Avenue
New York, NY 10017
(800) FIGHT-MS (344-4867)
http://www.nmss.org/

National Vulvodynia Association
P.O. Box 4491
Silver Spring, MD 20914-4491
(301) 299-0775
http://www.nva.org/

North American Chronic Pain Association of Canada
150 Central Park Drive, Unit 105
Brampton, Ontario L6T 2T9
(905) 793-5230
(800) 616-PAIN (7246)
http://www.chronicpaincanada.org/

Reflex Sympathetic Dystrophy Syndrome Association
P.O. Box 502
Milford, CT 06460
(203) 877-3790
http://www.rsds.org/

Resource Center for State Cancer Pain Initiatives
University of Wisconsin-Madison Medical School
Medical Sciences Center, Room 3675
1300 University Avenue, Room 4720
Madison, WI 53706
(608) 262-0978
http://www.wisc.edu/molpharm/wcpi/

Trigeminal Neuralgia Association
P.O. Box 340
Barnegat Light, NH 08006
(609) 361-6250
http://www.tna-support.org/

Varicella Zoster Virus Research Foundation
40 E. Seventy-second Street
New York, NY 10021
(212) 472-3181
http://www.vzvfoundation.org/index.cfm

Y-Me National Organization for Breast Cancer
212 W. Van Buren Street, Suite 500
Chicago, IL 60607
(312) 986-8338
http://www.y-me.org/

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