Practical Issues in Geriatrics
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Paolo Falaschi · David R. Marsh
Editors

In collaboration with
Stefania Giordano

Orthogeriatrics

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Practical Issues in Geriatrics

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Orthogeriatrics

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Preface – Why Orthogeriatrics?

Frail, elderly patients with fragility fractures make up a large proportion of the workload of most trauma and orthopaedic (T&O) departments. Their needs are very different from younger patients with musculoskeletal injury or conditions requiring surgery, such as total joint replacements. There is now sufficient evidence from around the world to say with confidence that a multidisciplinary approach to their care is not only better for them, but better also for the efficient and cost-effective running of the T&O unit as a whole.

The editors and most of the authors of this book are active members of the Fragility Fracture Network (FFN) of the Bone and Joint Decade – a global organisation that aims to facilitate the ability of health services everywhere to cope with the rising tide of fragility fractures, particularly hip fractures, that is a consequence of ageing populations. The FFN believes that, despite the differences between the health services of different countries, the superiority of multidisciplinary care in this group of patients is universal.

The term 'orthogeriatrics' is used as shorthand, because historically it was collaboration between the specialities of orthopaedic surgery and geriatric medicine that generated the evidence supporting the multidisciplinary approach. However, there are obviously many parts of the world where the speciality of geriatrics is not sufficiently established for this to be feasible. The purpose of this book is therefore to describe and analyse what are the essential components of the orthogeriatric approach that make a beneficial difference to the care of elderly fracture patients, so that activists in all countries can plan how to develop the necessary competencies within the available resources and deliver the care that patients need.

Several characteristic features of geriatric medicine can immediately be identified as being especially beneficial to elderly fracture patients:

1. Understanding of the geriatric syndrome of **frailty**. This is a physiological syndrome – quite distinct from **fragility** which is a mechanical issue affecting bone (it is unfortunate that the same word is used to denote both entities in some languages).
2. A holistic view of older patients' health, with an appreciation of the interactions between body systems and between physical, mental and social dimensions.
3. A pragmatic view of treatment goals, identifying what is achievable given the patient's overall state and what is worth the cost to the patient of treatment.

4. Familiarity with, and influence in, the network of resources available for elderly patients – particularly useful in planning timely discharge from the fracture unit.
5. Resources for, and experience in, coordinated multidisciplinary rehabilitation teams for older patients.

However, physicians with geriatric competencies are not enough to meet the needs of older fracture patients. Without the input of orthopaedic surgeons, their efforts would be the equivalent of one hand clapping. The geriatrician needs the surgeon to restore the patient's locomotor abilities and remove the cause of their pain – just as much as the surgeon needs the physician to keep the patient alive and safe throughout the perioperative and postoperative phases of the acute fracture episode. Furthermore, surgeons need to tailor their treatment to the needs of the frail elderly, for instance by recognising the importance of one single operation that allows full weight-bearing whenever possible (this may seem obvious now, but was not so before the involvement of geriatricians brought the necessary reality check).

Of course, the orthopaedic surgeon and the geriatrician are not the only members of the multidisciplinary team that the patient needs. Anaesthetists are also crucial team members; fracture units that have been fortunate enough to find one who sees the elderly fracture patient as a fascinating challenge - rather than a somewhat scary chore - have seen massive improvements in efficiency and quality. Nurses, particularly specialist nurses with experience of elderly patients and fractures, are an immensely valuable resource, capable of multiplying the contribution of geriatric co-management many fold. In countries with specialists in rehabilitation medicine, the later phases of functional recovery need to be integrated with the earlier pre- and postoperative phases. Psychological support for the patient and their carers has a valuable role to play.

As with all fragility fractures, an essential part of the management of the acute fracture episode is a systematic attempt to prevent another fracture, by addressing osteoporosis and falls risk. The system for reliably achieving this may be led by an osteoporosis specialist, but we consider this function as an integral part of the holistic orthogeriatric approach. Again, the role of nurses is usually central in delivering secondary prevention on the required scale.

We and our contributors have covered all these aspects to the best of our ability. We hope that this book will be helpful in spreading this modern system of management, to the benefit of patients worldwide.

Rome, Italy — Paolo Falaschi
London, UK — David R. Marsh

Contents

The Orthogeriatric Approach: Progress Worldwide

1

David R. Marsh

The first report of a 'Geriatric Orthopaedic Unit' was given to the Autumn meeting of the British Orthopaedic Association in 1966 by Bobby Irvine, a geriatrician, and Michael Devas, an orthopaedic surgeon, from Hastings in the UK [1]. They reported the results of their co-management of 100 hip fracture patients over 80 years of age. The brief report includes two seminal statements:

- "It was the experience of the unit that no operation for an injury in an old person was a good one unless the patient could walk at once" and
- "In the 100 eighty-year-old patients 209 other diagnoses of importance were made, excluding anaemia"

Thus two cardinal elements of multidisciplinary care – early mobilisation and recognition of comorbidities – were established right at the beginning of the story. The two colleagues went on to spread their enthusiasm and belief in further principles [2, 3]:

- "..it must be realised that in the elderly loss of function is loss of independence"
- No patient is too old to benefit from the relief of pain afforded by surgery
- Prevention of pressure sores should start immediately on admission
- The fracture should not be treated in isolation from the patient's other medical and social issues
- Such full assessment is best achieved by a multidisciplinary team

This beginning was followed by attempts to emulate it in several countries [4]. Although many of the pioneers worked in the belief that one of the benefits would

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be increased cost-effectiveness, by means of reduction in length-of-stay, towards the end of the 1990s there were quite a few negative reports in that regard [5, 6]. However, there was growing confirmation that the ***quality*** of care was improved [6, 7].

This early experience was mainly about the involvement of geriatricians in rehabilitation after the orthopaedic service had operated on the fractured hip. However, as it became ever clearer that the frailty and comorbidities of elderly hip fracture patients posed a threat to life in the acute phase – pre- and perioperatively – and that geriatricians were infinitely more capable of responding to this than the very junior orthopaedic surgeons generally charged with care on the fracture wards, there was a fundamental change. Like the early experience described above, this first took place in the UK; it will be described below in Sect. 1.2.

1.1 Global Development of Orthogeriatrics

A search in Google Scholar, using the single word 'orthogeriatrics' (May, 2016), brings up 2300 publications, many of which have that word in their title. The majority are from Europe and North America, with pockets of activity in places such as ANZ and Singapore. Very little comes from the emerging economies of SE Asia, Latin America and the Middle East, precisely the regions where the sharpest increases in hip fracture numbers are expected and therefore the need for maximum efficiency and cost-effectiveness is greatest.

1.1.1 Europe (Not Including the UK)

Orthogeriatric care is unevenly distributed across Europe. The unevenness is similar in both northern and southern Europe. However, the situation is changing very fast, with many new publications in the last 2 years.

In Italy, as long ago as 1996 an Association dedicated to geriatric trauma and orthopaedics (AITOG – Associazione Italiana di Traumatologia ed Ortopedia Geriatrica) was formed. It contains only surgeons, but the 2016 Congress of AITOG took 'the multidisciplinary approach' as its main theme [8]. On the geriatric side, an orthogeriatric newsletter was started in Reggio Emilia in 2008 and a useful classification of levels of orthogeriatric collaboration developed [9, 10]. Subsequently, the Gruppo Italiano Ortogeriatria (GIOG) was formed as an interest group derived from the Italian Society of Gerontology and Geriatrics (SIGG) and Association of Psychogeriatrics (AIP). GIOG produced a position statement on the management of hip fracture, which was modelled on the emerging experience of orthogeriatrics in the UK and elsewhere [11]. However, GIOG contains only geriatricians, so at national level there is no multidisciplinary organisation yet. Still, experience of multidisciplinary care has been documented [10, 12]. A study in Tuscany reported a 25 % reduction in 30-day mortality resulting from a multidisciplinary model of care [13].

Spain demonstrates a degree of heterogeneity in the management of hip fracture patients, because the healthcare system is organised on a regional, rather than national basis [14]. However, the level of interest in orthogeriatric co-management is high and growing rapidly, with two well-attended annual orthogeriatric meetings, which attract orthopaedic surgeons as well as geriatricians. As in other countries, the early experience was in the rehabilitation phase. However, two high-quality RCTs, from University hospitals in Madrid, published in 2005 [15] and 2010 [16], demonstrated the value of 'Acute Orthogeriatric Units' (AOGU). Hip fracture patients were randomised to be admitted either to a standard orthopaedic ward, with consultation by a geriatrician, or to an AOGU with joint care by orthopaedic surgeons and geriatricians. Neither trial reported significant differences in clinical and functional outcomes, partly because they were not powered to do so, but the patients admitted to the AOGU had substantial reductions in length of stay and other important process measures.

There is a strong possibility that Spain will participate in the international drive to hip fracture audit, discussed in Sect. 1.3.1.2. Several organisations have expressed interest in doing this and one has already done so on a small scale, namely SEFRAOS (Sociedad Española de Fracturas Osteoporóticas), a longstanding, truly multidisciplinary organisation that addresses both of the big issues of fragility fractures: acute multidisciplinary management and secondary prevention.

In Austria, an excellent lead came from Innsbruck, where the Tyrolean Geriatric Fracture Center was established with a full co-management model showing low mortality rates and length of stay [17]. This centre, like the Rochester centre in USA (see Sect. 1.1.2) was linked to the AOTrauma programme described in Sect. 1.3.2. An early review of different orthogeriatric models was also produced from this centre [18].

In Germany, the need for, and practicability of multidisciplinary acute management is rapidly becoming accepted. The German trauma organisation (Deutsche Gesellschaft für Unfallchirurgie, DGU) has initiated two critical developments. The first is the introduction of a certification process for a hospital to be designated as a geriatric trauma centre (AltersTraumaZentrum DGU). The second is the creation of a geriatric fracture registry, whose dataset includes the Fragility Fracture Network's Minimum Common Dataset for hip fracture care (see Sect. 1.3.1.2). These are considered to have laid excellent foundations for future growth of the orthogeriatric approach [19]. At the time of writing, a national consensus guideline, which has been prepared in collaboration with the German Geriatric Society (Deutsche Gesellschaft für Geriatrie, DGG) – echoing the orthopaedic-geriatrics alliance pioneered in the UK (see Sect. 1.2) – is almost ready to be published.

Several countries in Scandinavia have shown interest in orthogeriatric models, though such services are not yet generally widespread. Around the end of the first decade of the twenty-first century, two RCTs of orthogeriatric care were conducted in Norway. Both compared (i) total care of hip fracture patients in a geriatric ward, involving very little input from orthopaedics (other than the surgical procedure) with (ii) total care on an orthopaedic ward, involving very little input from geriatrics. The study in Oslo [20] was focused on the prevention of delirium. It showed no

superiority of 'orthogeriatric' care in that outcome, but it did show some improved mobility in patients who were living in their own home prior to fracture. The study in Trondheim [21] also showed improved mobility and ADL following comprehensive geriatric care. Secondary analysis [22] showed that the patients showing the biggest difference were, contrary to expectation, those with higher pre-fracture function. It is important to bear in mind the fact that neither study evaluated a truly multidisciplinary approach.

The negative outcome in terms of delirium from the Oslo trial was in contrast to a randomised trial conducted in Umeå, Sweden, of geriatric care in the post-operative period only [23]. This reported statistically significant reductions in the incidence and duration of postoperative delirium as well as other complications, such as pressure ulcers, and length of stay. A subsequent sub-group analysis [24] showed that this intervention was at least equally beneficial in patients with pre-existing dementia. Follow-up at 4 and 12 months showed persisting better performance in activities of daily living and walking ability in the patients who had received the geriatrician-led rehabilitation [25].

In Denmark, a study of improved hip fracture care was published in 2008 [26] following the implementation of an orthogeriatric service in the Bispebjerg area of Copenhagen, where it is now well established. A more recent study from the same unit [27] confirmed substantial reductions in 30 day, 90 day, and 1-year mortality – after adjusting for age, gender, and ASA score. Interestingly, this benefit was gained even though half the patients were not actually seen by a geriatrician, reflecting the upgrading of medical competencies among surgical and ward staff generally.

In Finland, an Orthogeriatrics Symposium was held in Seinäjoki in 2014 [28], but the model is not yet strongly established in that country. Similarly in France, orthogeriatrics is at a very early stage; however, a system of early postoperative geriatric follow-up and rehabilitation care in Paris has resulted in an increase in the flow of trauma patients, reduced mortality and higher home-discharge rate [29].

In Belgium, a RCT in a university hospital [30] assessed the effect of inpatient geriatric consultation teams (IGCTs). This intervention did take place pre-operatively, though the model fell short of actual co-management, consisting principally of detailed advice to the trauma ward team. The study showed no measurable benefit, possibly because the trauma ward staff were pretty good anyway and may have generalised the lessons they learned from the IGCT to the control group, whom the IGCT did not see. However, a later report of the same trial did show benefit in reducing the incidence of delirium post-operatively by 30 %, but not its duration in patients in whom it did occur [31].

The Netherlands, although having publications in the field of secondary prevention [32] and the rapid recovery approach to elective orthopaedics [33] has not yet produced much on multidisciplinary management of the acute fracture episode. However, at the 4th FFN Congress in Rotterdam, there were presentations on hip fracture care by representatives from multiple disciplines from Delft, Arnhem and Nijmegen [34], so hopefully more will appear in the near future.

The republic of Ireland has moved quickly to follow the path charted in the UK, with orthopaedic – geriatric cooperation at national as well as local level. Early

experience of orthogeriatric co-management in the Mater Hospital in Dublin was encouraging [35], with improvements shown in mortality and discharge destination. However, the methodology was weak, consisting of comparative retrospective audits. The Irish Hip Fracture Database [36], modelled on the UK-NHFD (see Sect. 1.2.2) and supported by both the Irish Gerontological Society and the Irish Institute of Trauma and Orthopaedics, began the collection of prospective national data in 2012. Their second annual report is available online [37]. A recent report from Limerick [38], using IHFD data, showed marked improvements in 1-year mortality, length of stay and requirement for further rehabilitation following the introduction of a dedicated orthogeriatric service. This was accompanied by a health economic analysis showing considerable net savings as a result [39].

In Switzerland, a prospective study was reported in 2014 [40], from a unit in which there was already regular input to the trauma team from a senior internal medicine resident, nurse specialists and physiotherapists. They introduced a care pathway modelled on the Geriatric Fracture Center from Rochester, USA [41], which involved standardised order sets and more integrated co-management by the orthopaedic and internal medicine co-residents. This innovation reduced the average length of stay from 11.3 to 8.6 days and the incidence of medical complications from 73 to 59 %, with no effect on 1-year mortality or discharge destination. The authors highlighted the importance of the early discharge-planning component of the pathway in achieving this result.

Eastern Europe has yet to get off the ground with orthogeriatric co-management, though there is widespread awareness of the idea, thanks to the work of AOTrauma and others (see Sect. 1.3.2), with an emerging desire to get such services funded in places such as Poland and Croatia.

1.1.2 North America

Orthogeriatric co-management of elderly hip fractures came later to the US than to Europe. A study published in 2001 had shown substantial reduction in the incidence of post-operative delirium in hip fracture patients as a result of pro-active geriatric input [7]. However, the first report of a modern service came from Rochester (NY) in 2008 [41]. It showed a reduction in in-hospital mortality, re-admission rate and length of stay, when compared to other fracture units in the locality. The Rochester Geriatric Fracture Center (GFC) formed the hub of a comprehensive programme of advocacy of full-blown orthogeriatric co-management, both in the US and internationally through work with the Synthes company and AOTrauma (see Sect. 1.3.2). A comprehensive exposition of the multidisciplinary aspects underpinning GFCs was given in a special issue of Clinics in Geriatric Medicine [42]. In 2012, the International Geriatric Fracture Society was formed, to promote orthogeriatric co-management worldwide [43]; its aims match those of the Fragility Fracture Network.

A meta-analysis performed in the US was influential in demonstrating the value of orthogeriatric co-management on length of stay and, in the most integrated management models, mortality [44]. A recent health economic analysis established that

the considerable re-configuration of services, required to institute genuine co-managed care, was likely to be cost-effective in fracture units treating moderate volume and may result in cost savings at higher-volume centres [45].

In Toronto, a geriatrician-led intensive rehabilitation programme [46] reported an increase in the proportion of hip fracture patients able to return home. However, there does not seem to be much work in Canada on acute orthogeriatric co-management yet. A study group – the Canadian Collaborative Study of Hip Fractures [47], is evaluating the validity of the 48-h benchmark for hip fracture surgery [48].

1.1.3 Latin America

Orthopaedic surgeons in Latin America are acutely aware of the demographic time bomb ticking under them [49]. However, only two studies of orthogeriatric care in hip fracture patients have been reported from Latin America. The first, from Chile in 2012 [50] measured the effect of introducing geriatric assessment pre- and post-operatively; it showed no difference in survival or length of stay but some improvement in prolonged hospitalisation and management of medical complications, notably delirium, without increase in length of stay. The second [51], from Colombia in 2016, measured outcome in the first 4 years after establishing an orthogeriatric programme, which appears to have consisted of the application, by surgeons and anaesthetists, of the standardised protocols developed in the Rochester model described above. Comparing the outcome in the first 2 years (2008–2010) with that in the second 2 years (2010–2012), there was a statistically significant decrease in 1-year mortality.

1.1.4 Asia-Pacific

India and China are clearly high priority since, by 2050, nearly half the world's hip fractures will occur within their borders. For this reason, Chap. 13 is devoted to consideration of how the care of fragility fractures can be improved in those countries. A Chinese meta-analysis of geriatric input to hip fracture care [52] shows that there is awareness and interest, but the supply of geriatricians up to now is low. A paper from Beijing illustrates how the international comparative audit described below (Sect. 1.3.1.2) might find application in China [53]. Taiwan is also acutely aware of the need [54].

In Japan, a national branch of the Fragility Fracture Network has been established and held its 4th annual congress in 2016 [55]. In Toyama Municipal Hospital, an orthogeriatric service has been established and encouraging early results were presented at the FFN 4th Global Congress in Rotterdam [56].

Much has already been achieved in Australia and New Zealand, where there is strong influence from the UK. The Australian and New Zealand Society for Geriatric Medicine issued a Position Statement on Orthogeriatric Care in 2011 [57], which is very much in line with the UK NICE guidance on hip fracture

management [58]. A strong call to action was made in an editorial in the Internal Medicine Journal [59]. An Orthopedic Aged Care and Rehabilitation Service (OARS) in Melbourne reported on the benefits of substantial geriatric input to the fracture wards [60]; it was an uncontrolled study but the mortality rate was lower than the state average.

A great leap forward was taken with the creation of the ANZ Hip Fracture Registry [61], which has the remit to achieve consensus national guidelines and standards and measure compliance to them by fracture units, exactly as described in the FFN strategic focus (see Sect. 1.3.1.3). Australian nurses are very engaged with this approach [62].

A retrospective cohort study from the Chinese University hospital in Hong Kong [63] showed very impressive improvements in time to surgery, mortality and ability to perform activities of daily living, following extension of orthogeriatric care to the pre-operative period. An encouraging report from Singapore [64] documents improvements in complication and mortality rates, as well as function, after the instigation of an orthogeriatric service.

1.1.5 Middle East

Geriatrics is just being established in the Arab countries and there are no reports yet of orthogeriatric co-management. A well-known model of orthogeriatric care is the Sheba model from Israel, which, after 5 years of experience, reported continuing good outcomes [65]. A subsequent health economic analysis from the same unit [66] showed both a 23 % reduction in cost per patient and a substantial increase in quality of life gained, compared to standard of care.

1.2 Lessons from the UK

Following the early experiences of orthogeriatric co-management described at the beginning of this chapter, the transition from geriatrician involvement solely in the rehabilitation phase to their participation in the acute perioperative phase, in various models of shared care with orthopaedics, began in the 1980s, also in the UK. A few pioneers – in Edinburgh, Glasgow [67], Cardiff [68] and Belfast [69] showed that it could be done and their example inspired what was in fact the key step – collaboration at national level.

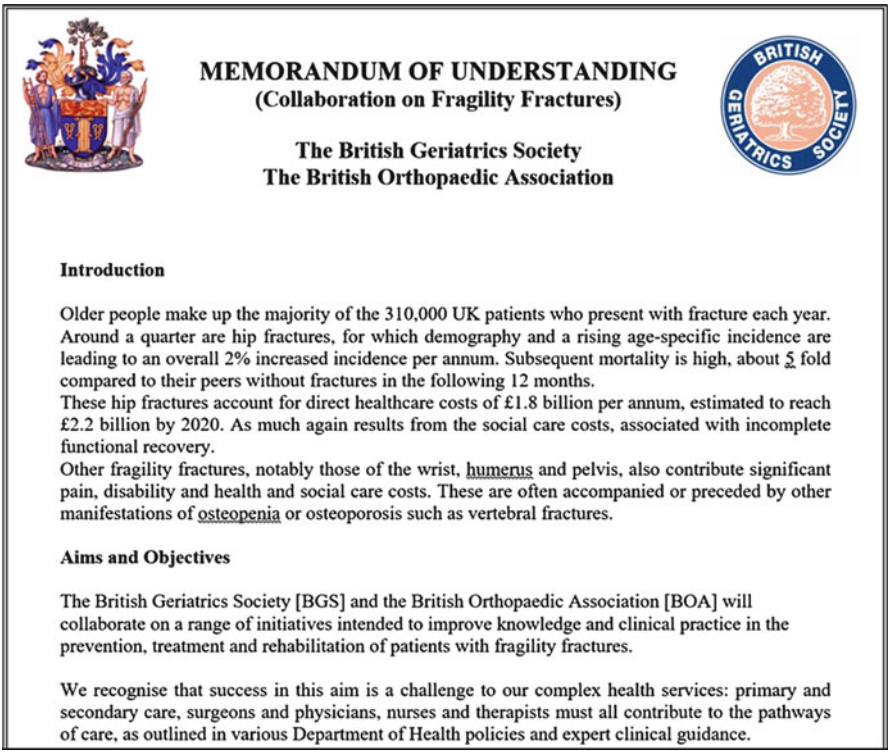
1.2.1 The Memorandum of Understanding

A very small number of champions from the British Orthopaedic Association and the British Geriatrics Society drew together two multidisciplinary groups in 2004: one to draft a set of guidelines and standards for management of fragility fractures and another one to design a national hip fracture database to measure compliance

with those standards. In 2007, they persuaded their respective Presidents to put their signatures to a formal memorandum of understanding (Fig. 1.1) and published the guidelines as a 'Blue Book' [70]. The Blue Book stipulated very clearly that orthogeriatric co-management was needed pre- and peri-operatively as well as in the rehabilitation phase. It also stipulated that the treatment of an incident fracture was not complete until action had been taken to prevent further fractures – secondary prevention.

The weight of professional opinion represented by the combination of these two national associations was sufficient to induce the National Institute for Health and Care Excellence (NICE) to convene a guideline group on the management of hip fracture in older adults. The guideline was published in 2011 [71], endorsing completely the recommendations of the Blue Book, advocating orthogeriatric co-management. In 2012, the recommendations were issued as Quality Standards [72], making them official NHS policy.

However, these developments at national level represented only half of the story. Equally important were the raising of consciousness and changing of practice in healthcare workers at local level. These were achieved by means of the National Hip Fracture Database (NHFD).



MEMORANDUM OF UNDERSTANDING
(Collaboration on Fragility Fractures)

The British Geriatrics Society
The British Orthopaedic Association

Introduction

Older people make up the majority of the 310,000 UK patients who present with fracture each year. Around a quarter are hip fractures, for which demography and a rising age-specific incidence are leading to an overall 2% increased incidence per annum. Subsequent mortality is high, about 5 fold compared to their peers without fractures in the following 12 months.
These hip fractures account for direct healthcare costs of £1.8 billion per annum, estimated to reach £2.2 billion by 2020. As much again results from the social care costs, associated with incomplete functional recovery.
Other fragility fractures, notably those of the wrist, humerus and pelvis, also contribute significant pain, disability and health and social care costs. These are often accompanied or preceded by other manifestations of osteopenia or osteoporosis such as vertebral fractures.

Aims and Objectives

The British Geriatrics Society [BGS] and the British Orthopaedic Association [BOA] will collaborate on a range of initiatives intended to improve knowledge and clinical practice in the prevention, treatment and rehabilitation of patients with fragility fractures.

We recognise that success in this aim is a challenge to our complex health services: primary and secondary care, surgeons and physicians, nurses and therapists must all contribute to the pathways of care, as outlined in various Department of Health policies and expert clinical guidance.

Fig. 1.1 The memorandum of understanding, signed by the presidents of BOA and BGS in 2007

1.2.2 The National Hip Fracture Database

The idea of systematically monitoring the care of hip fracture patients on an individual basis originated in Sweden with the Rikshöft, which started as long ago as 1988 and is still going strong today [73].

From there it was transported to Scotland and the Scottish Hip Fracture Audit (SHFA) ran continuously from 1993 to 2010, when its government funding was withdrawn in the belief that the problem of hip fracture management was now solved! In parallel with the SHFA, the Scottish Intercollegiate Guidelines Network (SIGN) produced guidelines on the Management of Hip Fracture in Older People, which were regularly updated (SIGN-15 in 1997, SIGN-56 in 2002, SIGN-111 in 2009). The SIGN guidelines benefitted from the data that the SHFA generated and the practice of hip fracture management benefitted from the publication of the guidelines, in a way that the SHFA was able to measure and document. This experience in Scotland was of the utmost importance, because it demonstrated the powerful synergy between guidelines/standards and audit in changing clinical behaviour for the better. However, it is to be noted that this only works if the audit is continuous, with individual patient-level data fed back to the participants as a benchmark of their performance against national peers. Clarity on this point was crucial in the design of the UK NHFD.

Another lesson that was applied in setting up the NHFD was that a minimal dataset, including only those variables that are necessary for benchmarking, is much more useful than an elaborate dataset because – in a busy fracture unit – the minimal dataset is the only one that will be captured with any degree of completeness. However, there are times when more detailed data are needed, so the NHFD was designed so that the basic dataset, common to all, could be supplemented by more detail for a limited time in a limited group of hospitals.

The NHFD dataset contains the patient variables that are needed to casemix-control the outcomes (including ASA score and pre-fracture domicile). The process measures include perioperative orthogeriatric care, pressure sore prevention, time to theatre and secondary prevention (falls as well as bone health). The outcome measures include return to home within 30 days and mortality at 30, 120 and 365 days – the latter is obtained reliably from the Office for National Statistics. From the outset, it was agreed that, since the care was a team effort, data would never be reported at the level of the individual surgeon, only at the level of the fracture unit as a whole. However, individual hospitals are named in the annual reports, which are in the public domain [74].

The NHFD went live in 2007 [75], using money raised from industry. Most of the funding was needed to employ coordinators, who were experienced orthopaedic nurses seconded from the NHS. These, together with lead clinicans from orthopaedics and geriatrics, were a crucial resource, in spreading the idea of continuous audit and how the data could be used to obtain better facilities, as well as helping the data-inputters understand the details of the web-based data entry forms. The number of hospitals making use of it steadily rose and, by 2009, the government had realised that the NHFD was improving care for patients and they took over its funding.

As well as producing annual reports covering all hospitals, the NHFD provides near-real-time web-based feedback to individual hospitals, with run-charts showing trends over time. They can show, for example, the 30-day mortality, or average time to surgery, for that hospital's hip fracture patients, displayed as a time series against the national or the regional average. These provide ideal discussion material for Fracture Unit audit or strategy meetings, which are very useful in keeping a high level of interest and awareness in spite of the inevitable turnover of staff.

In 2010, the UK Department of Health went a step further, by instituting a Best Practice Tariff (BPT) for hip fractures. This meant that – on an individual patient basis – a case that was treated to a high standard was reimbursed at a higher level than one that was not. The criteria for quality were orthogeriatric co-management, time to theatre less than 36 h and secondary prevention (both falls and osteoporosis). This brought the remaining hospitals into the NHFD and now at least 95 % of cases are captured in the NHFD. The annual reports of the NHFD show that the proportion of patients receiving high quality care (according to the BPT criteria) rose from 24 % in 2010 to 67 % in 2015.

A study by Neuberger and colleagues [76], using data independent of the NHFD (NHS Hospital Episode Statistics), showed that year-on-year improvements in process and outcome accelerated after hospitals began participating in the NHFD. However, the study also showed that this was at least equally true before the BPT was introduced. The implication is that the financial incentive is not essential; participation in continuous audit of hip fracture care is in itself a powerful driver of positive change.

1.2.3 The Role of Nurses

One of the factors that allowed standards in the UK to rise so quickly was the role played by specially trained nurses. Although the UK is relatively well-endowed with geriatricians, it is not possible for them to spend time on a daily basis in the fracture wards, except in the largest fracture units treating many hundreds of cases per year. Experienced nurses, from a geriatric or orthopaedic (or both) background, when employed permanently as Elderly Trauma Nurse Coordinators – or some such title – on a fracture ward, quickly become expert at recognising complications or comorbidities and assisting the junior surgeons in managing them per protocol or by contacting the orthogeriatrician.

This is hard for doctors in many countries to accept, because they are culturally conditioned to view nurses as caring but inexpert doers of the doctors' bidding. Yet it is obvious that a previously already-experienced nurse, who has then specialised in hip fracture care for 5 years and seen well over a thousand cases, has something to offer a young surgical trainee with less than 6 months' experience on the fracture ward. The experience in the UK has been that this relationship is usually a comfortable one, with benefits all round. It needs to be reinforced by several ward-rounds per week where the consultant geriatrician teaches them both at the bedside. For young doctors, particularly those whose destiny is to be other than surgeons, this

training is invaluable because, with an average age of 83 years, hip fracture patients provide rich medical experience.

It is to be hoped that international attitudes to nurses' roles can change rapidly because there are many parts of the world where there is neither the time nor the money to train large numbers of geriatricians in time to meet the tsunami of hip fractures that is on the way.

1.3 International Dissemination

The UK experience described above has been echoed in many other countries, mainly in Europe, North America and ANZ. It is now pretty clear that a multidisciplinary approach to the acute management of elderly fragility fracture patients, incorporating the philosophy and principles of geriatric medicine, not only gives a better quality of care, but also does so in a cost-effective way [44]. Although the details of how such a service can best be supplied will vary in the different healthcare systems around the world, the principle probably applies everywhere. The question arises – how, in practice, can that perspective be shared around the world, particularly in the emerging economies, where the trajectory of population ageing is such that extremely rapid increases in incidence will occur? Two international organisations are prominent in grappling with this challenge.

1.3.1 The Fragility Fracture Network (FFN)

1.3.1.1 Origins

In 2002, the International Society for Fracture Repair (ISFR) held a symposium in Bologna on the subject of osteoporotic fracture repair. The initial focus was on surgical technique but it was rapidly accepted that the clinical care of elderly osteoporotic fracture patients had to be a multidisciplinary affair, because of their frailty and comorbidities. From that meeting, the ISFR initiated an Osteoporotic Fracture Campaign (ISFR-OFC) [77] that has remained active, mainly through workshops synthesising the evidence for treatment of various fragility fractures but including scientific as well as more holistic issues such as multidisciplinary acute management and secondary prevention. However, as a research organisation, the ISFR was a little uncomfortable with the more political, campaigning challenges of fragility fractures.

In 2009, the Bone and Joint Decade launched an initiative, initially titled the Osteoporotic Fracture Line, which did aspire to have a more campaigning nature. However, by the time of the BJD networking conference and 10-year review in Lund in September 2010, it was clear that this organisation (by now renamed the Fragility Fracture Network) had not taken off – because it had not embraced multidisciplinarity and was composed almost entirely of orthopaedic surgeons. It was clear that the multidisciplinary aspect of the ISFR-OFC and the campaigning aspect of the BJD-OFL needed to be combined into one fit-for-purpose organisation.

A new organisation, the FFN, was registered in Switzerland in 2011 and a Constitution was designed, which attempted to enshrine and serve these goals. One hundred contacts from the two preceding organisations, from all over the world, were invited to an "Expert Meeting" in Berlin, where the multidisciplinary agenda of the FFN was laid out and the first General Assembly was held, formally adopting the constitution and electing the first Board. In a memorable and lengthy discussion at the first Board meeting, the mission statement of the FFN was thrashed out and has stood the test of time:

> *To promote globally the optimal multidisciplinary management of the patient with a fragility fracture, including secondary prevention*

Annual Global Congresses were organised and grew slowly but steadily. The Fifth was held in Rome in 2016. The ethos of the FFN is to be a network of activists, who work in their own countries and their own professional organisations but are united by a desire to change health policy and develop services to the benefit of older people with fragility fractures. As a matter of principle, the multidisciplinary management of the acute fracture episode and the secondary prevention of further fragility fractures were given equal priority. At the time of writing, orthopaedic surgeons constitute less than half of the FFN membership, but are the biggest single group, which is very appropriate given that most fragility fractures present to them. The two biggest non-surgical groups are geriatricians and trauma nurses.

1.3.1.2 The FFN Hip Fracture Audit Project

As described above, the Swedish Hip Fracture Registry, the Scottish Hip Fracture Audit, the UK National Hip Fracture Database and similar initiatives in Ireland, ANZ and elsewhere played pivotal roles in driving improvements in hip fracture care. Therefore, the question naturally arose within the FFN as to whether such a tool for measuring performance against agreed standards in managing fragility fractures might be more widely applicable. A Special Interest Group was formed, first to define a Minimum Common Dataset of the essential items needed to measure performance in hip fracture care. This was published on the FFN website [78] and attracted much interest. In 2014, funded by the implant company Biomet, a Hip Fracture Audit Database was developed and a pilot study conducted in Croatia, German, Spain and Malta, which demonstrated that a simple international hip fracture audit was feasible [79].

1.3.1.3 The 2015 Strategic Review

This strategic review reaffirmed the mission statement in the preceding section and complemented it with a Vision Statement:

> *A world where anybody who sustains a fragility fracture achieves the optimal recovery of independent function and quality of life, with no further fractures*

The discussions also concluded that the development path in the UK, described in Sect. 1.2, remained the most promising model for achieving positive change and that there was no reason to suppose it would not be successful in other parts of the world. This led to the formulation of a Strategic Focus for 2015–2020:

In the next five years, the FFN will facilitate national (or regional) multidisciplinary alliances that lead to:

Consensus guidelines
Quality standards
Systematic performance measurement

for the care of older people with fragility fracture.

Wherever possible, the multidisciplinary alliances referred to in this statement should be based on collaboration between orthopaedics and geriatrics, because those two disciplines best cover what elderly fracture patients need. However, it is recognised that geriatrician involvement will not be possible in many countries and, in any case, the alliances need to encompass other disciplines as well, such as anaesthetics and nursing.

The 'systematic performance measurement' in the statement refers in particular to hip fracture audit because that is what has been shown to drive positive change. For this reason, the FFN Hip Fracture Audit Database project is a key component of the operationalisation of the strategic focus. However, it is recognised that other ways of monitoring multidisciplinary management of the acute fracture episode could in principle be developed. Furthermore, the important dimension of secondary prevention is better monitored in a different way because it must include all fragility fractures, not just hip fractures. This aspect is covered in Chap. 12.

1.3.2 AOTrauma

One of the most enthusiastic industrial sponsors of the above-mentioned ISFR Osteoporotic Fracture Campaign was Synthes, a devices company (since absorbed by Johnson and Johnson into DePuy Synthes). Presumably inspired by the multidisciplinary aspect of the OFC, they initiated a Geriatric Fracture Program [80]. This was complemented by an ambitious global programme of education organised by AOTrauma [81], part of the AO Foundation, which has close historical ties with Synthes and the programme is mainly directed at orthopaedic surgeons.

The values and aims of this educational programme mirror very closely the aims of the FFN. However, they do not aim to influence healthcare policy, as the FFN explicitly aims to do, so the two organisations complement each other. Their courses are of very high quality and their penetration into emerging economies is second to none.

AOTrauma also led a project to define the outcome parameters that should be used to evaluate and compare different orthogeriatric services. They assembled a wide multidisciplinary and international group of clinicans experienced in the management of elderly fracture patients and published their consensus recommendations of both the multidimensional, patient-centred parameters and the most appropriate time points in the patient's course when they should be measured [82]. The recommended measures included length of hospital stay, mortality, time to surgery, complications both medical and surgical, 30-day re-admission rate, mobility, quality of life, pain levels, adverse drug reactions, activities of daily living, place of residence and costs of care.

A further imaginative initiative was the development of a mobile phone or tablet app, designed to be used at the bedside by orthopaedic surgeons looking after elderly fracture patients. It covers four key orthogeriatric topics: osteoporosis, delirium, anticoagulation and pain and the content was designed by a multidisciplinary panel drawn from Switzerland, Germany and Austria. Evaluation by nearly 18,000 users worldwide showed a very high approval rate, with 80 % finding the answer they sought and 47 % reporting a change in their management as a result [83].

Conclusion

Orthogeriatric co-management of elderly fragility fracture patients has developed rapidly in the last few years. It has progressed from being mainly about post-operative rehabilitation to encompassing multidisciplinary care in the acute, perioperative phase. This has been shown to raise quality, save lives and save money. In various forms, it has spread widely in Europe, North America and ANZ, but has only penetrated a little in the emerging economies. However, those are exactly the countries where some form of co-management is needed, because they face the fastest-growing burden of disease, particularly hip fractures, as a result of their rapidly ageing populations. The task for healthcare activists across the world is clear – and very challenging.

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Epidemiology of Hip Fracture and Social Costs

2

Nicola Veronese and Stefania Maggi

2.1 Introduction

Hip fractures constitute a remarkable public health problem in industrialised countries, since this condition is associated with a higher rate of disability and mortality [1]. Therefore, it is hardly surprising that hip fracture is also associated with enormous social and economic costs. Moreover, since hip fracture incidence linearly increases with advancing age, and it is estimated that older people will represent a substantial proportion of the worldwide population in future, the costs of hip fracture will probably increase.

In this chapter, we aim to summarise the current epidemiological data about this condition, with a special focus on the economic impact.

2.2 Epidemiological Data

2.2.1 Risk Factors for Hip Fracture

The pathogenesis of hip fracture is multifactorial. Although many conditions contribute to the development of hip fracture, the main factors can be summarised in two wide categories: those affecting/decreasing bone mineral density (BMD) and those increasing the rate of falls.

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2.2.2 Factors Affecting Bone Mineral Density

The factors negatively affecting BMD are the same as those that increase the risk of osteoporosis. Since another chapter is specifically dedicated to this important issue, we will say only a few words about it.

The conditions negatively affecting BMD could be further categorised as: non-modifiable and modifiable factors [2, 3].

In the first category, we should mention age, female sex, race, family history of osteoporosis and fractures, and low body frame size. In this category, we could insert the long list of the genetic factors and mutations leading to an increased risk of osteoporosis and so of fragility fractures.

Conversely, among the modifiable factors we can consider low calcium intake, reduced exposure to sunlight, inflammatory diseases (particularly if affecting the gastrointestinal system), some drugs (e.g. cortisone), excessive alcohol intake, eating disorders (particularly anorexia nervosa) and body mass index (BMI), which seems to be associated with hip fractures in a U-shaped way [4–6].

2.2.3 Factors Increasing Rate of Falls

Although in the literature it is mentioned that hip fracture can occur without any trauma, this is not the general rule. Older people, in fact, usually have a hip fracture after a trauma, although often it is a minor trauma, such as a fall from standing height. We could say that the interaction between trauma and low BMD typically lead to the hip fracture. This is somewhat different from other osteoporotic fractures, particularly vertebral ones, which do occur without explicit trauma, probably because of the different composition of bone components.

Therefore, knowledge of factors that increase the rate of falls seems to be important for tailoring appropriate preventive interventions. The risk factors for falls can be categorised as intrinsic (i.e. pertaining to the subject) or extrinsic (i.e. pertaining to the settings in which the person lives).

Among the first, we could count:

- Advanced age;
- Poor physical performance (including gait and balance problems): it is known that poor physical performance and particularly muscle weakness increased the risk of falls [7];
- Poor vision and hearing; [8]
- Orthostatic hypotension; [9]
- Chronic conditions including osteoarthritis, diabetes, neurological conditions etc.: these conditions are usually associated with a higher risk of falls through anatomical changes in the joints (like osteoarthritis), less sensitivity (diabetes) or higher use of psychoactive medications that could increase the risk of falls (like dementia or Parkinson's disease).
- Fear of falling;

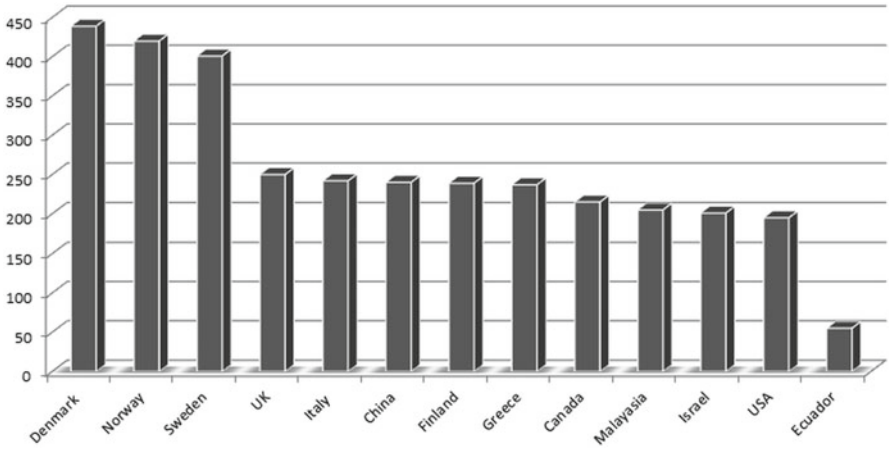

Fig. 2.1 Age-standardised hip fracture incidence rates (/100,000) for some representative countries

The extrinsic factors include those affecting the setting in which the older person lives. These are of particular importance because they are easily modifiable [10]. Some examples are:

- Lack of stair handrails;
- Poor stair design;
- Lack of bathroom grab bars;
- Dim lighting or glare;
- Obstacles and tripping hazards;
- Slippery or uneven surfaces;
- Improper use of assistive device.

2.3 Prevalence and Incidence of Hip Fracture

Prevalence and incidence rates of hip fracture reported in different studies vary significantly around the world and it is suggested that the two major causes of these differences are gender and race. The International Osteoporosis Foundation (IOF) estimates that worldwide hip fractures will occur in 18 % of women and 6 % in men [11].

Figure 2.1 shows the age-standardised incidence rates for hip fracture (/100,000) for some representative countries. Considering both genders together, the highest incidence was observed in Denmark (439/100,000), the lowest in Ecuador (55/100,000) [12].

Regarding the site usually affected by hip fracture, in the United States, femoral neck and intertrochanteric fractures are very similar in frequency in patients aged more than 65 years, with a higher frequency in white women than in men [13].

2.3.1 Gender Differences

Because women have more bone loss and higher rate of falls than men, the incidence of hip fracture in this sex is about twice that seen in men at any age in the industrialised countries [3].

It is estimated that about one third of women living to age 80 will have a hip fracture [14]. This risk is somewhat comparable to the combined risk of developing any kind of genito-urinary cancer [15]. In women, the lowest annual incidence rate was seen in Nigeria (2/100,000), the highest in Northern Europe countries, like Denmark (574/100,000), Norway (563/100,000) and Sweden (539/100,000) [12].

Regarding men, it is estimated that each year they experience about one third of the total hip fractures affecting a population. However, in this gender, the risk for hip fractures exponentially increases after age 70, and 17 % of men living beyond 80 years of age will report a hip fracture [16]. Although less frequent than in women, hip fractures in men seem to be more dangerous, since one third of men reporting a hip fracture die within 1 year [16].

In this gender, the lowest incidence rate was seen in Ecuador (35/100,000) and the highest in Denmark (290/100,000) [12].

2.3.2 Racial Differences

Whites (particularly if living at higher latitudes) exhibit a higher age and sex-adjusted incidence of hip fractures ranging from 420/100,000 new hip fractures each year in Norway [17] to 195/100,000 in USA [18]. After age 50, white women have an almost doubled risk of hip fracture than men with the highest annual incidence of hip fractures after 80 [1, 12].

Interestingly, people living in the Mediterranean area, although mainly whites, report lower incidence of fractures. This seems to be attributable to several factors, particularly higher serum 25-hydroxy vitamin D (25OHD) levels and healthier lifestyle [19]. Recent research highlights a role also for the Mediterranean diet since it is known that this dietary pattern is associated with lower inflammation levels, lower adiposity and decrease risk of falls, all these factors being important for the development of hip fracture [19, 20].

By contrast, fewer studies have investigated the epidemiology of hip fractures in other races.

Blacks seem to have a decreased risk of hip fracture compared to whites, reporting an age and sex adjusted incidence ranging from 31/100,000 in the Bantu population [21] to 185/100,000 in California [22].

Asians demonstrate a risk of hip fracture intermediate between whites and blacks [23, 24]. Around 30 % of the hip fractures occurring worldwide are thought to arise in Asian populations, most notably in China, making this country of particular

importance [25]. The incidence observed among men and women between 1966 and 1985 significantly increased (1.7 fold among men and 2.5 fold among women), however between 1985 and 1995 it remained steady [25]. Regarding other Asiatic countries, the most recent studies from Hong Kong and Singapore suggest that temporal trends may have reached a plateau, but those from Japan suggest significant age-adjusted increases [26, 27].

Finally, Hispanic populations show the lowest incidence of hip fractures among all the races investigated and interestingly the ratio between women and men is reversed [1, 12]. However, annual fracture rates among the Hispanic population increased significantly (4.2 % in men and 4.9 % in women) between 1983 and 2000, in contrast to other races [28].

2.3.3 Time Trends in the Incidence of Hip Fractures

The total number of persons affected by hip fractures may be increasing over time in the next years, mainly due to the progressive ageing of the population. Indeed, the absolute number of hip fractures is expected to increase to 4.5 million by the year 2050 [25]. However, these projections do not take into account several important confounders, such as the increased use of anti-osteoporotic drugs, the use of supplementation with calcium and vitamin D and the strategies adopted by some countries for the early identification of osteoporosis.

Right now, reported trends differ markedly across countries with some studies reporting a significant increase [29–32], some a decrease [33–37], and some others stable rates [38–40]. In studies reporting a lower incidence of age- and sex-specific incidence hip fracture over time, possible explanations seem to be a higher adherence to anti-osteoporotic medications as well as increased use of calcium and vitamin D supplementation, avoidance of smoking and alcohol, and more efficacious strategies for the prevention of falls [41].

In summary, with a few exceptions, age-specific incidence rates of hip fractures significantly rose in Western populations until 1980 with subsequent stability or sometimes a decrease. In Western countries, the trends seem to be more pronounced in women than in men [25]. However, a final word cannot be given regarding this relevant issue and future longitudinal studies (particularly in populations not including whites) are needed, to see in which direction we are moving.

2.4 Social Costs

In contrast to other types of fragility fracture (e.g. vertebral), hip fractures usually need immediate intervention and consequently hospitalisation. Every year about 300,000 subjects are hospitalised with hip fractures in the United States alone [42]. Approximately one-third of fracture patients receive prosthetic replacement. It is

therefore hardly surprisingly that in the United States alone, the estimated cost of treatment was approximately 10.3 to 15.2 billion dollars per year in 1990 [43] and 17 billion in 2002 [3].

Hip fractures require a long period of hospitalisation, usually longer than other medical conditions, except for psychiatric diseases [44].

The burden of hip fracture management on both the individual and society is substantial, and includes direct fracture-treatment costs and social costs resulting from functional impairment and increased morbidity [45].

2.4.1 Hospitalisation and Rehabilitation Costs

The data available suggest that hip fracture is a condition associated with a high social cost, particularly for expenses needed for hospitalisation and rehabilitation. Expenditures are rising very quickly and are a source of concern in many countries [3]. In a prospective study lasting 1 year in Belgium, a group of 159 older women totalled a mean cost of the initial hospitalisation of $9,534 and the total direct costs during the year after discharge were $13,470. These costs were almost triple that of a group of age- and sex-matched older subjects without hip fracture [46].

It is estimated that the expenditure needed for hip fracture exceeds that for breast and gynaecological cancers combined, but not those for cardiovascular disease in USA [47]. The comparison of costs between hip fracture and cardiovascular diseases is intriguing. In Switzerland, for example, osteoporotic hip fractures account for more hospital bed days than myocardial infarction and stroke and consequently lead to higher costs [48], while in Italy the costs due to hip fractures are comparable to those of acute myocardial infarction [44].

2.4.2 Hospital Costs

Hospital costs include costs associated with surgery (implant and theatre costs), laboratory and radiological investigations and length of hospitalisation in an acute ward [49].

The mean duration of hospitalisation is highly variable. In the United Kingdom, a study reported that, in people with a mean age over 80 years, the duration of hospitalisation was 23 days, without including the days due to rehabilitation [49]. In Italy, another study in people over 45 years of age found the mean duration of hospitalisation was about 15 days, again not considering rehabilitation [44]. In the United States, on the contrary, during the period from 1990 to 2003, the mean length of stay in the hospital for hip fractures declined by about half, leading to an average hospital stay of 6.5 days [50]. It should be noted that these huge differences probably depend on the different health systems and the relative costs for each day of hospitalisation. In the United States, for example, every day in hospital costs $1,791 in for-profit hospitals, $1,878 in state/local government hospitals and $2,289 in non-profit hospitals [50],

while in the United Kingdom 1 day costs $600 [51]. It should be noted that shorter lengths of stay have been associated with higher 30-day mortality in patients experiencing a hip fracture in Sweden [52]. By contrast, a recent study in USA demonstrated that decreased length of stay was associated with reduced rates of early mortality [53]. This difference might be related to the fact that increased time to surgery is associated with longer hospital stay and we know that time to surgery (more than 24/48 h after the fracture) is a key factor in predicting early mortality [54].

2.4.3 Rehabilitation and Nursing Home Costs

Rehabilitation is a mandatory step for people having experienced a hip fracture [55]. However, the advanced age and the co-morbidities affecting hip fracture patients often dictate that the completion of the rehabilitation programme takes place in a long-term care (LTC) facility or in a nursing home [56]. The percentage of people requiring a LTC facility or similar institution is estimated at between 6 and 60 % of people with a hip fracture, with a cost ranging from $19,000 to $66,000 [56]. The costs needed for a LTC seem to be almost double those required by a rehabilitation institute [57].

However, the roles of these organisations for rehabilitation of older patients are still debated. In a well-known study on this topic, hip fracture patients admitted to rehabilitation hospitals did not differ from patients admitted to nursing homes in their return to the community or in disability rate [58]. Moreover, costs were significantly greater for rehabilitation hospital patients than for nursing home patients and the evidence about the value of these organisations in the elderly is conflicting [58–60].

2.4.4 Other Social Costs Related to Hip Fracture

Hip fracture is associated with several negative outcomes. For example, reports of permanent disability in those surviving initial hospitalisation after a hip fracture ranged from 32 to 80 % [56].

The most common and important consequence of hip fracture is, however, increased mortality. It is estimated that about 20 % of the subjects die within the first 3–6 months of their injury [61]. Moreover, as for cardiovascular diseases, the likelihood of having any subsequent hospital episodes increased by 231 %, any subsequent incident increased future incident episodes by 9.4 %, the total number of hospital days by 21.3 % and the total charges by 16.3 % [62].

Other consequences may be loss of muscle strength, increased postural sway and decline in walking speed that can lead to loss of functional muscle mass, sarcopenia and finally to disability [61]. The impact on disability is striking: 1 year after fracturing a hip, 40 % of patients are still unable to walk independently, 60 % have difficulty with at least one essential activity of daily living, and 80 % are restricted in instrumental activities of daily living, such as driving and grocery shopping [63].

Finally, hip fracture seems to be associated with the onset of other co-morbidities with a high cost for society. Recent research has highlighted that people experiencing a hip fracture have a greater incidence of depression [64] and consequently a higher use of anti-depressant medications [65]. Another field of interest is the possible relationship between hip fracture and the onset of cardiovascular diseases. Hip fracture, in fact, seems to increase the risk of coronary heart disease, particularly during the first year after the event [66]. Since cardiovascular diseases are among the most expensive medical conditions [67], the impact of hip fracture in contributing to a huge increase in medical and social costs is highly relevant.

Conclusions

Hip fracture is a common and debilitating condition, particularly for older persons. Although the age (and gender) specific incidence is decreasing in some countries, the global incidence of hip fracture is rising everywhere, suggesting that more should be done for its prevention, also in view of its impact on social costs and quality of life. Future epidemiological studies are thus needed to better verify the trend in incidence of hip fracture and the strategies effective for its prevention.

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Osteoporosis in Elderly Patients

3

Paolo Falaschi and Stefania Giordano

3.1 Definition

Osteoporosis is a systemic bone disease characterised by a reduction and qualitative alterations of the bone mass leading to increased risks of fracture. There are two primary forms of osteoporosis: postmenopausal osteoporosis and senile osteoporosis, which appears with increasing age. Secondary forms of osteoporosis are associated with a vast range of diseases and drugs [1].

According to the World Health Organisation, the diagnosis of osteoporosis rests on densitometry, as described below in Sect. 3.4.1, with a threshold for diagnosis of a T-score of < -2.5 [1, 2].

3.2 Epidemiology

Osteoporosis is a disease with significant impact on society. Its incidence increases with age; in fact, it affects most of the population that has entered the eighth decade of life [1]. Common sites for osteoporotic fractures are the spine, hip, distal forearm and proximal humerus. In 2000, it was estimated that in Europe alone there were 620,000 new fractures of the hip, 574,000 of the forearm, 250,000 of the proximal humerus and 620,000 clinical spine fractures in men and women aged 50 or more. These fractures accounted for 34.8 % of similar fractures worldwide [3]. In total, osteoporotic fractures amount to 2.7 million in men and women in Europe at a direct cost (for 2006) of €36 billion [4]. A more recent estimate (for 2010) calculated the direct cost at €29 billion in the five largest EU countries (France, Germany, Italy, Spain and the UK) [5] and €38.7 billion in the then 27 EU countries [6]. Osteoporotic

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fractures are one of the chief causes of death in the population. Hip fractures cause acute pain and loss of function, and nearly always lead to hospitalisation. Recovery is slow, and rehabilitation is often incomplete, with many patients permanently institutionalised in nursing homes. Vertebral fractures may cause acute pain and loss of function but may also occur without serious symptoms. Vertebral fractures often recur, however, and the consequent disability increases with the number of fractures. Distal radial fractures also lead to acute pain and loss of function, but functional recovery is usually good, even excellent. It is widely recognised that osteoporosis and the fractures it causes are associated with increased mortality, with the exception of forearm fractures [7]. In the case of hip fracture, most deaths occur in the first 3–6 months following the event, of which 20–30 % are causally related to the fracture itself [8]. In 2010, the number of deaths causally related to osteoporotic fractures was estimated at 43,000 in the European Union [6]. For extensive description of the epidemiological distribution of osteoporosis and fragility fractures, see Chap. 2.

3.3 Risk Factors

Osteoporotic fractures are related to several risk factors (Table 3.1).

3.3.1 BMD

Several studies have demonstrated that the reduction of a single standard deviation in BMD corresponds to an increase in fracture risk of 1.5–3-fold. The predictive power of BMD is similar to that of hypertension in the case of stroke [1]. However,

Table 3.1 Summary of clinical risk factors [1, 2]

Age
Female sex
Low body-mass index
Previous fragility fracture, particularly of the hip, wrist and spine
Parental history of hip fracture
Glucocorticoid treatment (≥5 mg prednisolone daily or equivalent for 3 months or more)
Current smoking
Alcohol intake of three or more units daily
Premature menopause
Vitamin D deficiency
Reduced calcium intake
Drugs
Osteoporosis -related pathologies (see Table 3.2)
Organ transplant

fracture risk is not only related to BMD, but depends also on a number of other factors and, consequently, T-score values alone are not sufficient to define probability of fracture and determine when a patient needs to be treated [9]. Moreover the majority of fractures occur in osteopenic patients (T scores of −2.5 to −1.0) [10].

3.3.2 Age

Age contributes, independently of BMD, to fracture risk; therefore, in the presence of the same BMD score, the risk of fracture will be higher for the elderly than for the young [9, 11]. Another major problem regarding the elderly is their reduced muscular functionality. This is an age-related condition, but it is often exasperated by deficient nutrition and reduced mobility. Weakness is one of the five items that define the frailty syndrome as proposed by Fried and colleagues, the others being unintentional weight loss, self-reported exhaustion, slow walking speed and low physical activity [12]. Moreover, the "frail phenotype" is associated with a very high risk of falls leading to fracture [13].

3.3.3 Previous Fractures

The presence of a previous fracture, regardless of its site, is an important risk factor for further fractures and is independent of BMD. The most prognostic fractures are those of the vertebrae, hip, humerus, and wrist. Moreover, risk of further fracture increases with the number of previous fractures: patients with three or more previous fractures have a ten-times greater risk of fracture than patients who have never suffered from fractures [1].

3.3.4 Family History of Fracture

Family history influences fracture risk independently of BMD. In particular, parental hip-fracture is significantly related to higher risk of hip fractures in offspring and, to a lesser extent, of all other kinds of osteoporotic fractures [1].

3.3.5 Comorbidities

A large range of pathologies are related to increased rates of fracture risk (Table 3.2). In some cases, the increased fracture risk is caused through a reduction in BMD, but often other mechanisms are involved: chronic inflammation, alteration of bone quality, general impairment of health conditions, reduction of mobility, sarcopenia, with higher risk of falls and other complications. Vitamin-D deficiency, which often coexists with this pathology, is another negative factor [1].

Table 3.2 Osteoporosis-related pathologies

Endocrine disorders	Hypogonadism Hypercortisolism Hyperparathyroidism Hyperthyroidism Hyperprolactinaemia Diabetes mellitus types I and II Acromegaly GH deficiency
Haematological disorders	Myelo-lymphoproliferative diseases Multiple myeloma and monoclonal gammopathies Systemic mastocytosis Thalassemia Sickle-cell anemia Haemophilia
Gastrointestinal disorders	Chronic liver disease Primary biliary cirrhosis Celiac disease Chronic inflammatory bowel diseases Gastro-intestinal resection Gastric bypass Lactose intolerance Intestinal malabsorption Pancreatic insufficiency
Rheumatoid disorders	Rheumatoid arthritis LES Ankylosing spondylitis Psoriatic arthritis Scleroderma Other forms of connectivitis
Renal disorders	Renal idiopathic hypercalciuria Renal tubular acidosis Chronic renal failure
Neurologic disorders	Parkinson disease Multiple sclerosis Paraplegia Outcomes of stroke Muscular dystrophies
Genetic disorders	Osteogenesis imperfecta Ehlers-Danlos syndrome Gaucher syndrome Glycogenosis Hypophosphatasia Hemochromatosis Homocystinuria Cystic fibrosis Marfan syndrome Menkes syndrome Porphyria Riley-Day syndrome

(continued)

Table 3.2 (continued)

Other pathologies	Chronic obstructive pulmonary disease Anorexia nervosa AIDS/HIV Amyloidosis Sarcoidosis Depression

3.3.6 Drugs

Several drugs increase fracture risk. The most important class of drugs are glucocorticoids that have a negative effect on bone, causing rapid bone-quality loss and BMD depletion. Among the more recent classes of drugs, hormone-blockade treatments (aromatase inhibitors for women operated for breast cancer and GnRH agonists for men with prostate cancer) also lead to a reduction of BMD but at a slower rate. Other drugs involved are SSRI, PPI, H2 inhibitors, anticonvulsants, loop diuretics, anticoagulants, excess of thyroid hormones and antiretroviral treatment.

3.3.7 Assessment of Fracture Risk

Although BMD acts as the cornerstone when diagnosing osteoporosis, as mentioned above, the use of BMD alone does not suffice to identify an intervention threshold. This is why a large number of scores are generated in order to better identify fracture risks; the most widely used assessment tool is FRAX®. This is a web-based algorithm (http://www.shef.ac.uk/FRAX) which calculates the 10-year probability of a major fracture (hip, clinical spine, humerus or wrist) and a 10-year hip-fracture probability. Fracture risk is calculated on the basis of age, body mass index and dichotomised risk factors including prior fragility fracture, parental hip-fracture history, current tobacco smoking, long-term use of oral glucocorticoids, rheumatoid arthritis, other causes of secondary osteoporosis and alcohol consumption. Femoral-neck BMD may be inserted to improve fracture risk prediction. Fracture probability differs considerably in different countries around the world; that is why FRAX is calibrated to match those countries where the epidemiology rates for fracture and death are known [14].

FRAX has some limitations: it does not take into account dose responses for several risk factors, for example glucocorticoid exposure, smoking, alcohol intake and the number of previous fractures [15]. A further limitation is that the FRAX algorithm uses only T-scores for the femoral neck and does not take T-scores of the lumbar spine into account when, at times, there is discordance between these two measurement sites [16].

Despite the fact that international literature has demonstrated the validity of these instruments when evaluating risk of fracture, the intervention thresholds for osteoporosis currently depend on regional treatment and reimbursement policies which are increasingly based on cost-effectiveness evaluations [17].

3.4 Diagnosis

There is no universally accepted population-screening policy in Europe for the recognition of patients with osteoporosis or those at high risk of fracture. In the absence of such a policy, patients are identified opportunistically using a case-finding strategy based on previous fragility fractures (see Chap. 12) or on the presence of significant risk factors [2].

3.4.1 Instrumental Diagnosis

Bone Mineral Density (BMD) may be evaluated by several techniques generally described as bone densitometry. Densitometry permits accurate measurement of bone mass, which is the best predictor of osteoporotic fracture risk. The result is expressed as a T-score, which is the difference between the subject's BMD value and the mean BMD value for healthy young adults (peak bone mass) of the same sex, expressed in standard deviations (SD). BMD can also be expressed by comparing the average value for subjects of the same age and sex (Z-score). The threshold required to diagnose the presence of osteoporosis, according to WHO, is a T-score < -2.5 SD.

Dual X-ray Absorptiometry (DXA) this is, at present, the technique preferred for bone-mass evaluation to enable the diagnosis of osteoporosis, prediction of fracture risk and follow-up monitoring. The technique uses X-Rays of two different energies, which allow the subtraction of soft tissue absorption and the estimate of calcium content of the bone. When projected onto a surface this gives a parameter called Bone Mineral Density (BMD g/cm^2), from which Bone Mineral Content (BMC, g/cm^3) may be inferred. In general, measurement at a particular site provides a more accurate estimate of fracture risk for that site. Since the most clinically relevant osteoporotic fractures occur in the spine and in the hip, the most frequently measured sites are the lumbar spine and proximal femur. However, there are a number of technical limitations to the application of DXA to diagnosis. For example, the presence of osteomalacia will underestimate total bone matrix because of decreased bone mineralisation while, on the other hand, osteoarthrosis or osteoarthritis of the spine or hip will contribute to density but not to skeletal-strength [2]. In the latter case, the specific site involved must be excluded from the analysis; at least two lumbar vertebrae must be evaluated so that the densitometry result may be considered reasonably accurate. For this reason, femoral densitometric evaluation is probably preferable after the age of 65. Recently some software has been developed to enable DXA to measure, not only BMD, but also some of the geometrical parameters related to bone strength, such as HSA (hip structure analysis) and TBS (Trabecular Bone Score). TBS processes the degree of inhomogeneity of the spinal densitometry scan, thus providing indirect information regarding trabecular microarchitecture. Although this device has been approved by the FDA, its everyday use in clinical practice is still limited.

Quantitative Computerized Tomography QCT this technique, because it is able to separate the trabecular BMD from the cortical BMD, permits total and local volumetric BMD (g/cm^3) measurements at both vertebrae and femur levels. However, this method exposes patients to high radiation dose levels (about 100 μSv). As a technique, DXA is usually preferred to QCT because of its accuracy, shorter scan times, more stable calibration, lower radiation dose and lower costs.

Quantitative Ultrasound (QUS) This technique provides two parameters (speed and attenuation) which are indirect indicators of bone mass and structural integrity; it is used mainly to carry out measurements in two sites, the phalanges and the calcaneus. It has been demonstrated that ultrasound parameters are capable of predicting risk of osteoporotic fractures (femoral and vertebral) no less accurately than lumbar or femoral DXA, both in post-menopausal women and in men, but this technique does not provide direct bone-density measurements. Discordant results between ultrasonographic and DXA evaluations are neither surprising nor infrequent and they do not necessarily indicate an error, but rather, that the QUS parameters are independent predictors of fracture risk influenced by other characteristics of the bone tissue. However, this does mean that QUS cannot be used for the diagnoses of osteoporosis based on WHO criteria. QUS can be useful when it is not possible to estimate a lumbar or femoral BMD with DXA and may be recommended for epidemiological investigations and first-level screening, considering its relatively low cost, easy transportability and absence of radiation.

3.4.2 X-ray of the Dorsal and Lumbar Spine

The presence of a non-traumatic vertebral fracture indicates a condition of skeletal fragility, regardless of BMD, and is a strong indicator of the need to start treatment in order to reduce risks of further fractures. Since most vertebral fractures are mild and asymptomatic, the use of diagnostic imaging is the only way to diagnose them. Vertebral fractures are defined, applying Genant's semi-quantitative method (SQ), as a 20 % reduction in one vertebral body height.

3.4.3 Laboratory Tests

Laboratory tests are an indispensable step in the diagnosis of osteoporosis because they can distinguish between this pathology and other metabolic diseases of the skeleton, which may present a clinical picture similar to that of osteoporosis. Moreover, they can identify possible causal factors, permitting the diagnosis of secondary osteoporosis and suggesting an aetiological treatment where one exists. First-level tests are: blood count, protein electrophoresis, serum-calcium and phosphorus levels, total alkaline phosphatase, creatinine, the erythrocyte sedimentation rate and 24 h urinary calcium. Normal results for these tests exclude 90 % of other diseases or forms of secondary osteoporosis. Sometimes it is necessary to perform

second-level tests too, such as: ionised calcium, TSH, PTH, serum 25-OH-vitamin D, cortisol after a suppression test with 1 mg of dexamethasone, total testosterone in males, serum and/or urinary immunofixation for anti-transglutaminase antibodies and specific tests for associated diseases.

The specific markers of bone turnover, detectable in serum and/or urine, are divided into bone-formation (bone isoenzyme of alkaline phosphatase, osteocalcin, type I procollagen propeptide) and bone-resorption markers (pyridinoline, deoxypyridinoline, N or C telopeptides of collagen type I). In adult subjects, the increase in bone turnover markers indicates accelerated bone loss or the existence of other primary or secondary skeletal disorders (osteomalacia, Paget's disease, skeletal localisations of cancer). Markers are overall indices of skeletal remodelling and they may be useful when monitoring the efficacy of and adherence to a therapy. However, these markers are characterised by broad biological variability so, at present, they cannot be used for routine clinical evaluations.

3.5 Treatment

3.5.1 General Management

Immobility is one of the most important causes of bone loss and should be avoided wherever possible. Weight-bearing exercises are optimal for skeletal health and are therefore an important component of the management of patients with osteoporosis [18].

Prevention of Falls Risk factors for falls include history of fracture/falls, dizziness and orthostatic hypotension visual impairment, gait deficits, urinary incontinence, chronic musculoskeletal pain, depression, functional and cognitive impairment, low body mass index, female sex, erectile dysfunction (in male adults), and people aged over 80 [19]. Some of these factors are modifiable: reduced visual acuity can be corrected, medication that may diminish awareness and/or balance can be reduced or stopped and modifications to the home environment can be performed (slippery floors can be corrected, mats can be fixed or removed, lighting improved, handrails placed in bathrooms etc.) [20]. A programme of exercises may prevent falls by improving confidence and coordination and by preserving muscle strength but there is no consensus around the most suitable programme for the 'oldest old' [20, 21].

Vitamin D Vitamin D is involved in the intestinal absorption of calcium and phosphorus and is necessary for the mineralisation of bone and the maintenance of muscle, but it also has numerous beneficial effects on other organs. Most Vitamin D is synthesised in the skin during exposure to the sun but, as this capacity is reduced in older people, they produce lower amounts of vitamin D; moreover, they also tend to expose their skin less than younger adults. Thus, the majority of older people suffer from hypovitaminosis D [22]. Threshold values for vitamin D are presented below in Table 3.3. Several trials have demonstrated lower fracture risk

Table 3.3 Threshold values for vitamin D [1]

Serum Vitamin D level nmol/l	Serum Vitamin D level ng/ml	Definition
<25	<10	Severe deficiency
25–50	10–20	Deficiency
50–75	20–30	Insufficiency
75–125	30–50	Target

in patients having a plasma concentration of 25-hydroxy-vitamin D (25-OH-D) of at least 60 nmol/L compared to those having levels below 30 nmol/L [23]. Moreover, there is growing evidence that vitamin D supplementation has beneficial effects on other systems, in addition to the skeleton. It has been demonstrated that improvement of 25-OH-D levels leads to a lower incidence of falls in older people; other trials have demonstrated that vitamin D supplementation is associated with a reduction in all-cause mortality [24]. The Recommended Nutrient Intakes (RNI) are 800 IU of vitamin D per day in men and women over 50 [2]. Intakes of at least 800 IU of vitamin D can be recommended in the general management of patients with osteoporosis, especially in patients receiving bone protective therapy [25]. Considering that hypovitaminosis D is epidemic among the elderly, there is probably no strong necessity to measure circulating levels of 25-OH-D in patients with high fracture risk [22]. Vitamin D supplementation should start as soon as possible, and it should precede the administration of any drug used to treat osteoporosis [25]. Since the inactive form of vitamin D (cholecalciferol) is stored in fat tissue, it is sensible to saturate the stores with repeated small loading doses and then to continue with maintenance doses.

Calcium Calcium is an element necessary for the mineralisation of the bone. It is mainly contained in dairy products, which – for example in yoghurt and milk – may have calcium and vitamin D added. The Recommended Nutrient Intakes (RNI) are at least 1,000 mg of calcium per day for men and women over 50 [2]. It is fundamental to ensure the right calcium intake by means of a balanced diet, but when this is not possible, calcium supplements of a daily dose of 0.5–1.2 g are recommended, especially in patients receiving bone protective therapy [5, 26]. Calcium and vitamin D supplements decrease secondary hyperparathyroidism thus reducing bone resorption. Although, in a meta-analysis, calcium supplementation seemed to increase the risk of myocardial infarction, other studies contradict these results [27, 28].

Protein Nutritional insufficiency – particularly protein-energy malnutrition – is frequent in the elderly. Adequate nutrition is very important for bone health [29]. Insulin-like growth factor-I (IGF-I) mediates the effects of growth hormone (GH) and has promoting effects on several body tissues, especially on skeletal muscle, cartilage and bone. Moreover, it plays a role in the regulation of phosphate reabsorption in the kidney and in the active uptake of Ca2+ and phosphate from the intestine via the renal synthesis of calcitriol. In cases of poor nutrition the production

of IGF-1 in the liver is down-regulated so its plasma concentration may be useful when assessing nutrition [30]. Another validated tool for assessing nutritional status is the Mini Nutritional Assessment (MNA). In view of the impaired protein assimilation in older people, for them, the RDA should be increased from 0.80 g/kg body weight per day to 1.0 or 1.2 g/kg per day [21].

3.5.2 Antiosteoporotic Drugs

Bisphosphonates Bisphosphonates are stable analogues of pyrophosphate characterised by a P–C–P bond. Several bisphosphonates have been synthesised and their potency depends on the length and structure of the side chain. Bisphosphonates have a strong affinity for bone apatite and act as potent inhibitors of bone resorption by reducing the recruitment and activity of osteoclasts and increasing their apoptosis. Bisphosphonates act on osteoclasts by inhibiting the proton-pumping vacuolar adenosine triphosphatase (ATPase) and by altering the cytoskeleton and the ruffled border. Aminobisphosphonates also inhibit the farnesyl pyrophosphate synthase step in the mevalonate pathway modifying the isoprenylation of guanosine triphosphate binding proteins. Bisphosphonate oral bioavailability is low (1 % of the dose ingested), and is reduced by food, calcium, iron, coffee, tea and orange juice. It is rapidly cleared from plasma: 50 % is deposited in bone and the remainder excreted in urine. Their half-life in bone is long. The safety profile of bisphosphonates is favourable. The most frequent side effect is mild gastrointestinal disturbances, and sometimes oesophagitis. Intravenous amino-bisphosphonates can cause transient acute-phase reaction with fever as well as bone and muscle pain. Sometimes osteonecrosis of the jaw occurs in cancer patients receiving high doses of intravenous pamidronate or zoledronate. Finally, the use of bisphosphonate may cause atypical subtrochanteric fractures, although the data on this are conflicting. However, the risk–benefit ratio remains favourable [2].

Alendronate is one of the most frequently used bisphosphonates. A post hoc analysis of patients aged ≥75 who took part in the Fracture Intervention Trial (FIT-I) showed a considerable (38 %) reduction in the risk of a new vertebral fracture, versus those taking the placebo [31]. Moreover, a small study of women in long-term care demonstrated that BMD increased after 2 years of alendronate versus placebo (+4.4 % for spine and +3.4 % at femoral neck) [32].

Ibandronate, in a daily dose of 2.5 mg, reduces the risk of vertebral fractures by 50–60 %, but its effect on non-vertebral fractures was only demonstrated in a post hoc analysis [33, 34]. Studies have shown that oral ibandronate, 150 mg once monthly, is equivalent or superior to the daily 2.5-mg dose in increasing BMD and decreasing biochemical markers of bone turnover [35].

In a post hoc analysis, of patients over 80, of the pivotal studies, Hip Intervention Program (HIP), Vertebral Efficacy with Risedronate Therapy-Multinational (VERT-MN), and VERT-North America (NA), *Risedronate* produces an estimated reduction of 44 % in the incidence of new vertebral fractures [36].

Several studies have demonstrated that yearly infusion of *zoledronic acid* 5 mg over a 3-year period is efficient: zoledronic acid reduces the incidence of vertebral fractures by 70 % and that of hip fractures by 40 % compared to the placebo group [37, 38]. It has been demonstrated that early intravenous infusion of zoledronic acid decreases the risk of fracture and mortality when administered soon after a first hip fracture but not earlier that 15 days after fracture [39].

Strontium Ranelate Although its mechanism of action in humans is unclear, strontium ranelate is approved for the treatment of postmenopausal osteoporosis. The recommended daily dose is one 2-g sachet, once daily, by mouth. Its intestinal absorption is reduced by food, especially milk and its derivatives, so it should be administered at bedtime, at least 2 h after eating. The dose does not need to be adjusted according to age or in cases of patients with mild to moderate renal impairment, but it is not recommended in patients with severe renal impairment. Several studies have shown the fracture efficacy of strontium ranelate in a wide range of patients, from osteopenia subjects to women over 80, including osteoporotic patients with or without prior vertebral fractures. The reduction in fracture risk is similar to that described for oral bisphosphonates [40, 41]. The most common side effects are diarrhoea and nausea that generally appear at the beginning of treatment but disappear after a few months. An increase in the incidence of venous thromboembolism (VTE) and myocardial infarction has been reported, so strontium ranelate is contraindicated in patients with previous episodes or at risk of these diseases [42].

Denosumab is a totally-human antibody with a very high degree of affinity towards RANKL, whose interaction with the RANK receptor it prevents [43]. The dose of denosumab to be administered subcutaneously every 6 months is 60 mg. Studies have demonstrated, after 3 years of denosumab, a reduction in incidence of new vertebral fractures (68 %), non-vertebral fractures (20 %) and hip fractures (40 %) [44]. Patients who continue Denosumab for 5 years present an increase in lumbar spine and total hip BMD. Adverse events did not increase with long-term administration of Denosumab [45]. Its efficacy in reducing the risk of fracture is particularly marked in patients with a high probability of fracture [46].

Teriparatide primary or secondary hyperparathyroidism, or exogenous administration of parathyroid hormone (PTH), promote the resorption of bone, but intermittent administration of PTH, injected subcutaneously every day, leads to an increase in the number and activity of osteoblasts, resulting in an increase in bone mass and in an improvement of skeletal architecture. 1–34 N-terminal fragment (teriparatide) is used for the treatment of osteoporosis, with a daily dose of 20 μg, administered by subcutaneous injection for no more than 24 months [47]. Its use significantly reduces the risk of vertebral but also of non-vertebral fractures, and its beneficial effects on non-vertebral fracture persist for up to 30 months after ceasing administration [48]. The most common adverse effects are nausea, pain in the limbs, headache and dizziness. In normocalcaemic patients, there are transient rises in serum calcium concentrations 4–6 h following the injection of teriparatide, but the levels

return to baseline 16–24 h after each dose. The change is small, and routine monitoring of serum calcium during therapy is not required. Teriparatide may cause minor increases in urinary calcium, so, as a precaution, these agents should not be used in patients with active or recent urolithiasis. The use of teriparatide is contraindicated in conditions of abnormally increased bone turnover (e.g. hyperparathyroidism and Paget's disease of the bone; unexplained elevation of alkaline phosphatase; prior external beam or implant radiation therapy to the skeleton or in patients with skeletal malignancies or bone metastasis). The use of teriparatide is also contraindicated in patients with severe renal impairment. Studies on rats have shown an increased incidence of osteosarcoma in cases of long-term administration of very high doses of teriparatide, but these findings are not considered relevant for humans treated with considerably smaller doses [47].

3.5.3 Therapeutic Adherence in Osteoporosis

Non-adherence is common in drug therapy for chronic asymptomatic diseases, and this is certainly true in the case of osteoporosis. An important epidemiological study by Rabenda and colleagues demonstrated that the medication possession ratio (MPR) at 12 months was higher among patients taking weekly as compared to daily doses of alendronate [49]. The obvious clinical consequence of low adherence is an increase in fracture risk. Adherence to therapeutic regimens is challenging, particularly for the elderly, who generally have a long list of drugs to take. Often they are rather forgetful; it seems, however, that most instances of non-adherence are intentional, due to elderly patients carrying out an (erroneous) risk/benefit analysis on their own behalf. In elderly people who are not suffering from dementia, the main cause for non-adherence is misunderstanding about their disease and worries about the adverse effects of their medication and polypharmacy. It is important to explain to patients who have experienced a fracture that this was due to 'fragility' caused by osteoporosis and show them how drug treatment can help. It is fundamental to understand their reasons and excuses for not adhering to their medication programme. In general, periodic follow-up visits are beneficial: during which the patients should be asked to describe how they take their medicines while avoiding any notion of judgment [21].

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Frailty, Sarcopenia, Falls and Fractures

4

Finbarr C. Martin

4.1 Frailty

There is consensus on the general notion of frailty being an increased vulnerability to adverse health outcomes. There are however two distinct concepts that emerge from the clinical and research literature. The first is of a syndrome associated with underlying physiological and metabolic changes that are *responsible* for driving progressive physical and cognitive impairments through to loss of functional capacity, often helped on the way by acute or chronic disease or injury. This can be encapsulated by a definition proposed some two decades ago [1]:

> a condition or syndrome which results from a multi-system reduction in reserve capacity to the extent that a number of physiological systems are close to, or past, the threshold of symptomatic failure. As a result the frail person is at increased risk of disability or death from minor external stresses.

The second concept underpins a pragmatic approach, which treats frailty as a collection of risk factors for future adverse events, whilst not necessarily bearing a pathophysiological relationship to these outcomes.

As discussed later these positions are not incompatible. Either way, both epidemiologically and conceptually, frailty overlaps with but is distinct from multimorbidity and disability [2]. In cross sectional studies, some frail individuals are neither multimorbid nor disabled, but multimorbid individuals are more likely than others to be frail, and frail individuals are by definition more likely to develop a new disability.

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4.1.1 Diagnosis of Frailty

There are several diagnostic definitions and measures of frailty, validated in various populations in terms of predicting an increased incidence of adverse outcomes such as new disability, hospitalisation, and death. The two best-established approaches are the phenotype model developed by Fried's group in USA [3] and the deficit accumulation model developed by Rockwood and Mitnitski in Canada [4]. The phenotype approach has been operationalised with five components – unintentional weight loss, self-reported fatigue, low physical activity, and impairment of grip strength and gait speed. Three or more abnormalities defines frailty, with pre-frailty defined as having one or two. The criteria for judging abnormality is illustrated in Fig. 4.1, but in practice subsequent researchers have adapted criterion definitions to the data available.

This phenotype model therefore does not include cognitive or psychosocial features that are also well known to be predictive of adverse health outcomes. Nevertheless, there is substantial evidence that this predominantly physical frailty phenotype has predictive power for adverse health outcomes in several cohorts of older people.

The deficit accumulation approach is quite different. It operationalises frailty as the sum total of factors that may be regarded as detrimental ("deficits"). These could be symptoms, sensory impairments, abnormal clinical findings or laboratory test results, diseases, disabilities or lack of social support. Generally each is regarded as present or absent and thus accorded a score of 0 or 1, although some domains lend themselves to be divided in three or occasionally more grades, so become fractions of one. The total score, termed the frailty index (FI), is calculated from the sum of

The Fried Phenotype Model of Frailty

Weight loss	**Self-reported weight loss of more than 4·5 kg or recorded weight loss of "5% per year**
Exhaustion	Self-reported exhaustion on US Centerfor Epidemiological Studies depression scale73 (3–4 days per week or most of the time)
Low energy expenditure	Energy expenditure <383 kcal/week (men) or <270 kcal/week (women)
Slow gait speed	Standardised cut-off times to walk 4·57 m, stratified by sex and height
Weak grip strength	Grip strength, stratified by sex and body-mass index

Fig. 4.1 Thresholds for abnormality in the components of frailty

all the deficit scores divided by the number of items included. The theoretical range of the FI is therefore between 0 (no deficits apparent, good health) to 1 (deficits in every item), but in practice a number of studies have now shown that survival is rare with scores above about 0.7. The deficit accumulation model is an approach rather than a fixed tool, and is therefore highly flexible. A FI can be constructed from any comprehensive dataset about an individual as long as it covers a broad range of these health related domains and includes upwards of 30 items.

Despite these approaches being quite distinct, they perform fairly similarly in identifying frailty when applied to a common dataset [5, 6].

4.1.2 Epidemiology of Frailty

Whatever approach is used to define frailty, it becomes more prevalent with increasing age, with estimates of 5–10 % in the 65+ population, rising to 20–50 % by age 85+ [7]. Frailty is more common in women, but several studies suggest that women are more resilient to frailty than men. Geographical differences in frailty prevalence may be related to health inequalities, as rates are significantly associated with national economic indicators. Differences within countries may also be associated with socioeconomic factors including social deprivation [8].

4.1.3 Why and How Does Frailty Develop?

Frailty may be best understood from the standpoint of ageing and evolution. Ageing is the gradual and progressive process of acquiring deleterious changes to body structure and function, affecting all individuals to variable degrees and not associated with a specific external cause. Ageing is associated with an increased chance of certain "degenerative" diseases, but these are not universal. Disability results from the critical impairment of specific attributes, such as strength or balance, these impairments arising from ageing or disease or more usually both.

These ageing related impairments result from the lifelong accumulation of unrepaired molecular and cellular damage. This damage takes multiple forms, particularly important being random errors arising in DNA replication, protein translation and post-translational synthesis. Oxidative damage arising as an inevitable product of metabolic activity is an important mechanism. A number of detection and repair processes have evolved which limit the impact of these changes. The efficiency of these defences also reduces with ageing. The biological economy needed to optimise survival chances dictate that these processes are good enough to enable growth, development and reproduction, but do not need to be robust enough to provide centuries of protection. Thus the reserve capacity is limited, and when sufficient damage is done at cellular level, then the functioning of organs and systems will decline.

The pathophysiological pathway from these changes to clinically evident phenomena is not fully elucidated, but candidates include cytokines and other components of the inflammatory response [9]. The vulnerability inherent in the

notion of frailty comes from the loss of metabolic or physiological reserve to the point where additional stressors precipitate clinically significant loss of function. These age-related changes may affect organs differentially depending upon other individual factors such as particular exposures, different activity levels and chance as there are both independent and linked mechanisms operating across organ or physiological systems. The changes in the neuroendocrine and immune systems seem particularly important [10]. The pro-inflammatory profile has prompted the idea of "inflammaging" producing a net catabolic profile associated with frailty.

At first glance, the phenotype model of identifying frailty more closely reflects this explanation than the deficit accumulation approach. Longitudinal study has suggested that in apparently healthy older people, the emergence of weakness, slower walking and reducing physical activity usually precede the other two dimensions of weight loss and exhaustion, the presence of which predicts earlier decline [11]. The FI depends upon the number of deficits rather than which ones they are. The increased likelihood of disability or death with a higher FI is not necessarily driven by the specifc deficits detected, but as explained earlier, age related deficits do not arise in isolation from each other as there are common cellular and system level processes at work.

4.1.4 Frailty and Clinical Practice

If the key early pathophysiological changes could be identified, then it might become possible to intervene at a preclinical stage of frailty before operational phenotypic criteria develop. Even without this understanding, there is evidence that increasing physical activity levels, enhancing social participation, and optimising nutrition are associated with lower levels of age-related cellular damage suggesting that a public health approach is indicated.

Addressing frailty with a generic approach may also provide additional clinical benefit along with the condition-specific management of patients with chronic diseases. Disease-specific factors do not fully explain well-being and quality of life and frailty may contribute independently of disease. Comprehensive geriatric assessment encompasses an approach that combines disease-specific and non-specific aspects to the assessment and treatment of older people. Frailty recognition would enable targeting of this approach.

Recognition of frailty through better definition may also improve clinical decision making by informing the prediction of benefit or the risk of the adverse effects of clinical interventions including medications, surgical interventions, physical displacement and so on. For example, the ability to improve prediction of post-operative functional recovery would be invaluable, as disease-based predictive models are far from perfect. The NICE guidance on management of multimorbidity emphasises the need for individual patient judgements about treatments incorporating a measure of their frailty (due for publication in September 2016).

Category of frailty	Description
Very fit	Robust, active, energetic, well motivated and fit: these people commonly exercise regularly and are the most fit group for their age
Well	Without active disease, but less fit than people in category 1
Well,with treated comorbid disease	Disease symptoms are well controlled compared with those in category 4
Apparently vulnerable	Although not frankly dependent, these people commonly complain of being “slowed down”or have disease symptoms
Mildly frail	With limited dependence on others for instrumental activities of daily living
Moderately frail	Help is needed with both instrumental and non – instrumental activities of daily living
Severely frail	Completely dependent on others for all activities of daily living or terminally ill

Fig. 4.2 The Clinical Frailty Scale

4.1.4.1 Assessment of Frailty in Clinical Practice

Neither the phenotype model nor the FI are particularly feasible however in routine clinical practice, so simpler tools are more commonly used such as the Clinical Frailty Scale [4] or the Edmonton Frail Scale [13]. The Clinical Frailty Scale uses descriptors covering the domains of mobility, energy, physical activity, and function to enable a standard clinical assessment to characterise seven levels from very fit, healthy to very severely frail (Fig. 4.2). This provides a feasible description based on routine clinical assessment but does not conceptually distinguish frailty from multimorbidity or disability. Its mortality prediction is comparable to that of the more detailed FI.

The Edmonton scale requires a number of specific but fairly simple clinical measures to be performed which would be additional to routine clinical practice. The domains included are cognition (the clock drawing test), general health status, functional ability, social support, medication use, nutrition, mood, continence and a mobility function test – the *Timed Up and Go*. Scores range from zero to 17, scores of 8 or above usually being considered to be frail, but relevant cut offs can be established empirically depending upon the purpose. For example, prediction of likely higher rate of postoperative complications may be associated with lower scores. In contrast to the phenotype approach, the Edmonton scale identifies potential targets for intervention across a number of clinically important domains.

In community or primary care settings, the issue may be to identify a target group for health-promoting interventions such as optimising nutrition and increasing physical activity levels. Here a more simple screening approach may be needed. A recent systematic review assessing available tools suggested that PRISMA-7 may

Prisma-7 questions

1. Are you more than 85 years? Yes = 1 point
2. Male? Yes = 1 point
3. In general, do you have any health problems that require you to limit your activities? Yes = 1 point
4. Do you need someone to help you on a regular basis? Yes = 1 point
5. In general, do you have any health problems that require you to stay at home? Yes = 1 point
6. In case of need, can you count on someone close to you? No = 1 point
7. Do you regularly use a stick, walker or wheelchair to get about? Yes = 1 point

Fig. 4.3 Prisma-7 questions

be the most accurate [14], a score of 3 or more suggesting increased likelihood of incident disability [15] (Fig. 4.3).

4.2 Frailty and Sarcopenia

Sarcopenia was the term suggested by Rosenberg for the well-recognised loss of muscle with ageing [16]. It is a major component of frailty. Skeletal muscle accounts for a third or more of total body mass. As well as movement, muscle plays a key role in temperature regulation and metabolism. Low muscle mass is associated with poor outcomes from acute illness, probably because of reduced metabolic reserve, as muscle is a reservoir for proteins and energy that can used for synthesis of antibodies and for gluconeogenesis. Muscle mass and strength are of course related but not linearly [17]. Function is more important than mass for physical performance and disability [18].

4.2.1 Key Features of Sarcopenia

Sarcopenia is characterised by motor neurone loss, reduced muscle mass per motor unit, relatively more loss of fast twitch fibres and reduced strength per unit of cross sectional area.

Muscle fibres are lost by drop-out of motor neurones. Reinnervation of fibres by sprouting from surviving neurones cause a less even distribution of fibre types cross-sectionally and a relatively greater loss of type II fibres which are associated with generation of power (the product of force generation and speed of muscle contraction) [19]. Loss of efficiency also results from an accumulation of fat within and between fibres and an increase in non-contractile connective tissue material. Leg power accounts for 40 % of the decline in functional status with ageing [20]. Men who maintain physical activity into their 80s show compensatory hypertrophy of muscle fibres to compensate for the decrease in fibre number.

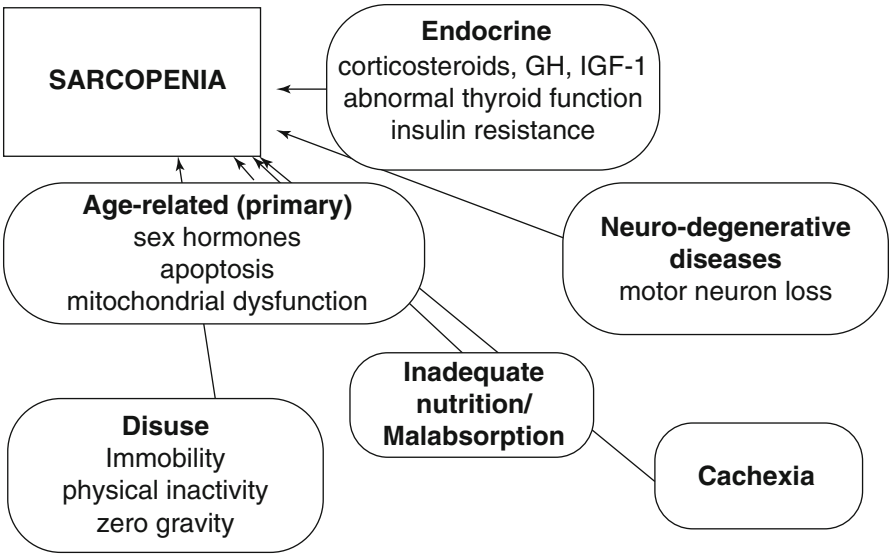

Fig. 4.4 Aetiological factors and mechanisms of sarcopenia (Reproduced with permission from [23])

4.2.2 How and Why Does Sarcopenia Develop?

Muscle fibre development occurs before birth but fibres enlarge during childhood reaching a peak in early adulthood. Mass and function then gradually decline into older age [21]. Peak mass is affected by maternal, genetic and early life influences. Decline is affected by physical activity, nutrition and sex. Decline is more pronounced in women from menopause onwards. Adding to the inevitable moderate decline of some 15–25 % by old age is the impact of acute illness or chronic conditions, which have generally negative effects through the mechanisms of catabolic stress, reduced food intake and physical activity.

The loss of muscle mass is thought to be multifactorial with potential factors illustrated in Fig. 4.4.

The factors implicated in sarcopenia overlap with those for frailty. A central feature of sarcopenia is a decrease in the rate of muscle protein synthesis. This leads to reduced protein levels including mitochondrial oxidative enzymes responsible for enabling work intensity. The age-related shift of the hormonal balance towards low testosterone, growth hormone and IGF-I contributes to the lower muscle protein synthesis rates, which also limits the structural recovery from muscle damage or apoptosis and possibly reduces the synthetic stimulus of exercise [22].

The role of cytokines such as interleukins IL-1β and IL-6, and TNF-α is less certain. They play a role in the catabolic processes of acute illness and chronic inflammatory conditions, but whether the small differences in circulating levels associated with frailty reported from some population studies is relevant to the age related sarcopenia is not established.

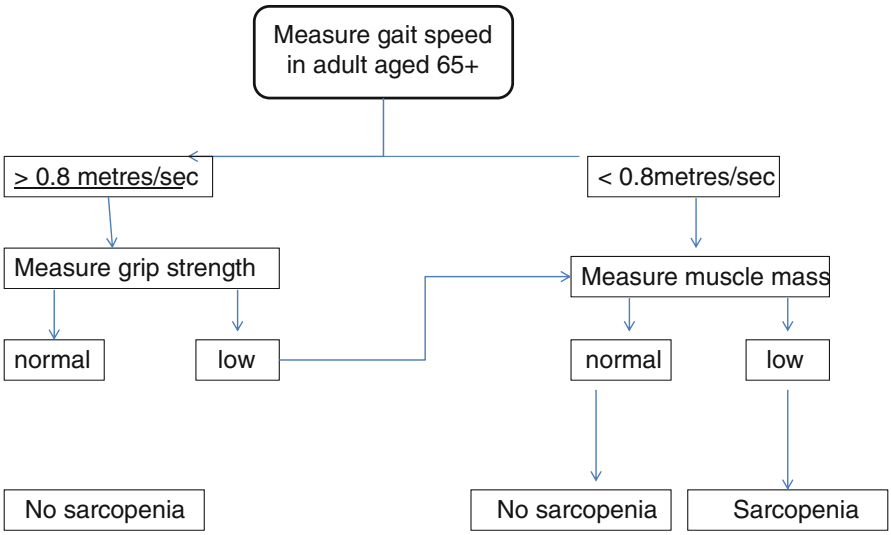

Fig. 4.5 An algorithm for the diagnosis of sarcopenia (Reproduced with permission from [23])

4.2.3 Identifying Sarcopenia

There are several different diagnostic definitions resulting in variable prevalence rates being reported in community dwelling populations of older people. A consensus definition and approach to screening and classification has been proposed by the European Union Geriatric Medicine Society [23]. This is shown in Fig. 4.5.

Measuring gait speed is feasible in almost any setting and is a useful global indicator of health, slower gait being associated with greater likelihood of incident disability, falls, institutionalisation and death [24]. Grip strength was chosen as it is a portable, simple, reliable and valid proxy measure of body strength, and has good correlation with lower limb physical performance. Low grip strength of community dwelling older people is associated with falls, increased incident disability and earlier mortality. It also predicts slower and less complete functional recovery from illness in men [25]. Measurement of muscle mass can be done with CT scan or, less accurately, with impedance techniques.

4.3 Frailty, Sarcopenia and Falls

Falls are one of the "geriatric giants", syndromes that are more prevalent with increasing age, have multifactorial causes and are associated with worse health outcomes including disability, institutionalisation and death. A fall can be defined as "an event whereby an individual comes to rest on the ground or another lower level with or without a loss of consciousness." This definition was adopted for the guidelines issued from the American and British Geriatrics Societies and the National Institute for Health and Care Excellence (NICE) [26, 27]. The definition does not

attempt to exclude syncope for the good reason that an overlap exists in the phenomenology, experience, and pathophysiology of these events.

In a clinical context with an individual patient, assessment involves an attempt to place the event in the spectrum with syncope at one end and loss of balance due to postural instability at the other. Sometimes this is clear-cut, sometimes not. Falls may occur in individuals with a specific condition leading to an obvious balance disturbance such as a stroke causing hemiparesis. The majority of falls in older people however are associated with multicomponent impairments, particularly of muscle function, balance and cognition, so are best understood as resulting from complex systems failure as part of the frailty syndrome.

4.3.1 Epidemiology of Falls

Falls rates vary internationally but in most populations studied they occur in about one third of community dwelling individuals aged over 65 each year, about half of these being multiple falls, and rates then increase with age to over 50 % of those 80 plus [27, 28]. Falls rates seem higher among Caucasian populations compared with the Chinese. Rates are particularly high in older people with dementia unless mobility is lost [27, 29]. Living in long-term care facilities is also associated with higher falls rates. This relates both to the clinical characteristics of the residents and the complexity of the environment. WHO reported in 2007 from international data that falls result in 5.5–8.9 Emergency Department attendance visits per 10,000 people aged 60 plus, with about a third being admitted [30]. Falls account for over half of all injury-related hospital admissions for older people aged 65 plus, head injuries and fractures being the most common and serious. Older women fall relatively more than men but sustain relatively fewer injuries. People with lower socioeconomic status and those living alone have more falls.

4.3.2 Risk Factors and Assessment

Prospective observational studies have produced a long list of risk factors that may help identification of higher risk groups [28]. Falls happen to individuals with intrinsic impairments, performing specific activities in specific environments. It is the combination that matters. Most falls are associated with impairments of mobility function and/or cognitive decline, particularly of higher-order functions that affect gait pattern, balance, and executive function. Low muscle strength itself has been reported to increase risk but it is functional mobility that seems more important. Environmental hazards alone are seldom responsible. Likewise, most fallers were doing something fairly routine, even mundane. For an individual with dynamic balance that is only just sufficient for their usual activities, the fall may occur from chance variation in performance, or may have been compromised by cognitive distraction, pain or anxiety. For someone with limited functional mobility reserve, intercurrent illness will often determine the exact time and place of the fall. For

example, a urinary tract infection may require more frequent visits to the toilet, perhaps at night in the dark and may prompt the individual to move faster than usual.

The point here is that the magnitude of association of a fall with any intrinsic or environmental factor is not fixed but mutually interdependent and contingent on additional factors influencing performance of the specific activity in question. These factors are more difficult to identify but include speed, technique, fluidity of intent and execution, attention and so on. So in terms of prediction, risk factors will behave differently depending upon the population in question, the activity, the place and the time. Of course, polypharmacy and particularly medications affecting blood pressure and sedatives increase risk. But the risk may be related to chronic medical conditions as much as their treatments. Circulatory disease, chronic obstructive pulmonary disease, depression and arthritis all contribute to an increased falls risk which, when adjusted for drugs, was cumulative from about 50 % increase with one chronic condition to almost four-fold increase with five or more conditions [31].

Orthostatic hypotension may result in syncope or in balance impairment without the patient reporting the typical sensation of "feeling faint". Amnesia for a fall, or recurrent falls without evident mobility issues are suspicious of syncope. Vision may also be important and contrast sensitivity rather than acuity seems more discriminatory for risk [32]. Social isolation is a risk factor, perhaps because of habitual lower activity levels leading to poorer function. This can be compounded by fear of falling, which increases future risk even in those who have not fallen.

4.3.3 Prevention of Falls and Risk Assessment Tools

In all patients who fall and fracture, the immediate rehabilitation and subsequent secondary prevention strategies must include assessment of falls risk factors and individually tailored preventative interventions. These will be discussed further in later chapters.

Primary prevention at a population level is essentially about the prevention of frailty and disabling long-term conditions including dementia. For example, the well-established approaches to vascular risk reduction will reduce risk of falls, even though that is not the stated purpose. Programmes for the prevention of frailty are being developed, with promotion of increased social engagement and physical activity being important components [33].

Guidance on falls prevention in the community setting [26, 27] suggests an initial screening approach to identify those at high risk. People with a history of two or more previous falls, or of probable syncope, merit a full multidimensional risk assessment. This requires trained staff and usually a multidisciplinary team. Those with no reported falls do not require an individualised approach. Those with one fall without syncope require an assessment of gait and balance to distinguish those at risk, who are then treated as for multiple fallers. There is no single tool that does this adequately across all settings [34].

The "timed up and go test" [35] is probably the best feasible assessment for the community setting. This is the time in seconds to rise from a chair, walk 3 m, turn, walk back and sit down. A cut off at 14 s was the optimum discriminatory cut off associated with increased falls risk [36] but some services employ shorter or longer times to increase sensitivity or specificity respectively. Other well established tools include the Berg Balance Scale [37]. The more detailed Physiological Profile Assessment, an impairment-based tool which also identifies dimensions to address for risk reduction, has been validated in a number of patient populations [32].

4.3.3.1 Interventions in Community Populations

The evidence in systematic reviews suggests that an individually tailored multidimensional approach can reduce falls by about one third at best [38]. An important component is strength and balance training which for effectiveness needs to be, on average, 50 h at moderate or high intensity [39]. There are several evidence-based programmes for delivering the exercise and balance components; choice depends on individual preferences, for example between exercising in a group or individually following written or video instructions. The OTAGO programme has been well tested in different populations [40] but was less effective than the FAME programme [41] in an England primary care-based trial [42].

Uptake and adherence is a challenge for many people and therefore programmes that embed the key exercises in routine functional tasks may be more successful for some [43].

For lower risk populations, several trials of Tai Chi have been effective [44]. Occupational therapist interventions to reduce hazards or hazardous behaviours, medication modifications, and improving vision by cataract removal have all been effective in one or more trials.

Not all trials involving frail older people have demonstrated effective falls prevention [45]. The heterogeneity of the risk profile suggests that there might be differential efficacy of individual intervention components. There may also be challenges to achieving sufficient intensity of the exercise interventions in frail individuals. Exercise can be effective for people with dementia but may need to be adapted and combined with other interventions to improve executive function [46]. In general, for frail older people, many or most of whom will have sarcopenia and significant falls risk, a broad individualised approach for managing the frailty syndrome as a whole is needed.

4.3.3.2 Preventing Falls in Care Settings

Prevention of falls in acute hospital patients requires a more tailored approach. The STRATIFY tool has been validated in a number of settings to identify higher risk patients [47] but has not been shown to lead to successful falls prevention. NICE guidance for hospital patients does not recommend using a screening tool. Falls prevention in long-term care facilities is more problematic. Most studies concluded no or limited effectiveness of either single or multidimensional interventions, though targeting vitamin D deficiency or specific behaviours may help [48].

Furthermore, exercise interventions modelled for people with some dementia are promising.

4.4 Frailty, Sarcopenia and Fractures

With the exception of the vertebra, most fractures in older people are related to falls. Poor bone health makes a fracture more likely but from the population perspective, risk of falling is more predictive of fractures than bone mineral density [49], leading to the suggestion that the focus of fracture prevention must rest with identifying those at risk of falls rather than those with osteoporosis [50]. There are common risk factors and overlap in the biology of frailty, sarcopenia and osteoporosis. Frailty predicts lower bone mineral density, an increased likelihood of falls, vertebral and hip fractures [51, 52]. The typical hip fracture sufferer is a frail woman over 80, so prevention requires a multicomponent approach embracing frailty.

For older people with osteoporosis, a consensus panel recommended a multicomponent exercise program including resistance and balance training [53].

Recognition of frailty is also key in the management of those who have fractured. For example, frailty as assessed with the FI was associated with longer hospital length of stay and reduced chance of returning home within 30 days after hip fracture [54].

Conclusion

There are close links epidemiologically and biologically between frailty, sarcopenia, poor bone health and the geriatric syndrome of falls. This calls for an integrated clinical approach to prevention and treatment of fragility fractures.

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Pre-Operative Management

5

Helen Wilson

5.1 Pre-Operative Management

The majority of frail older patients with fragility fracture have fallen and present with pain and immobility. Managing pain and restoring mobility where possible are the primary aims of orthopaedic surgery.

As soon as a hip fracture is suspected, appropriate x-rays should be arranged. For patients with frailty or those with a history of respiratory disease, a baseline chest x-ray should be performed at the same time.

It is important at triage to review briefly the cause of the fall. Those who have fallen due to unstable medical conditions such as dehydration, sepsis, gastrointestinal haemorrhage, stroke or cardiac syncope will need a more thorough medical work-up.

Those with complex fractures or those on anti-platelets or anticoagulants may bleed significantly into the fracture site and resuscitation with intravenous fluids should be commenced on arrival. Caution must be taken in those with decompensated heart failure or fluid overload from other conditions.

An orthopaedic assessment should occur as soon as the x-rays are available and, if a fracture is confirmed, a proposed time for the operation agreed. Patients should then be encouraged to eat and drink if able, until 6 h before surgery. For elective patients there is evidence to suggest that it is safe to continue with clear fluids up until 2–3 h pre-surgery [1]. Oral carbohydrate loading drinks are actively encouraged for elective patients with evidence from enhanced recovery programmes. However, there is little evidence for emergency patients. Care must be taken with frail older patients with fragility fractures as some will have required opiates for pain control and may have delayed gastric emptying.

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5.1.1 Management of Pain

Pain from a fracture is best managed by initial immobilisation and fixation where possible to aid healing. Immobilisation in plaster or with traction without surgery has significant risks in frail patients, as skin integrity is often poor. Immobility often rapidly leads to poor oral intake, generalised muscle weakness, orthostatic pneumonia, thromboembolic disease, incontinence and skin breakdown. For these reasons, a decision for early surgery is usually the best option.

5.1.1.1 Analgesics

Pain leads to distress and is the symptom that people fear the most. It may be a key feature in the development of delirium in those at risk.

It is important to monitor both pain at rest (static pain) but also on movement (dynamic pain) as even immobile patients experience pain during personal care and toileting. Pain should be measured using a validated score on admission and after 30 min of administering analgesia to ensure effectiveness [2]. On-going review of pain should form part of routine nursing observations.

Static pain may be relieved by simple analgesics. Intravenous Paracetamol has been demonstrated to be as effective as morphine for patients with acute traumatic limb injury [3] and should be administered initially by the paramedics and every 6 h pre-operatively. The dose should be weight-adjusted. Paracetamol has very few side effects and may be effective in reducing delirium [4].

Opioids such as Codeine, Tramadol and others have significant side effects and are poorly tolerated by older people causing nausea, vomiting, constipation and confusion; they should be avoided.

Opiates may be required but should be used in the lowest possible dose to avoid nausea, vomiting, sedation and respiratory depression. Older patients with poor renal function may not metabolise opiates effectively and even small doses can cause prolonged side effects.

Non-steroidal anti-inflammatory drugs (NSAID) should only be used with extreme caution. Trauma and poor oral intake increase the risk of gastric irritation and bleeding and this may be exacerbated with the use of NSAIDs. Those on antihypertensive medication are at high risk of renal impairment with NSAIDs.

5.1.1.2 Local Nerve Blocks

Local nerve blocks are increasingly being used to manage both static and dynamic pain and to reduce the requirements for opiate analgesia. For hip fracture, both femoral nerve blocks and fascia-iliaca compartment blocks (FICB) have been shown to be effective [5]. Traditionally performed as part of the anaesthetic, these procedures are being used earlier to manage pre-operative pain in the first 8–16 h. FICB is a low-skill, inexpensive procedure that may be performed by trained individuals, including non-physician practitioners, as outlined in a position statement by the Association of Anaesthetists of Great Britain and Ireland (AAGBI) [6]. The fascia-iliaca compartment is a potential space, into which a single high volume injection (usually about 30 ml) of local anaesthetic through the fascia lata will affect the femoral nerve, the lateral femoral cutaneous nerve and to some extent the

obturator nerve. These supply the medial, anterior and lateral aspects of the thigh and the femoral head. This can be performed without ultrasound by trained practitioners with good effect. A small study suggests that ultrasound guidance where available may improve efficacy from 47–60 % up to 82–95 % [7].

5.1.2 Comprehensive Geriatric Assessment

Comprehensive Geriatric Assessment (CGA) has a strong evidence base in reducing mortality, increasing the number of patients discharged back to their own homes and reducing length of stay [8]. This approach should form the basis of assessment for any frail older person in hospital. The pre-operative assessment is also interdisciplinary with a number of different specialists involved. The first stage is to explore an individual's medical history. Whether this is performed by physicians, anaesthetists, peri-operative physicians or orthogeriatricians, the skill is in developing a clear understanding of the implications of co-morbidities on an individual's ability to function, in addition to gauging the likely impact of trauma, anaesthesia and surgery.

Therapists often conduct initial assessments pre-operatively to gather information about functional ability, cognition, mood, environmental and social circumstances. Patients recognised as needing assistance with feeding or malnutrition should be referred early to dieticians. A nutritional assessment on admission is part of UK NICE guidance with many patients requiring nutritional supplements. Nutritional support for those who require it has been shown to improve outcome [9].

Skin integrity and continence concerns should be reviewed by nursing staff soon after admission. Pain and immobility can rapidly lead to skin breakdown and a specialist mattress may be required. There are no guidelines on urinary catheter use for pre-operative patients with fragility fracture. Many hospitals offer a catheter for comfort for those who struggle to use bedpans. Many older men with a degree of outflow obstruction from prostate enlargement will have difficulty in passing urine whilst lying down. Some orthopaedic surgeons prefer pre-operative catheterisation of all patients to prevent incontinence during the operation and to reduce the risk of infection. A significant proportion of patients undergoing spinal anaesthetic will develop early urinary retention in the first 12 h post-operatively. Consequently, many patients have urethral catheterisation for a period of time. Documentation of the reason for insertion is essential together with a clear plan for removal early in the post-operative period to reduce the incidence of catheter-associated infection.

5.1.2.1 Information Gathering

This can be more complex than it seems, since older patients are often unaware of their personal medical history, previous investigations or reasons for prescribed medications. A significant proportion also have cognitive impairment and are unable to provide information. Collateral history from carers, the primary care physician, previous hospital medical notes, previous imaging and pathology results are key to piecing together a complete picture.

Table 5.1 Metabolic equivalents

Physical activity	METs
Sitting reading/watching television	1.0
Washing and dressing	2.1
Walking slowly on flat	2.3
Gentle housework	2.5
Walking a small dog (3 km//h)	2.7
Light static cycling/Bowling	3.0
Gardening	3.6
Walking quickly (5 km/h)	3.6
Golf	3.7
Climb flight of stairs without stopping	4.0
Dancing	4.5
Playing tennis/racquet sports	8.5

Having a standardised clerking proforma can help to ensure that all necessary information is captured including a pre-operative assessment of cognition. This, together with concomitant information from family/friends/carers, can identify those with established dementia in addition to those with likely undiagnosed dementia. These patients are at particularly high risk of developing peri-operative delirium. Proactive orthogeriatric management has been shown to reduce the incidence of delirium post hip fracture by one third and severe delirium by half [10].

Other studies have looked at using haloperidol routinely peri-operatively in those at risk of delirium. A randomised controlled trial of 430 patients given either placebo or haloperidol 1.5 mg per day showed no reduction in incidence of delirium but it did reduce the severity and duration of delirium with a reduction in length of stay [11].

The 4AT is a useful tool for recognising and monitoring delirium [12]. It is a simple score that can be performed with good reliability by all staff and requires no specific training. It has been validated in patients with hip fracture [13] and should be a routine part of hip fracture management.

A description of an individual's functional ability adds to an understanding of the impact and severity of co-morbidities particularly with regard to cardiac and respiratory disease. This is often described in metabolic equivalents (METS) with one MET being defined as the amount of oxygen consumed while sitting at rest and is equal to 3.5 ml O_2 per Kg per minute [14]. Those able to undertake activity such as easily managing a flight of stairs (four METs or more) are unlikely to have significant cardiorespiratory disease and have low cardiovascular risk (see Table 5.1.).

Those with low levels of activity may have asymptomatic underlying cardiovascular disease or may be limited by musculoskeletal disorders including arthritis, osteoporosis with kyphosis, sarcopenia or indeed obesity.

5.1.2.2 Cardiovascular Disease

Patients with a history of ischaemic heart disease are clearly at risk of peri-operative cardiac events. Cardiovascular risk factors should also be considered including the presence of diabetes, hypertension and smoking.

The Goldman cardiac risk index [15] or the Revised Cardiac risk index [16] may be used to identify high-risk patients and predict likelihood of perioperative cardiac event or death.

A baseline electrocardiogram may give indications of asymptomatic cardiac disease with left bundle branch block or evidence of q waves or poor r wave progression in the anterior leads.

An echocardiogram will give an indication of regional wall abnormalities from myocardial infarction, an estimate of left ventricular function and an indication of underlying valvular heart disease. This information can assist with risk stratification but should not delay surgery.

Patients with suspected coronary artery disease should be discussed with an anaesthetist. Those already on beta-blockers should continue their usual dose pre-operatively unless there is significant bradycardia or hypotension. Attention to haemoglobin levels is important as peri-operative anaemia may increase cardiac strain and increase the risk of a cardiac event.

Valvular Heart Disease

Cardiac murmurs are often present in older people; insignificant aortic sclerosis or mild mitral regurgitation are the most common. A large retrospective study showed that 6.9 % of patients with hip fracture had previously undiagnosed significant aortic stenosis [17]. This may influence the type of anaesthetic and the need for invasive cardiac monitoring. Significant aortic stenosis is suspected if the patient has an ejection systolic murmur in the aortic area in combination with a history of angina on exertion, unexplained syncope or near syncope, a slow rising pulse clinically in the brachial artery, an absent 2nd heart sound or LVH on the ECG without hypertension. Patients with significant aortic stenosis require careful fluid balance and are at high risk of pulmonary oedema.

Heart Failure

Many older patients will have a history or symptoms in keeping with poor ventricular function on a background of hypertension, ischaemic heart disease, valvular heart disease or atrial fibrillation. The mainstays of medical treatment are diuretics, ACE inhibitors, angiotensin receptor blockers, beta-blockers, aldosterone antagonists and a combination of hydralazine and nitrates. Increasingly, therapies for heart failure include electrophysiological interventions such as cardiac resynchronization therapy (CRT), pacemakers with or without implantable cardioverter-defibrillators (ICDs). Severity can usually be gauged from the history, symptoms and required medication.

Those who are euvolaemic should undergo early surgery omitting heart failure medication until 48–72 h post-operatively. Caution should be observed with administering intravenous fluid. Anaemia should be managed proactively to maintain haemoglobin levels above 100 g/l. Once able to transfer out of bed medication can be slowly re-introduced. These patients often develop increasing peripheral oedema 5–7 days post operatively and may require an increased dose of diuretics for a period of time.

Patients with decompensated heart failure and fluid overload at presentation need careful attention. Those with acute left ventricular failure need stabilising before theatre. This is often associated with an acute ischaemic event. Antiplatelet and anticoagulant therapy may cause increased blood loss at the fracture site and should only be started with caution for acute cardiac ischaemia. Discussion with cardiologists regarding appropriate intervention and an individualised decision about timing of surgery should be made.

Those with poor right ventricular function and fluid overload need high dose diuretics with close monitoring of peripheral oedema levels, weight and renal function. This is often associated with hyponatraemia, hypotension and renal impairment and requires close observation. Correction to achieve a euvolaemic state often takes 5–10 days. It is usually better to proceed with surgery and manage the decompensated heart failure in the post-operative period. Significant peripheral oedema in the thigh however may increase the risk of wound breakdown.

Pacemakers and Implantable Cardiac Defibrillators (ICD)

Pacemakers have become increasingly sophisticated and a basic knowledge of different devices and their indications is required to aid the acute management of patients with fragility fracture. All patients with pacemakers have routine annual checks and a pre-operative check is only required if there is concern about malfunction or if it has not been checked within the previous 12 months.

It is important to understand the reason for the device and whether the patient is pacemaker-dependent. External pacing equipment and a defibrillator must be available during surgery.

The use of surgical diathermy/electrocautery can give rise to electrical interference and this can present additional risks when used in patients with pacemakers and ICDs. Energy can also be induced into heart lead systems causing tissue heating at lead tips through high frequency current [18]. The manufacturers recommend avoiding surgical diathermy if surgery is occurring within 50 cm from the device. If diathermy is deemed essential then the use of Bipolar diathermy with short bursts of energy minimises the risk. Where available, the use of a harmonic scalpel should be considered.

ICDs

If a cardiac technician is available then an ICD device can be turned onto monitor only mode to prevent shock delivery during surgery. Otherwise, ICDs should be turned off by placing a magnet over the device, and securing it with micropore tape. Any sustained VT or VF intraoperatively should be managed with external

defibrillation. Post-operatively the magnet should be removed and the patient monitored until the device has been checked.

Atrial Fibrillation

Public campaigns such as 'know your pulse' have increased public awareness of the risk of stroke from atrial fibrillation. Patients with AF and a controlled ventricular rate should continue with rate control medication (usually a beta-blocker, dioxin or verapamil) pre-operatively with their usual dose administered on the day of surgery. A history of atrial fibrillation may be permanent (AF) or paroxysmal (PAF). Amiodarone, Flecanide or beta-blockers are often used to maintain sinus rhythm and prevent PAF. Peri-operative AF is common in these patients.

Those with new AF, persistent AF or PAF with a fast ventricular rate need review. Tachycardia may be due to pain, a cardiac event or sepsis and clinical review with a 12 lead ECG, measurement of lactate and inflammatory markers is advised. Those with no evidence of inter-current illness may simply have new AF or poor rate control. If the rate is persistently above 110 bpm then urgent rate control is required pre-operatively. Digoxin and beta-blockers (iv metoprolol) may take 24 h to establish rate control. The most effective method is with intravenous Amiodarone. This is usually administered with a slow bolus of 300 mg over 1 h followed by a 24-h infusion of 0.5 mg/kg/h (450 mg in 500 ml Normal Saline). This must be administered through a large bore cannula and ideally into a central line with cardiac monitoring. Cardiology advice may be required for complex patients.

5.1.2.3 Anticoagulants and Anti-platelets

Antiplatelet drugs are mainly used for secondary prevention of stroke, in peripheral vascular disease and following cardiac events. Antiplatelet agents cause irreversible platelet dysfunction and recovery only occurs with production of new platelets over 7–10 days or by platelet transfusion given more than 6–8 h after the last dose. Aspirin is usually of little consequence for patients with hip fracture and does not influence anaesthetic technique or appear to increase risk of complications. Two recent small studies have shown no significant increase in complications in patients who went to theatre on clopidogrel [19]. The AAGBI recommends avoiding spinal anaesthesia for patients on clopidogrel if possible as there is a small risk of epidural haematoma.

Around 5 % of patients presenting with hip fracture are anticoagulated requiring a clear understanding of the different drugs on the market and locally agreed protocols on management. The AAGBI have produced useful guidelines for regional anaesthesia in patients with abnormalities of coagulation [20] that give advice as to when it would be considered safe to proceed with a spinal anaesthetic. For many, general anaesthesia is an acceptable alternative and surgery should proceed when the surgical bleeding risk is felt to be acceptable. This is not a straightforward decision and should be made on an individual basis depending upon type of anticoagulant, renal function, the type of surgery required, anticipated blood loss, pain control and risk of immobility. Table 5.2 gives details of suggested management for different medications.

Table 5.2 Antiplatelets and anticoagulants in patients with fragility fracture

Drug	Elimination half-life	Management	Acceptable to proceed with spinal
Warfarin	4–5 days	5 mgs vitamin K intravenously and repeat INR after 2 h. This can be repeated or consider Beriplex for immediate reversal	If INR <1.4
Clopidogrel	Irreversible effect on platelets	Proceed with surgery with General Anaesthetic Monitor for blood loss Consider platelet transfusion if concerns regarding bleeding	7 days or post platelet transfusion (at least 6 h post last dose)
Unfractionated iv heparin	1–2 h	Stop iv heparin 2–4 h pre-op	4 h
Low molecular weight heparin sub-cutaneous prophylactic dose	3–7 h	Last dose 12 h pre-op	12 h
Low molecular weight heparin sub-cutaneous Treatment dose	3–7 h	Last dose 12–24 h pre-op. Monitor for blood loss	24 h
Ticagrelor	8–12 h	Proceed with surgery with General Anaesthetic Monitor for blood loss Consider platelet transfusion if concerns regarding bleeding	5 days or post platelet transfusion at least 6 h post last dose
Aspirin	Irreversible effect on platelets	Proceed with surgery	Continue
Rivaroxiban	7–10 h	May be partially reversed with Beriplex Consider surgery 18–24 h after last dose Review renal function	18–48 h
Dabigatran	12–24 h	Consider surgery 24–48 h after last dose Review renal function Consider Pradaxibind for immediate reversal	48–96 h or post Pradaxibind
Apixiban	12 h	Consider surgery 12–18 h after last dose	24–48 h

Understanding the reason for antiplatelet/anticoagulant medication is essential in managing peri-operative risk of thromboembolic events. Patients with cardiac stents are at high risk of thrombosis and cardiac events and antiplatelet medication should either continue or be stopped for the shortest possible time.

Patients with mechanical heart valves (particularly mitral valves), known AF with recent stroke, and recent DVT or PE are at high risk of peri-operative thromboembolic complications and bridging strategies should be considered. Treatment dose subcutaneous low molecular weight heparin can be given until 24 h before surgery or intravenous unfractionated heparin until 2–4 h before surgery. The latter requires careful monitoring with 4–6 hourly APTT levels to ensure correct dosing.

Temporary insertion of an inferior vena cava filter should be considered for those with recent proximal DVT or PE.

Tranexamic acid has been shown to reduce the need for transfusion in a small study of patients with hip fracture with no difference in 3-month mortality [21] but, in another similar small study, there appeared to be a significant increased risk of thromboembolic events [22]. There is a meta-analysis underway with results eagerly awaited.

Use of reversal agents needs to be weighed up against potential risk of thromboembolic events.

5.1.2.4 Anaemia

Anaemia on admission is an independent predictor of poor outcome and is present in about 10–12 % of those presenting with hip fracture [23]. It often reflects underlying disease such as malignancy, chronic kidney disease or poor nutrition. It is important to send blood for haematinics pre-transfusion to aid diagnosis and subsequent management. Macrocytic anaemia should not be transfused without an understanding of the cause and in liaison with haematologists. Although the evidence is controversial, most clinicians would aim for a pre-operative haemoglobin of at least 100 g/dl.

It is possible to predict blood loss depending upon the type of fracture; intracapsular fractures lose about 1000 ml, extracapsular about 1200 ml and intertrochanteric or subtrochanteric up to 1600 ml [24]. This may be greater in those on antiplatelet therapy or anti-coagulants.

The FOCUS study is a large randomised controlled trial comparing liberal transfusion with restrictive transfusion in patients following hip fracture, which showed no difference in mortality, ability to walk across a room at 60 days or length of hospital stay [25]. However, a decision about transfusion trigger should be made on an individual basis pre-operatively taking into account frailty, cardiorespiratory reserve and levels of function. Usual practice is to keep haemoglobin above 80 g/dl for those who are well and to aim for a haemoglobin of above 100 g/dl for those with poor cardiorespiratory reserve.

5.1.2.5 Diabetes

Poor glycaemic control in the peri-operative period can lead to dehydration and poor wound healing with prolonged hyperglycaemia. Hypoglycaemia can also have serious consequences contributing to delirium, falls and seizures.

In the pre-operative period, patients with fragility fracture are often reluctant to eat due to pain, immobility and side effects of analgesia. Immobility may lead to reduced calorie requirements but pain and stress result in hyperglycaemia.

It is important to review diabetes medication pre-operatively and to monitor the blood sugar levels regularly. The AAGBI have produced comprehensive guidelines for peri-operative management of diabetes [26]. Patients who have been taking long-acting oral hypoglycaemics or long-acting insulin need close monitoring and may need slow 5 % glucose infusion if being kept nil by mouth for surgery.

Withhold pre-operative carbohydrate loading or high sugar dietary supplements in patients with diabetes as these may lead to poorly controlled blood sugar levels.

Most patients on oral hypoglycaemics can be managed by simply omitting usual medication on the day of surgery. However, there is no need to stop Pioglitasone. Metformin should be withheld for 48 h in anyone at risk of renal impairment, as there is an association with lactic acidosis. If pre-operative blood sugars rise above 12 mmol/L, consider variable rate intravenous insulin infusion (VRIII). Oral medication should restart as soon as the patient is able to eat and drink.

Those usually on insulin should omit usual insulin dose and start on VRIII pre-operatively with intravenous fluid. This should be 5 % glucose if the blood sugars are low. For patients with Type I Diabetes, insulin should never be stopped completely.

Long acting insulin analogues (Glargine, Lantus, Detemir or Levimir) can be continued in the peri-operative period with some advocating reducing dose by one third.

It is important to make a post-operative plan and to withdraw the VRIII as soon as the patient is eating and drinking to avoid fluid overload and electrolyte disturbance. Normal insulin doses may need adjusting until the patient is eating and drinking and mobilising normally.

5.1.2.6 Chronic Kidney Disease (CKD)

CKD is common in older people and can be associated with an excess surgical morbidity [27]. It is important to establish the duration of CKD and baseline renal function. CKD may reflect impaired excretory function with raised urea, creatinine and metabolic products. In addition, there may be impaired synthetic function resulting in acidosis, hyperkalaemia, hypertension and oedema. CKD also results in reduced erythropoietin with anaemia and reduced hydroxylation of vitamin D causing hypocalcaemia and hyperphosphatemia. Platelet dysfunction is common in CKD, increasing the risk of bleeding.

Anaemia and metabolic abnormalities should be corrected to acceptable limits pre-operatively. Fluid overload is difficult to correct pre-operatively but those with end stage renal disease who are dialysis dependent should be dialysed within 24 h pre-operatively to reduce fluid overload.

Many drugs are excreted by the kidneys and can accumulate in patients with CKD. These may require dose adjustment or administration interval adjustment and in some cases avoiding completely.

Anaesthesia often results in hypotension and a significant reduction in renal blood flow with worsening of renal function in the post-operative period. It is essential that anaesthetists are aware of patients with CKD who have poor renal reserve so that they can make every effort to prevent hypotension.

Patients with CKD often have concomitant ischaemic heart disease and continuation of beta-blockers and correction of anaemia may help to reduce the incidence of cardiovascular events.

5.1.2.7 Respiratory Disease

Pre-operative clinical assessment, chest x-ray and arterial blood gases give important baseline information. Predicting those who are at highest risk of post-operative complications enables pre-operative intervention and optimisation. All patients with hip fracture are at risk of atelectasis and of chest infection, which is one of the reasons for early operation and mobilisation. Those with underlying lung disease or smokers with undiagnosed lung disease have a higher risk. Low serum albumin, recent weight loss and dependency is also associated with an increased risk of poor outcome following anaesthetic [28].

Opiate analgesics and anaesthetic agents can reduce respiratory drive resulting in hypoxia, hypercapnia and atelectasis and should be used with caution.

Obesity also contributes to reduced gas exchange through reduced lung volume and in severe cases can lead to hypercapnic respiratory failure but there is no evidence that hip fracture patients with a high BMI have an increased rate of post-operative complications [29].

Cor pulmonale and pulmonary hypertension carry significant morbidity and mortality.

Exacerbations of chronic obstructive airways disease may need treatment and optimisation pre-operatively but most respiratory infections should not delay operation unless accompanied by sepsis, cardiovascular compromise or very high oxygen requirements.

The choice of anaesthetic is discussed in Chap. 7.

5.1.3 Medication Review

In some countries, medicine reconciliation soon after admission is undertaken by a pharmacist. Understanding how a patient manages a complex regime is important, giving insight into cognition and compliance. Specific medication may suggest certain diagnoses but care should be taken in making assumptions.

All regular medication should be written up on the drug chart with the indication for each drug and clear documentation of which should be continued or withheld pre-operatively. Most frail older patients admitted with fragility fracture will be volume-depleted and it is important to withhold medications that could contribute to renal hypoperfusion and acute kidney failure in the peri-operative period (e.g. diuretics, ACE inhibitors, anti-hypertensives).

Long-term sedatives (e.g. benzodiazepines, antipsychotics) should be reviewed and possibly reduced in the immediate peri-operative period, as many of the anaesthetic drugs will also cause sedation. These should not be stopped abruptly or withheld for prolonged periods of time.

Other medications must be given on the morning of surgery with a small sip of water (e.g. beta-blockers for angina or rate control, anticonvulsants and medication for Parkinson's disease).

Some medications need reviewing and adjusting during the peri-operative period (see anticoagulants and antiplatelets and management of diabetes). Patients on hydrocortisone for pituitary failure or long-term low dose steroid with possible adrenal failure should be given an increased dose – usually 50 mg of hydrocortisone on induction via intramuscular or intravenous route and three times a day for the first 24 h. Inhalers may be changed to nebulisers for better delivery while a patient is immobile in bed.

Every prescribed medication should have a clear current indication and benefits of the medication should outweigh the risks. Hospital admission with multidisciplinary input is an opportunity to review this. It is an important aspect of comprehensive geriatric assessment and takes considerable time. It should start pre-operatively but will need to continue to be reviewed and adjusted in the post-operative period.

Considerable thought should be given to medication that may contribute to falls (see Chap. 4)

5.1.4 Preventing Complications

5.1.4.1 Thromboembolic Events

Patients with fragility fracture are considered at particularly high risk of thromboembolic events due to the effects of trauma, surgery and immobility. Frail older patients may have other co-morbidities such as heart failure or a history of thromboembolic events that increase this risk further. UK NICE guidelines recommend daily low molecular weight heparin (LMWH) for all hospitalised patients unless there are specific contraindications [30]. LMWH should be prescribed on admission but omitted if the patient is going to surgery within 12 h. If there is likely to be a delay to surgery pre-operative dosing should be considered taking into account risks of bleeding further into the fracture site.

The incidence of symptomatic venous thromboembolic events (VTE) is between 1 and 9 % and symptomatic pulmonary emboli (PE) 0.2–1.7 % following hip fracture surgery. However, the risk of significant bleeding with LMWH is 0.8–4.7 % [31].

There is no good evidence for compression stockings in patients following hip fracture and the potential harm in patients with poor skin and circulation should not be underestimated. Local policies should be followed but with a review of risks and benefits in each individual patient.

5.1.4.2 Antibiotic Prophylaxis

Antibiotic prophylaxis is strongly recommended for surgical management of fractures to help to prevent deep wound infection. Each hospital will have its own policy to reflect likely pathogens and local patterns of resistance. This usually involves a

single dose pre-operatively and 24 h cover post-operatively. Antibiotic choice may vary for patients who have fallen and fractured while in hospital or from a nursing home environment, where incidence of drug resistance is higher.

5.1.5 Predicting Risk and Setting Expectations

The American Society of Anaesthesiologists classification grades patients from I to V. The majority of patients with hip fracture are ASA grade III or IV [32] – see Table 5.3

The Nottingham hip fracture score was validated in a UK population of more than 65,000 patients [33]. The prediction of risk is important for informed decision-making, communication with patients and relatives and planning of care (see Table 5.4).

5.1.6 Appropriate Ceilings of Care

Many patients with fragility fracture live with significant frailty and almost a third of patients are in their last year of life. It is important that they and their next of kin have a realistic understanding of which treatments may result in benefit and which are likely to cause harm or distress. Organ failure resulting from end stage chronic disease is usually irreversible so, under these circumstances, organ support in an intensive care unit setting is likely to be ineffective and therefore inappropriate. Where there is a reversible element to organ failure, decisions regarding invasive treatments should be pro-actively discussed pre-operatively where possible.

Cardiopulmonary resuscitation in the event of cardiac arrest is unlikely to be effective in those with poor physiological reserve and an anticipatory form (Do Not Attempt Cardiopulmonary Resuscitation or DNACPR form) is required in some countries.

Table 5.3 American Society of Anesthesiologists Classification scores in 65,486 patients with hip fracture in UK as part of the ASAP study

ASA Grade	Patient status	% of total patients	30 day mortality
1	Normal healthy patient	2.9 %	0.7 %
2	Mild systemic disease	28 %	2.5 %
3	Systemic disease that causes functional limitations on life	49 %	8.3 %
4	Severe systemic disease that is a constant threat to life	10 %	24 %
5	A moribund patient that is not expected to live more than 24 h without surgery	0.3 %	35 %

Adapted from White et al. [23]

Table 5.4 Nottingham hip fracture score

Variable	Value	Proportion of 11,670 patients
Age <66 years	0	4 %
Age 66–85 years	3	59 %
Age >86 years	4	37 %
Sex Male	1	21 %
Haemoglobin <100 g/l	1	10 %
AMTS <6/10	1	33 %
Co-morbidities >2	1	27 %
History of malignancy	1	8 %

Predicted 30 day mortality	
Total score	Predicted 30 day mortality
0	0.7 %
1	1.1 %
2	1.7 %
3	2.7 %
4	4.4 %
5	6.9 %
6	11 %
7	16 %
8	24 %
9	34 %
10	45 %

From Moppett et al. [33]

Many older people do not wish to receive life-prolonging treatments and may have discussed this with relatives or completed an advance care plan. It is important to discuss this with the patient and their next of kin during the pre-operative assessment to ensure that all are aware of the patient's priorities. A DNACPR order may be reversed in the immediate peri-operative period, in theatre and in recovery area to ensure that recovery from anaesthesia is complete and does not contribute to cardiac or respiratory compromise. The use of drugs and techniques often used as part of CPR may be indicated in the short-term [34].

Conclusion

Pre-operative assessment of patients with fragility fracture requires skill, time and effort. It is best achieved through multi-disciplinary review and information gathering to provide a clear and accurate understanding of a patient's background. This should enable an informed decision to be made with regard to the best form of management for that individual, taking into account the risks and benefits in addition to the patient's priorities.

To date there is no evidence that pre-operative assessment by an orthogeriatrician reduces mortality although the UK National Hip Fracture Database

Table 5.5 Reasons for delaying surgery for hip fracture

Acceptable	Unacceptable
Haemaglobin concentration <8 g/dl	Lack of facilities or theatre space
Plasma sodium concentration <120 or >150 mmol/L	Awaiting echocardiography
Uncontrolled diabetes	Unavailable surgical expertise
Uncontrolled left ventricular failure	Minor electrolyte abnormalities
Correctable cardiac arrhythmia with ventricular rate > 120 beats/min	
Chest infection with septic shock	
Reversible coagulopathy	

From the AAGBI Management of Proximal femoral fracture 2011

shows a clear improvement in quality of care and a reduction in mortality associated with the introduction of overall orthogeriatric management [35]. For elective surgery pre-operative review of patients with frailty does reduce post-operative morbidity and reduces overall length of stay [36]. However, there is often limited access to senior orthogeriatric review. Local protocols and evidence-based guidelines should be made available to help guide appropriate pre-operative management.

Acceptable reasons for delaying surgery have been agreed by the AAGBI where it is felt that optimisation is likely to be achieved quickly and to be worthwhile Table 5.5 [37]. For the majority of patients early surgery remains the best approach.

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Hip Fracture: The Choice of Surgery

6

Henrik Palm

6.1 Aim of Surgery

The aim of hip fracture surgery is to allow immediate mobilisation with full weight-bearing, aiming to achieve the previous level of function, ranging from maintaining normal walking in self-reliant elderly patients to pain relief in chronic bedridden nursing home residents. Three in four patients are expected to live beyond the first postoperative year, so proper surgery is required to alleviate an otherwise long-standing suboptimal functional level. Surgery is technically challenging, with body weight transfer through a broken oblique column, often with reduced bone quality due to osteoporosis – thus the risk of reoperation is high. A poorly operated hip fracture often leads to unequal leg length, pain and irreversible mobility loss, greatly influencing quality of life.

6.2 Fracture Types

Hip fractures are divided into different types by use of classification systems. A fracture classification should ideally have a high degree of reliability and reproducibility, be generally accepted, and have a prognostic validity in the clinical situation.

Historically, several classification systems have been proposed, but the following are the most commonly used in the literature. Hip fracture classifications are based on radiographic fracture patterns, while previous hip surgery, arthritis, cancer, dysplasia, bone-quality, soft-tissue and pain are normally not taken into account.

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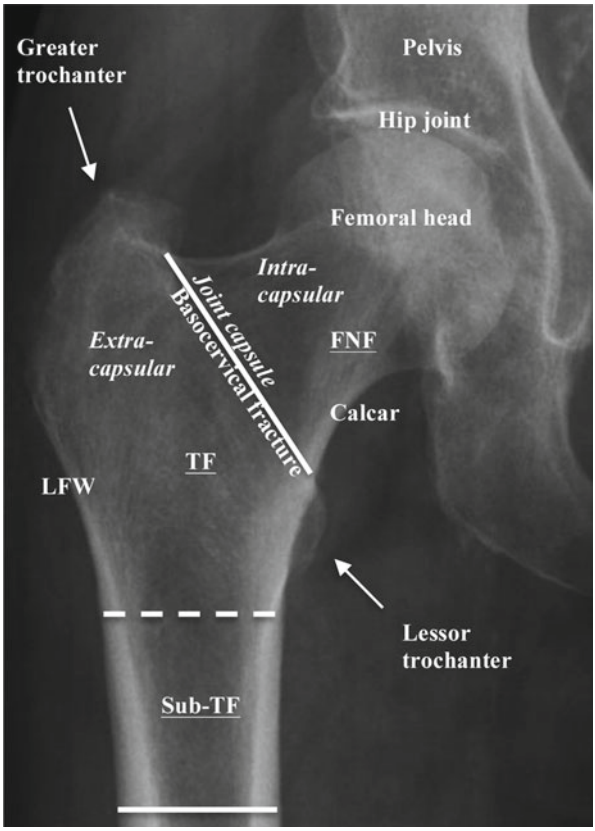


Fig. 6.1 Antero-posterior radiograph of right side proximal femur showing the anatomy and fracture positions. *FNF* femoral neck fracture, *TF* trochanteric fracture, *Sub-TF* sub-trochanteric fracture, *LFW* lateral femoral wall

Hip fractures cover proximal femoral fractures predominantly located up to 5 cm distal to the lesser trochanter [44], and are classified by fracture anatomy on plain radiographs (Fig. 6.1), if necessary supplemented by CT or MRI scans [9].

The hip joint capsule divides fractures into two main categories with an almost equal patient distribution: (1) Intra-capsular femoral neck fractures and (2) Extra-capsular basicervical, trochanteric and sub-trochanteric fractures.

6.2.1 Intra-capsular Fracture Types

In a fragility fracture context, intra-capsular hip fractures are in fact through the femoral neck, as femoral head fractures are uncommon in the elderly.

Femoral neck fractures are at risk of non-union with/without mechanical collapse due to insufficient fixation and/or avascular necrosis of the femoral head.

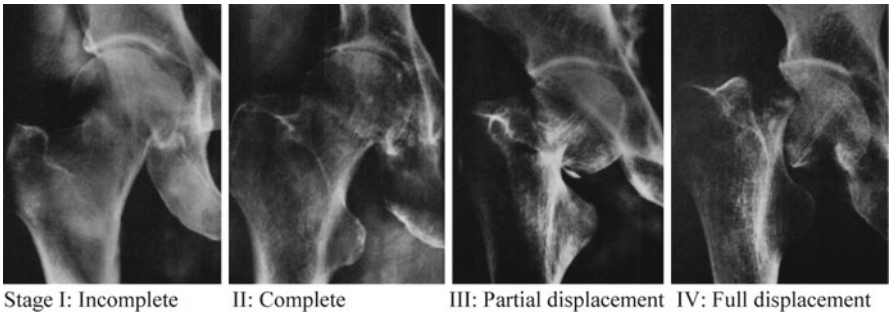


Fig. 6.2 Garden's classification (Reproduced with permission and copyright © of the British Editorial Society of Bone and Joint Surgery)

In adults, the femoral head is primarily supplied by the distal recurrent vessels entering the femur on the shaft side of the fracture. Avascular necrosis is caused by ischaemia hypothetically due to either a direct trauma to the arterial supply crossing the fracture-line or by a temporary arterial impingement, caused by vessel stretching or intra-capsular hematoma. Preoperative scintigraphy, electrode measurement and arthroscopic visualization of ischaemia have been tested but lack prognostic value. Since ischaemia could be temporary, acute reposition within hours (maybe supplemented by hematoma emptying) has been suggested [23, 27].

Femoral neck fracture classification has historically been contentious with several different systems, primarily based on fracture displacement seen in the anterior-posterior radiographs. *Garden's Classification* (Fig. 6.2) has in the last half a century been the most widespread. Fractures are divided into four stages based on fracture displacement [16]. Garden's classification has only fair inter-observer reliability when using all four stages, but moderate to substantial if dichotomized into just undisplaced (Garden I–II) or displaced (Garden III–IV) fractures [17].

In addition, a vertical fracture-line in the anterior-posterior radiograph or posterior wall multi-fragmentation, femoral head size, and posterior tilt angulation seen in the lateral radiograph are believed to influence outcome [12, 25, 42]. However the dualism of undisplaced versus displaced (with reference to Gardens stages I–II versus III–IV) remains the most consistent predictor of failure and the most widespread fracture classification, with respectively around 1/3 and 2/3 of femoral neck fractures [36, 65].

6.2.2 Extra-capsular Fracture Types

Extra-capsular fractures are at risk of mechanical collapse and non-union due to insufficient fixation. The fracture-line is anatomically located laterally to the nutrient vessels to the femoral head, so avascular necrosis is rarely seen, but muscle attachments often dislocate the fragments and bleeding into surrounding muscles can be severe and life-threatening. Classification systems are primarily based on fracture-line location and number of fragments.

Basicervical fractures are a few percent of borderline cases between the intra- and extra-capsular fractures, anatomically positioned on the capsular attachment line. The AO/OTA classification describes them as intra-capsular, but biomechanically they behave like the extra-capsular fractures [31] – except for the risk of rotation of the medial segment due to lack of muscle attachments.

Trochanteric fractures cover the trochanteric area from the capsule until just below the lesser trochanter. The often-used unnecessary prefixes per-, inter- and trans- are undefined, confusing and unhelpful for classification.

The *AO/OTA Classification* (Fig. 6.3) from 1987 is nowadays the most widespread. It divides the 31-A trochanteric area into nine types by severity (1-2-3, each subtyped .1-.2-.3) [32].

Fracture type 31-A1 covers the simple two-part fractures, while 31-A2 demands a detached lesser trochanter, with an intact (31-A2.1) or a detached greater trochanter (31-A2.2-3). 31-A3 covers fracture lines through the lateral femoral wall – defined as the lateral cortex distal to the greater trochanter – in which the subgroup 31-A3.1 represent the reverse fracture and 31-A3.2 the transversal, while the most comminuted 31-A3.3 fracture demands both a fractured lateral femoral wall and a detached lesser trochanter.

The AO/OTA classification covers most fractures within previous classification systems, except the few trochanteric fractures with a detached greater trochanter and an intact lesser trochanter. The reliability when using all nine types is poor, but increases to substantial if only classifying into the three main groups (A1-2-3) [52].

Subtrochanteric fractures are positioned distally to the trochanters, and constitute around 5 % of all hip fractures. These have historically been classified by as many as 15 different systems, most often into the 8 types from 0 to 5 cm below the lesser trochanter by Seinsheimer or the 15 types from 0 to 3 cm in the AO/OTA classification for femoral shaft fractures, the type 32ABC (1–3).1 sub-division. A review doubts the value of such division and proposes simplicity into: (1) a stable two-part and unstable (2) three-part and (3) more comminuted fractures from 0 to 5 cm below the lessor trochanter, without involvement of the trochanters. It however still has to be established whether this easier classification is useful and necessary for decision-making and prognosis [28, 32, 36, 60].

6.3 Implants

There are two major strategies for treating hip fractures, prosthesis or osteosynthesis. A prosthesis involves removing the fracture-site, and replacing the femoral head with a Hemi-Arthroplasty or a Total Hip Arthroplasty, the latter also including an acetabular cup. An osteosynthesis involves reducing bone fragments to an acceptable position and retaining them until healing – usually with parallel implants, sliding hip screw or intramedullary nail (Fig. 6.4).

Prostheses are inserted with the patient supine or lateral depending on the surgical approach, while osteosynthesis is always performed through one or more lateral

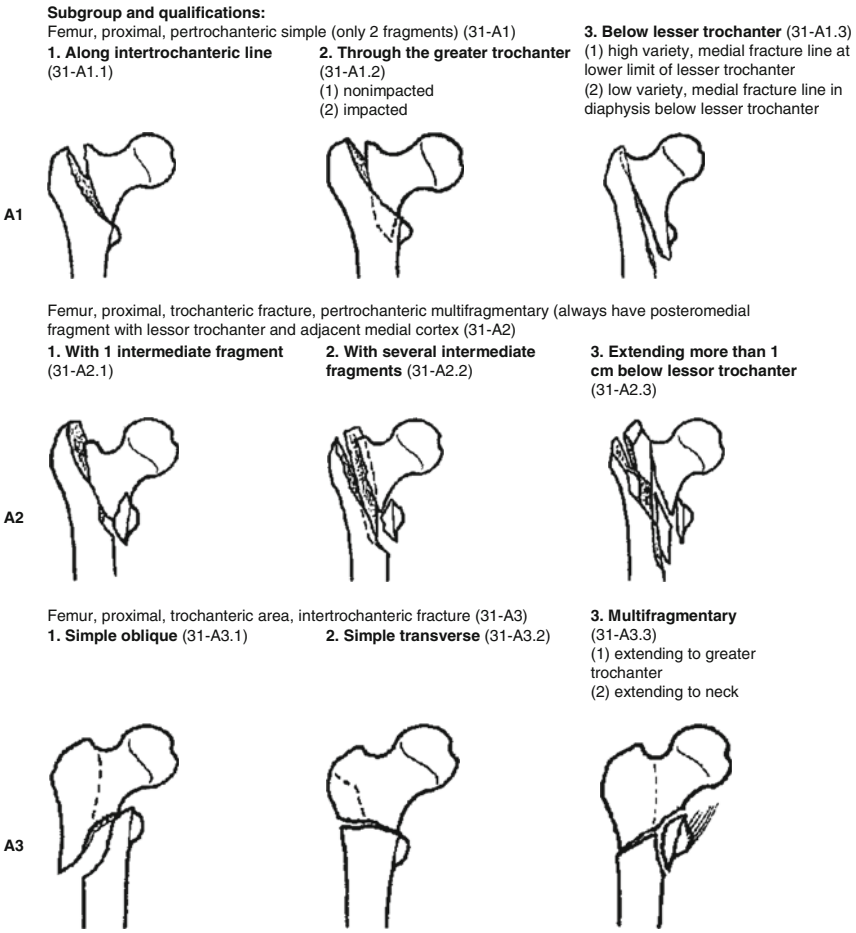


Fig. 6.3 AO/OTA Classification for trochanteric fractures (Reproduced with permission from *J Orthop Trauma*)

approaches, with the patient supine on a traction table and the use of a radiographic image-intensifier. There are pros and cons for all implants, but all are dependent on proper use, which is why well-defined implant position measurements are needed for optimal evaluation of one implant against another.

Parallel implants are inserted with limited operative bleeding and soft tissue damage through a few lateral stab-incisions or a single <5 cm incision. In spite of many clinical and cadaver studies, choice (screws/hookpins) and number (2/3/4) of implants lacks consensus [49]. Parallel implants permit fracture compression and they should be inserted as vertically as possible and in different head-quadrants. Furthermore, the posterior implant should have posterior cortex contact and the inferior implant calcar contact to achieve three-point fixation that best supports

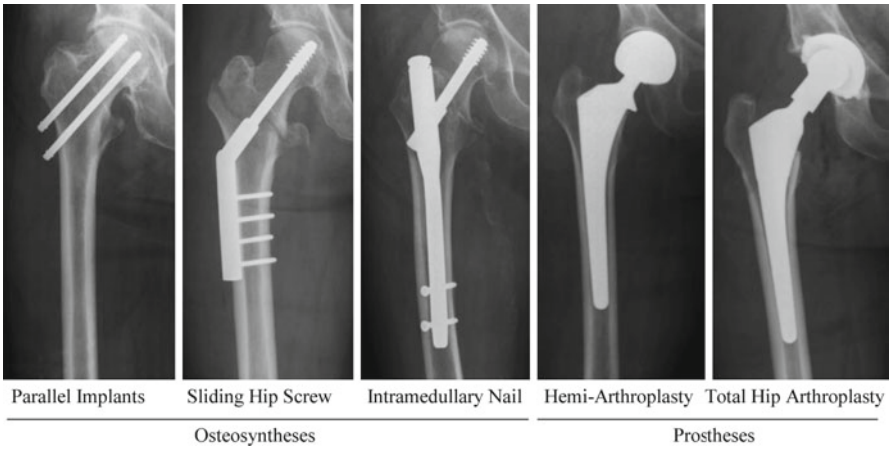


Fig. 6.4 The main implant groups for hip fracture surgery

weight transfer from (1) the subchondral bone to (2) a calcar seat and (3) a lateral femoral cortex counterpoint [59]. The main reasons for failure are non-union, with or without mechanical collapse, due to insufficient fixation and/or avascular necrosis. Salvage normally necessitates a hip-prosthesis or, depending on patient demand, a simple removal of the femoral head. A new fall can result in fractures around the parallel implants, which should be reoperated with a sliding hip screw or an intramedullary nail.

Sliding hip screws have been the Gold Standard for treating trochanteric fractures for several decades – but have recently also gained ground for femoral neck fractures [49]. After reduction, the femoral head fragment is held by a large diameter screw, which can slide inside an approximately 135° angle plate attached laterally to the femoral shaft. The implant is inserted under the lateral vastus muscle through a single lateral approach, around 10 cm long depending on chosen plate-length.

To reduce the risk of cut-out of the screw into the hip joint, it should be positioned centrally or central-inferiorly in the femoral neck with the tip attached subchondrally in the femoral head, providing a short so-called tip-apex distance [4]. Beyond cut-out, the common reasons for failure are mechanical collapse, with or without non-union and a distal peri-implant fracture. Depending on femoral head bone status, salvage can be an intramedullary nail or a distally seated hip-prosthesis.

Intramedullary Nails have, during the last decade, outnumbered sliding hip screws as treatment for trochanteric fractures [55]. After reduction, the femoral head fragment is held by a large diameter screw, which can slide at an angle of approximately 130° through an intramedullary nail with 1–2 distal locking screws. The nail is inserted at the greater trochanter tip, through a 5 cm lateral incision, with the sliding and locking screw(s) inserted by use of a guide through stab incisions in the lateral vastus muscle. A central-inferior position in the femoral head and a short

tip-apex-distance for the threaded types is important, while the new bladed types might need more distance [37, 58].

Some old nails had a reputation for risking a shaft fracture, but newer nails have moved beyond this, although the many new smaller designs, with different screw, blade, sleeve, locking and anti-rotation mechanisms, lack convincing clinical evidence so far [6, 53].

Reasons for failure are the same as for the sliding hip screws, and salvage can be a distally seated hip-prosthesis for bone-collapse. In case of a distal peri-implant fracture, a longer nail or a condylar plate can be used, depending on the nail-length.

Prostheses involve a metal femoral head replacement attached by a stem seated in the shaft cavity. To fit individual patients' anatomy, implants are modular and assembled during surgery; thus mono-blocks are no longer recommended [56]. Reoperations are primarily caused by repeated dislocations or by a peri-prosthetic fracture (produced during insertion or subsequent to a new fall). For dislocations, closed reduction is the norm, but reposition or modification with a low-range-of-motion constrained liner is necessary in recurrent cases. Peri-prosthetic fractures are treated with circumferential wires and/or a plate, and a loose prosthesis is changed or removed depending on the patient's demands.

Hemi-arthroplasties (HA) traditionally have reduced dislocation rate, shorter operating time and less blood loss than a total hip arthroplasty. Reports of acetabular chondral erosion, following unipolar HA, have encouraged bipolar heads with an additional ball-joint – their efficiency is however still debated [24, 48, 57].

Total Hip Arthroplasties (THA) also replace the acetabular cartilage, theoretically a source of pain and thus reduced functional ability, and THAs might provide a better result than HAs in active, independent living, and cognitively intact patients [8, 48]. Despite the higher implant price, the total cost of using THA is probably lower when taking complications and function into account, in the healthiest patients [62]. THAs however have an increased dislocation risk [8, 48], which might be reduced by the technically demanding new dual-mobility types [1, 5].

Beyond optimal implant positioning, the dislocation rate following both HA and THA might be reduced to 1–3 % of patients using the antero-lateral approach, compared to 4–14 % by use of the postero-lateral approach, though the latter can probably be improved by an optimal capsular and muscle repair [13, 14, 51]. The only randomized study however found no difference in dislocation rate between the two methods [50] and research is on-going regarding the consequences of the surgical approach for soft-tissue, pain and mobility. It may be that dual-mobility cups can justify the continued use of the postero-lateral approach [1, 5].

Cementation is associated with more dislocations in some studies but less in others. Cementation seems to improve patient mobility, reduce pain and the rate of peri-prosthetic fractures (1–7 % for uncemented prostheses), although only a few studies include the newer hydroxyapatite-coated surfaces. Cementation probably increases blood loss and operation time, but registries have shown that the higher acute mortality appears to equilibrate after a couple of months [2, 18, 23, 48, 57, 63].

6.4 Surgical Management

Patients should receive their operation as soon as possible, because the negative impact on body functions, while waiting for surgery, appears to be significant. Surgery on the day of, or the day after admission (12–48 h) is recommended, although studies to prove this are difficult, because stratification by comorbidities is challenging [7, 26, 35, 61].

Surgical drains [11], and pre-operative traction are no longer recommended [21]. Conservative treatment should be avoided in modern healthcare systems [20], except in a few terminally ill patients who can be kept pain-free by analgesics in their last few days of life.

Patients sustaining a metastatic fracture should be identified, the cancer investigated and the proximal femur fixed in a way that takes into account the growing cancer, normally by use of a long nail or a distally seated THA.

Prophylactic antibiotic treatment should be given. Deep infection is rare (Table 6.1), but potentially devastating, often with several procedures and implant removal. While treating the infection, an external fixator can be used to keep extracapsular fractures reduced. Predictors of infections are primarily surgeon experience and operation duration [19, 38].

6.4.1 Intra-capsular Operations

The overall choice stands between (1) femoral head removal and insertion of a prosthesis, or (2) femoral head preservation by internal fixation, wherein the main overall predictor for failure is initial fracture displacement [27]. However, patient age, co-morbidity, mobility demands and so on should also be taken into account in the choice of implant. Patients should be asked about pre-fracture hip-pain, and a THA chosen if hip arthritis coexists.

Undisplaced femoral neck fractures may be complicated by non-union, with or without fracture collapse and, after a minimum of 3–6 months, radiographically evident avascular necrosis of the femoral head (Table 6.1). Around three quarters of undisplaced fractures are treated with parallel screws or pins, which appears to be adequate [27, 44, 46, 49]. The sliding hip screw is comparable, and enables a more stable fixation due to the fixed angle attachment when three-point fixation is unachievable due to a vertical and/or basal fracture-line – but necessitates a larger incision. Although debated, posterior tilt might increase the reoperation rate [12], suggesting that this may be an indication for prosthesis, rather than osteosynthesis.

Displaced femoral neck fractures are followed by the same complications after internal fixation as the undisplaced – but at a higher rate (Table 6.1).

If using internal fixation, the fracture must be anatomically reduced within a short time and the implants optimally positioned. Prostheses are now the most common treatment for displaced fractures, with improved results (Table 6.1) varying with the approach, cementation and THA/HA [2, 18, 23, 29, 44, 45, 49, 55, 59].

Table 6.1 Overall rates of surgical complications

	Deep infection	Non-union & cut-out	Avascular necrosis	Distal fracture	Dislocation	Aseptic loosening	Reoperation
Undisplaced FNF, IF	≈1 %	5–10 %	4–10 %	<1 %	–	–	8–12 %
Displaced FNF, IF	≈1 %	20–35 %	5–20 %	<1 %	–	–	15–35 %
FNF, Prosthesis	1–7 %	–	–	1–7 %	1–14 %	1–3 %	2–15 %
Extra-capsular	≈1 %	1–10 %	<1 %	1–4 %	–	–	2–10 %

FNF femoral neck fracture, *IF* internal fixation

A large number of studies report a significantly lower reoperation rate following prosthetic replacement. Newer studies also find less pain, better hip function and higher patient satisfaction after a prosthesis. However this is at the expense of a greater primary operation (operating time, soft tissue damage, blood loss and impact on body functions) resulting in a higher immediate mortality. Fortunately, this appears to equilibrate later [23, 29, 45, 54, 57].

Using internal fixation for all displaced fractures, with insertion of a prosthesis later if required, is not recommended, as a salvage prosthesis insertion has a much higher complication risk than a primary. Prostheses however have a shorter lifetime in the mobile young patients, who might out-live their prosthesis once or more. It has therefore been suggested to use internal fixation in the youngest patients, THA in active patients around 65–80 years and HA in the oldest [23, 30, 57].

The subgroup of demented patients might benefit more from internal fixation – their functional scores are generally low – but the literature is so far limited [22, 64]. Osteosynthesis in the most fragile patients, who are demented or have a high risk of dying on the operation table, should however be used with caution, as the fixation often turns out to be inadequate and painful in the short term – requiring a reoperation – if the patients live longer than expected. In a few selected bedridden, oldest patients, a simple removal of the femoral head can be chosen as the primary procedure to reduce fracture pain and eliminate complications.

6.4.2 Extra-capsular Operations

Basicervical fractures are treated with a sliding hip screw, attached to a short lateral plate. Parallel implants are insufficient, because of the lack of implant support by the calcar bone area [31].

Trochanteric fractures may be complicated by a non-union or mechanical collapse in 1–10 % of patients. The pull of muscles often displaces fragments, while a near-anatomical reduction is necessary for the majority of weight to pass through the bone. Use of retractors and/or a posterior-reduction-device on the fracture table is recommended to prevent sagging of the fracture.

During the early postoperative months, an inadequate reduction and implant position may lead to femoral shaft medialisation and femoral head varus position with risk of a screw cut-out, pain and a shortened femoral neck- and leg-length. The overall rate of reoperation is 2–10 % [10, 33, 34, 36, 44, 53]. A salvage prosthesis can be inserted primarily, but this is challenging due to the damaged bone stock.

The choice of implant is between the sliding hip screw and an intramedullary nail but, after many cohort studies and more than 40 RCTs over three decades, the comparison remains inconclusive overall. However, all but a few have included the whole group of trochanteric fractures, so it is possible that the implants could each be superior in different subgroups. The current status appears to be that, although the sliding hip screw remains the recommended implant, nails might have advantages in the more unstable trochanteric fractures [6, 47]. The Norwegian national registry reported fewer reoperations after sliding hip screws in 7,643 stable (AO/

OTA type 31A1) and after nails in 2,716 unstable trochanteric fractures (AO/OTA type 31A3) [33, 34].

Part of the explanation for a higher sliding hip screw failure rate in the unstable fractures (AO/OTA type A3) might be the lack of a buttress from the lateral femoral wall. A trochanteric buttress shield might prevent lateralisation, but the evidence is not convincing and the method demands a much larger incision than simply inserting a nail. The sliding hip screw is also considered insufficient for fractures with a detached greater trochanter (AO/OTA type A2.2 and A2.3) as the resulting thin lateral femoral wall is at a very high risk of per-operative fracture. The integrity of the lesser trochanter does not seem to influence outcome, and unstable trochanteric fractures should probably thus be defined by a detached greater trochanter or a lateral femoral wall fracture (AO/OTA type 31A.2.2-2.3 + A3) [40, 41].

So far knowledge is limited on whether use of the longest possible nail can reduce risk of later shaft-fractures, although femoral shaft bending, entry-point and distal locking appears more challenging in long nails [39].

Sub-trochanteric fractures are nowadays most often treated with a long nail, which is probably beneficial with reoperation rates declining to 5–15 %. Most literature however also included the AO/OTA 31A3 fractures, due to difficulties of differentiation and more knowledge is needed. Circumferential wires can be added for keeping the oblique and comminuted fractures reduced with low risk of bone-necrosis [3, 28].

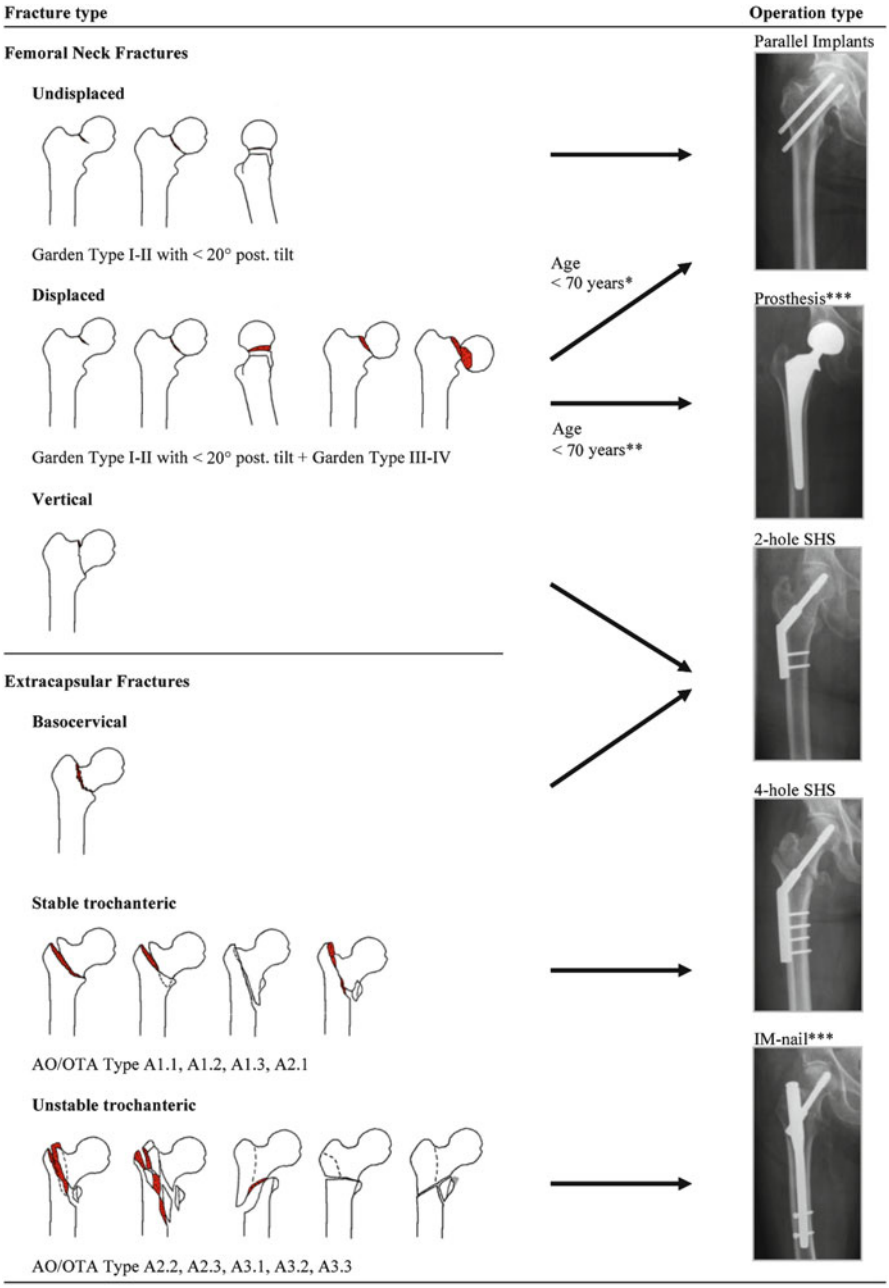
6.5 Surgical Algorithms and National Guidelines

As indicated above, the published evidence in the last decades has created a degree of consensus for the surgical treatment of hip fractures. In everyday clinical practice however, the exact choice of implant often remains uncertain, and an easily used surgical algorithm for all hip fracture patients might be warranted.

Younger, less experienced surgeons probably feel more confident when guided by a strict algorithm, while older surgeons could feel their individual right of choice restricted. It is however important to underline that a treatment algorithm does not negate the individual surgeon's responsibility for the individual patient. A surgeon still has the right and duty, now and then, to defy a guideline due to individual circumstances, but the decision to do so should be justified in the patient record.

Creating an algorithm embracing the heterogeneous group of hip fracture patients is challenging, and the balance between detail and usability must be considered. Many published articles recommend treatment for some aspects, but only a few authors have published comprehensive decision-tree algorithms for hip fracture surgery – among which the simple, exhaustive and exclusive Copenhagen Algorithm (Fig. 6.5) appears to be the best scientifically evaluated [42, 43].

National guidelines including surgery have emerged in Australia, New Zealand, USA and most European countries during the last decades. Consensus is widespread for some overall recommendations based on the same evidence.



*Prosthesis, if not fully reducible on traction table. **Femoral head removal, if no pre-fracture mobility. ***Mandatory supervision of junior residents. SHS: Sliding hips screw. IM-nail: Intramedullary nail.

Fig. 6.5 An algorithm for hip fracture surgery (Reproduced with permission from *Acta Orthop*)

Among the intra-capsular fractures, all recommend internal fixation for undisplaced femoral neck fractures and to some extent prosthetic replacement for the displaced in elderly patients. Among the extra-capsular fractures, the sliding hip screw is recommended for the stable (often defined as AO/OTA type A1) while a nail is recommended for the unstable fractures (often defined as AO/OTA type A3 and further distal). The purpose of national guidelines is to recommend evidence-based surgical treatment for improving outcome. National hip fracture registries have gained ground, especially in the last decades, to enable continued evaluation of treatment quality and the identification of positive and negative outliers [15, 36, 43].

The multidisciplinary global Fragility Fracture Network has now the strategic focus of facilitating national (or regional) consensus guidelines including quality standards and systematic performance measurement – and offers an easily used minimum dataset for hip fracture audit [15]. Hopefully such knowledge dissemination will help to overcome barriers to implementation, globally spreading evidence-based national guidelines, standards and registries for improving surgical quality.

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Orthogeriatric Anaesthesia

7

Stuart M. White

7.1 Introduction

Traditionally, perioperative care of elderly patients requiring surgical hip fracture fixation was less than exemplary. Patients were administered relatively large amounts of opioid analgesia before surgery, which itself was often delayed for more than 48 h for 'organisational' or 'anaesthetic' reasons. A significant proportion of patients were not operated on, because the perioperative risk of death was perceived to be too high, and so received conservative management (bed rest). Patients undergoing surgery would be anaesthetised and operated on by junior clinicians, who administered heavy-handed general anaesthesia with opioid analgesia and used a wide variety of surgical techniques and implants. Postoperative care was coordinated by orthopaedic surgeons, and generally passive and intermittent. Mortality and morbidity were high, and length of postoperative inpatient stay was long.

This approach to care, however, was economically unsustainable given the rapidly changing demographics of first-world societies. Although the age-specific incidence of hip fracture has remained stable or has fallen slightly, increased longevity has led to increases in the number of elderly patients presenting with hip fracture. As a result, a number of European countries began to develop orthogeriatric services, to streamline and co-ordinate hip fracture care pathways.

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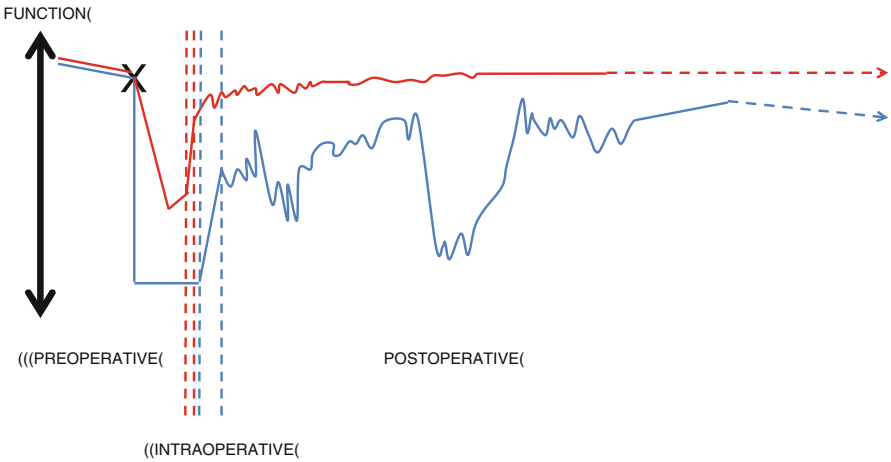

Fig. 7.1 Timeline of functional capacity after hip fracture with traditional anaesthetic care (*blue line*) vs proactive multidisciplinary care (*red line*)

7.2 The Relationship Between Anaesthetist and Orthogeriatrician

Reconfiguration towards multidisciplinary, orthogeriatrician-led care has probably delivered the greatest improvement in hip fracture outcomes in the last two decades. The main benefit of this model is that it allows for continuous, specialised medical care throughout the perioperative period, delivered by anaesthetists and orthogeriatricians.

There are three phases to perioperative care, the preoperative, intraoperative and postoperative phases (Fig. 7.1).

The preoperative phase describes the period from fracture to the patient's arrival in the operating theatre for surgery. Hip fracture is painful, if not always at rest, then usually on movement. Surgical fixation is the only method of providing analgesia and remobilisation in the long term, for which reason it should always be considered an option in preference to non-operative management. Conservative treatment carries the additional risks of immobility – thromboembolism, pressure ulceration, and loss of independence. The aim of the preoperative phase therefore, is to facilitate prompt preparation for surgery. Coordinated orthogeriatric/anaesthetic care enables standardised preoperative assessment (for example, delivered according to an agreed proforma, detailing history, examination, preoperative investigations and blood cross-matching), risk assessment using scoring systems, analgesia provision according to agreed protocols, fluid resuscitation, and organisational and patient-centred preparation for surgery.

Intraoperatively, the aim of anaesthesia is to mitigate the pathophysiological effects of surgery without destabilising the patient's physiology. Patients are at comparatively high risk of perioperative morbidity and mortality, because they are

usually frail and elderly (and so have limited physiological reserve), and have one or more comorbidities for which they take one or more drugs; cognitive dysfunction is common. Conceptually, anaesthesia is less about getting high-risk patients through 0.5–2 h of major, emergency surgery, but more about normalising a patient's (patho)physiology so that they are able to return to their normal function within hours following surgery.

National audits have shown that a wide variety of anaesthesia techniques are used, a result of personal preference and the lack of conclusive evidence for superiority of one technique over another [1, 2]. However, observational studies and meta-analysis indicate certain anaesthesia techniques probably improve outcome [3, 4]. Of potentially greater relevance is the idea that hospitals should adopt standardised anaesthesia protocols, so that postoperative care and the management of inevitable complications of anaesthesia and surgery become predictable for orthogeriatricians.

Postoperatively, orthogeriatric care aims to remobilise, re-enable and remotivate patients in preparation for hospital discharge; ideally back to their place of residence before fracture. The early postoperative phase is critical, as delayed remobilisation is associated with a prolonged duration of inpatient stay. Good anaesthesia care facilitates early recovery, by providing non-opioid analgesia, and avoiding delirium, hypotension and anaemia.

Figure 7.1 shows a reconceptualised timeline of what joint anaesthesia/orthogeriatric care should aim to achieve. The blue line represents traditional anaesthesia care. The patient's functional condition has been declining for some time, until they fall and break their hip ('X'), at which point they become entirely dependent. They are taken to hospital but receive minimal care until surgery, and so experience no functional improvement. Intraoperatively, the fracture is fixed, analgesia, fluids/blood are given, the blood pressure monitored, and the patients functional status improves, which continues into the immediate postoperative period. However, perhaps the patient develops delirium or feels too nauseous to remobilise for several days in the early postoperative period, as a result of reliance on postoperative opioid analgesia. They recover function over the next few days, but then develop pressure sores or suffer a pulmonary embolism related to their prolonged bedrest, and their functional recovery is delayed again. Eventually, they recover, not quite to their pre-fracture level of function but enough to be discharged from hospital. However, their relatives report that the patient 'was never quite the same' after this episode, with a slow ongoing decline in function after discharge (dotted lines).

Instead, proactive multidisciplinary care (red line) aims to return patients quickly to their pre-fracture functional status. Simple resuscitation (analgesia, fluids, food) decreases the relative decline in function after fracture, and may indeed begin to improve function pre-operatively. The patient undergoes surgery sooner and for a shorter period, during which resuscitation and normalisation of function continues using standardised anaesthesia. The patient's functional status rapidly returns to prefracture levels, there are no immobilising complications, the patient is discharged from hospital sooner and remains 'well' after discharge.

7.3 Preoperative Care

Guidelines published in 2012 by the Association of Anaesthetists of Great Britain and Ireland (AAGBI), in association with the British Geriatrics Society, detail organisational and interdisciplinary aspects of care for hip fracture patients [5]. Recommendations include the delivery of care by a multidisciplinary team of senior clinicians, fast-track hospital admission to an acute orthopaedic/hip ward, the provision of daily, and protected trauma lists that prioritise hip fracture surgery.

Several aspects of preoperative care involve coordinated anaesthetic and orthogeriatric input, including analgesia provision, pre-operative preparation and ethical/legal considerations.

7.3.1 Preoperative Analgesia

Hip fractures are usually low impact injuries sustained after a fall from standing height onto osteoporotic bone. Extracapsular fractures (intertrochanteric, subtrochanteric) are more painful than intracapsular fractures (subcapital, transcervical, basicervical), due to the greater degree of periosteal disruption.

Approximately a third of fractures are associated with mild pain, a third with moderate pain, a third with severe pain. Fractures are usually more painful on movement, for example, when the affected leg is raised passively by 20°.

After admission to hospital, pain is often poorly assessed. Numerical rating scales do not adequately describe pain duration or quality. Assessment needs to take place at rest *and* on movement, before *and* after the administration of analgesia. Communication difficulties (deafness, blindness, hemiplegia) can make assessment difficult, as can cognitive impairment related to dementia, or narcotic analgesia administered in the prehospital phase.

Standardised analgesia protocols ensure that pain is properly assessed and appropriately treated, such that analgesia is provided without opioid-induced cognitive compromise. In turn, this facilitates other aspects of preoperative care, such as physical assessment, communication, eating and drinking and self-care.

Paracetamol (acetaminophen) is an effective analgesic that is well tolerated by hip fracture patients, and should be prescribed routinely throughout the perioperative period.

Renal dysfunction is common (~40%) among this patient group, and so non-steroidal anti-inflammatory drugs (and codeine and tramadol) should be used with caution, or avoided completely.

Opioid analgesics are effective, but can affect cognition and increasingly so with older age and/or declining renal function (in which patients the dose should be reduced and the dosing interval prolonged). Depending on availability, buprenorphine, fentanyl and oxycodone may be preferable to morphine for longer-term use.

With the aim of trying to minimise the administration of cognition-impairing analgesics, increasing attention is being focused on providing preoperative peripheral nerve block [6]. The sensory innervation of the hip involves the femoral,

obturator and sciatic nerves and, in the skin surrounding the operative incision site, the lateral cutaneous nerve of the thigh. Femoral nerve block and fascia iliaca blocks have been used successfully to reduce pain and limit opioid use preoperatively. Although the efficacy of both blocks is improved by nerve stimulation and (more so) by ultrasound location [7], requiring additional equipment and expertise, both methods have proven to be relatively easy to learn by junior non-anaesthetists, and allied health professionals, such that their protocolised administration by orthogeriatricians should be possible without anaesthetic input. Although additional expertise is required, the use of tunneled femoral nerve/fascia iliaca catheters can be used to provide prolonged non-opioid analgesia in defined patients for whom surgery is not an option, or where surgery may delayed for medical reasons.

7.3.2 Preoperative Preparation

Hip fracture patients are often frail and old, with multiple comorbidities demanding polypharmacy. Any of these factors alone or in combination may have contributed to the fall that preceded the fracture, but it is only rarely that the outcome benefits of attempting to improve any of these factors outweighs the risk of delaying surgery. Instead, anaesthetists need re-assurance from orthogeriatricians that the patient is appropriately fit for anaesthesia and surgery – 'normalised' rather than 'optimised' – and encouragement that risk is best managed by administering an appropriate anaesthetic. Orthogeriatricians should understand what an 'appropriate' anaesthetic involves (see below), and discuss this with anaesthetists who are less familiar with anaesthetising hip fracture patients, and so more likely to cancel patients for medical reasons, delaying surgery.

The AAGBI guidelines detail common patient problems that can increase the risk of anaesthesia or its conduct, such as anticoagulation, valvular heart disease, pacemakers and electrolyte abnormalities, and recommend how these should be managed preoperatively [5]. Similarly, generic algorithms are available online that can be modified according to institutional protocols [8]. These are intended as *aides-memoire* for preoperative patient preparation, and are not intended to replace direct communication between anaesthetist and orthogeriatrician.

Most usefully, the AAGBI guidelines identify acceptable and unacceptable reasons for delaying surgery in order to treat certain conditions (Table 7.1). Even so, 'acceptable' is not synonymous with 'obligatory', and surgery may still proceed even if these are present, if the additional risk is managed appropriately. These recommendations serve as a useful starting point when anaesthetists and orthogeriatricians convene to discuss the timing of surgery.

7.3.3 Ethical and Legal Considerations

Hip fracture in elderly patients is associated with significant mortality, morbidity, psychosocial change and reduction in quality of life, although intraoperative

Table 7.1 Acceptable and unacceptable reasons for delaying hip fracture surgery [5]

Acceptable	Unacceptable
Haemoglobin concentration <8 $g \cdot dl^{-1}$ Plasma sodium concentration <120 or >150 $mmol \cdot l^{-1}$ and/or potassium concentration <2.8 or >6.0 $mmol \cdot l^{-1}$ Uncontrolled diabetes Uncontrolled or acute onset left ventricular failure Correctable cardiac arrhythmia with a ventricular rate >120 $beats \cdot min^{-1}$ Chest infection with sepsis Reversible coagulopathy	Lack of facilities or theatre space Awaiting echocardiography Unavailable surgical expertise Minor electrolyte abnormalities

Table 7.2 The Nottingham hip fracture score. A score out of ten is calculated by summating weighted points for eight criteria (left). The total score is used to predict the risk of a patient dying within 30 days of hip fracture surgery (right)

Variable	Points	Total score	Predicted 30 day postoperative mortality (%)
Age 66–85 years	3	0	0.4
Age 86 years or older	4	1	0.6
Male	1	2	1.0
Hb less than or equal to 10 $g \cdot dl^{-1}$ on admission to hospital	1	3	1.7
Abbreviated mental test score <=6/10 at hospital admission	1	4	2.9
Living in an institution	1	5	4.7
More than one co-morbidity[a]	1	6	7.6
Active malignancy within last 20 years	1	7	12.3
Total score		8	18.2
		9	27.0
		10	38.0

[a]Comorbidities include myocardial infarction, angina, atrial fibrillation, valvular heart disease, hypertension, cerebrovascular accident, transient ischaemic attack, asthma, chronic obstructive pulmonary disease and renal dysfunction

mortality is uncommon (<0.5 %). Traditionally, discussion between doctors, patients and relatives about the risks and benefits of the various surgical options and recovery approaches has been limited, and hampered by difficulties quantifying risk. Recent national validation of the Nottingham Hip Fracture Score (NHFS) (Table 7.2) supports its use as a risk adjustment for estimating 30-day mortality after hip fracture, in addition to other evidence for its value in predicting 1-year mortality and likelihood of early hospital discharge [9, 10]. The NHFS serves as a useful starting point when discussing risk, but requires patient-specific adjustment. This is best achieved by preoperative communication between the anaesthetist and orthogeriatrician so that discussions with patients and their relatives accurately reflect the possible outcomes of their decisions about treatment.

Similarly, anaesthetists should be involved in discussions about perioperative resuscitation status and/or treatment boundaries, which should be confirmed before every patient undergoes surgery.

Anaesthetic input is also of value when developing patient information literature, for instance, describing what analgesia, antiemesis and anaesthesia interventions the patient can expect to receive.

7.4 Intraoperative Care

In a similar fashion to anaesthetists needing to understand the importance of frailty to orthogeriatric management, orthogeriatricians need to understand how anaesthesia affects postoperative outcome.

Anaesthesia delivered appropriately for a patient's age, frailty and comorbidities can help re-enable patients after hip fracture surgery by improving analgesia, remobilisation, eating, drinking, and cognitive function.

Ideally, in the immediate postoperative period, patients should be sitting up, conversing coherently, drinking and eating, pain free and disconnected from oxygen, intravenous fluids and urinary catheters (all of which impede remobilisation). Although it is not always possible to achieve each of these factors, the aim is to administer anaesthesia in such a way as to facilitate as many as possible.

Evidence for the effect of anaesthetic interventions is limited. Previously, debate has centred mainly on whether general anaesthesia or spinal anaesthesia (with or without sedation) is preferable in terms of outcome. Randomised controlled trials have proved inconclusive for several reasons: 'general' and 'spinal' anaesthesia can describe a myriad of different techniques, a 2 h period of anaesthesia is probably unrelated to mortality 30 days later, early mortality (within) 5 days is an infrequent outcome for which very large trials would be needed to detect any difference, inclusion and exclusion criteria significantly affect selection bias, equipoise is lacking (most anaesthetists think one or other technique is 'best') and recruitment to follow up is complex [11]. Instead, with the advent of 'Big Data', regional and national observational studies have been conducted, but have so far failed to find consistent benefits of one technique over another, at least in terms of mortality [1, 8, 12].

7.4.1 General or Spinal Anaesthesia?

General anaesthesia involves the administration of narcotic and hypnotic anaesthetic agents that render a patient unconscious for the duration of surgery. The patient requires airway support, regardless of whether they are allowed to breathe spontaneously or are paralysed and their lungs ventilated artificially.

Spinal anaesthesia is effectively a reverse dural tap, in which 1–3 mls of local anaesthetic (usually bupivacaine) is injected through a fine bore needle into the subarachnoid cerebrospinal fluid in the lumbar region, providing analgesia, akinesia

and anaesthesia below the umbilicus for several hours. Additional sedation is usually administered, either as a bolus or continuously.

Recent meta-analyses, RCTs and large observational studies report conflicting results about whether mortality is lower after general or spinal anaesthesia [1, 8]. However, there is greater consensus in terms of postoperative morbidity and cost, favouring spinal over general anaesthesia. Anecdotally, anaesthetists would prefer to have spinal anaesthesia themselves if they needed hip fracture surgery, orthogeriatricians report better patient recovery after spinal anaesthesia, and physiotherapists report easier patient remobilisation after spinal anaesthesia.

However, of greater relevance than whether spinal or general anaesthesia is better for patients is how well that anaesthesia is delivered. Although there are theoretical and experimental reasons for avoiding general anaesthesia (and sedation) in the elderly, the effect of these is seemingly small compared to numerous other adverse effects of anaesthesia and surgery, including hypotension, pain and analgesia, hypoxia and anaemia. Instead, anaesthetists should focus on careful monitoring of patients during surgery and the provision of appropriate interventions to normalise physiology, for example, fluid and vasopressor therapy, depth of anaesthesia/cerebral oxygenation monitoring.

Future research needs greater focus on early postoperative outcomes that are more anaesthesia-specific, such as pain, hypotension and delirium, and clear definition of the anaesthetic techniques compared (for example, self-ventilating general anaesthesia + nerve block vs. opioid-free spinal anaesthesia + local anaesthetic infiltration without sedation).

7.4.2 Peripheral Nerve Block

Peripheral nerve blockade (fascia iliaca, femoral nerve, lumbar plexus blocks, or local anaesthesia infiltration) should always be administered with either general or spinal anaesthesia, as part of a multimodal analgesia protocol that aims to minimise opioid co-administration [5, 13, 14].

Intraoperatively, fascia iliaca blocks are probably the technique of choice, as they provide analgesia of both the hip and surgical incision site, without dense blockade of the femoral nerve, which can be prolonged and impair remobilisation. Administered beforehand, a fascia iliaca or femoral nerve block can reduce sedation requirements when positioning patients laterally for spinal anaesthesia administration, and precludes the need to co-administer subarachnoid opioids, which can cause itching, respiratory depression and urinary retention postoperatively.

Co-administration of peripheral nerve blockade beforehand reduces age-adjusted maintenance doses of general anaesthesia.

7.4.3 Spinal Anaesthesia

The aim of spinal anaesthesia is to achieve unilateral blockade on the operative side to a sensory level of ~$T_{10–12}$ for ~2 h maximum operating time, whilst avoiding

excessive hypotension related to spinal-induced sympatholysis. This can be achieved using opioid-free 1–1.5 mls subarachnoid 0.5 % hyperbaric bupivacaine [15], but this dose is administered to less than 20 % of patients receiving spinal anaesthesia. Instead, anaesthetists commonly administer in excess of 2 mls 0.5 % bupivacaine [12, 16], which is associated with greater relative falls in blood pressure from pre-spinal baseline and a wider range of blood pressure reductions compared to lower doses, changes which can persist into the early postoperative period and prevent patients from sitting out of bed or standing up after surgery.

Orthogeriatricians have an important role in encouraging anaesthetists at their institutions to use lower doses of spinal anaesthesia.

7.4.4 Sedation

Similarly, orthogeriatricians have a role in encouraging anaesthetists to consider using less, or no, sedation during spinal anaesthesia.

Commonly, patients co-administered spinal anaesthesia and peripheral nerve block sleep through surgery, because the relative narcotic effect of preoperative opioids increase when pain is alleviated during spinal anaesthesia, and patients are often sleep deprived from the night preceding surgery.

If patients request sedation, or sedation is necessary for patient comfort and immobility during surgery, then the minimum amount should be used for the shortest time, to avoid accumulation and sedation in the postoperative period.

Several papers have shown that sedative infusions result in general anaesthesia (without airway support) in a significant proportion of hip fracture patients [17], and so sedation may better be limited to small bolus administration of during key periods of surgery (sawing, hammering, relocation). Depth of anaesthesia monitors should probably be used to guide sedation if infusions are to be administered.

Theoretically, propofol is the sedative of choice, as it is metabolised rapidly, its metabolites are inert (unlike midazolam) and it does not cause prolonged cognitive impairment (unlike ketamine). There is no evidence supporting the use of combinations of sedatives, even though this is common practice.

7.4.5 General Anaesthesia

Older patients are sensitive to the cardiovascular effects of general anaesthesia (negative inochronotropicity and peripheral vasodilation). Hypotension is more common during general anaesthesia compared to spinal anaesthesia, but decreasing the amount of inhalational or intravenous anaesthetic agent administered during surgery can reduce its prevalence. Moreover, compared to younger patients, the elderly require lower doses of drugs to maintain anaesthesia, particularly when a peripheral nerve block is administered preoperatively.

Minimising hypotension while maintaining anaesthesia without awareness can be achieved using depth of anaesthesia monitors (for example, bispectral index

(BIS) and E-Entropy), and it has been recommended that these be used during any type of general anaesthesia in older patients [5]. Alternatively, a Lerou nomogram can be used to adjust inhalational anaesthesia agent dose for age, or age-adjusted doses programmed into a total intravenous anaesthesia syringe pump.

One of the enduring debates among anaesthetists concerns whether the airway of a hip fracture patient administered general anaesthesia should be supported using a laryngeal mask airway, thereby avoiding the pathophysiological effects of mechanical ventilation, or should be intubated, to avoid the risk and consequences of aspiration pneumonia. Respiratory failure is significantly more prevalent after general compared to spinal anaesthesia, and use of paralysing agents is dose-dependently associated within an increased risk of postoperative respiratory complications, but it remains unclear whether hip fracture patients benefit more by avoiding aspiration or by avoiding mechanical ventilation.

7.4.6 Avoiding Ischaemia

Both general and spinal anaesthesia are associated with a high prevalence of hypotension during anaesthesia for hip fracture surgery, general more so than spinal anaesthesia, and postoperative mortality correlates with increased relative fall in blood pressure [12]. Hypotension can be predicted, and ameliorated by administering less anaesthesia, monitoring blood pressure closely, avoiding preoperative dehydration, and administering fluids and vasopresssors appropriately.

Hypothetically, avoiding hypotension should reduce the prevalence of postoperative complications related to organ ischaemia, such as confusion/delirium [18], dysrhythmia, acute kidney injury and poor remobilisation. Ischaemic complications may further be attenuated by ensuring adequate postoperative oxygen saturations (for example, by providing (nasal) oxygen if $SpO_2 <= 95\,\%$), avoiding excessive anaemia (for example, by measuring blood haemoglobin concentration immediately after surgery and on day 1, and considering transfusion) and providing adequate pain relief (to reduce oxygen consumption). Note that simply reducing anaesthetic dose reduces the prevalence of hypotension, requiring reduced fluid administration, in turn causing less dilutional anaemia, and so, in combination with additional peripheral nerve blockade, less ischaemia.

7.4.7 Bone Cement Implantation Syndrome (BCIS)

BCIS describes a complication occurring during surgical instrumentation and/or cementing of the femoral canal, and is characterised by cardiorespiratory compromise/arrest. It occurs in about 20 % of hip fracture operations in which cement is used, and results in cardiopulmonary arrest in about 0.5 % [16, 19].

The AAGBI, British Geriatrics Society and British Orthopaedic Association have recently published multidisciplinary guidelines highlighting the need for joint decision-making, team working and attention to detail during the peri-operative period [20].

Of particular importance is the need to identify patients who are at higher risk of BCIS, including those who are very elderly, male, taking diuretic medication and have comorbid cardiorespiratory disease (particularly acute lung pathology).

Compared to uncemented prostheses, the use of cemented prostheses for hip fracture repair increases the likelihood of pain-free mobility after surgery and reduces the risk of re-operation. However, the guidelines recommend that surgeons, anaesthetists and orthogeriatricians discuss preoperatively whether the benefits of using a cemented prosthesis outweigh the risk of BCIS.

7.4.8 Standardisation of Anaesthesia

Clinical outcomes and other measures of care quality have gradually improved in the UK after hip fracture repair over the last decade. This has resulted from the general standardisation of care, with payments to hospitals for care supplemented by a bonus if they can show that defined care targets were met ('payment by results'). Conspicuously absent are targets related to anaesthesia which, combined with an ongoing lack of research evidence and lack of formal professional training in how to anaesthetise hip fracture patients, has meant that there continues to be wide national variation in anaesthesia practice for hip fracture [1, 2, 12, 16].

Of course, a lack of standardisation may not matter – anaesthesia may have little effect on outcome after hip fracture – but this is unlikely to be the case, given that anaesthesia is administered at the most critical phase of a patient's recovery after hip fracture and has an immediate effect on the trajectory of recovery postoperatively.

Whilst there is some evidence supporting the use of protocolised rather than physician-individualised care (eg Enhanced Recovery After Surgery (ERAS) programs), there is no evidence supporting physician-individualised over protocolised care.

In healthcare, standardisation is particularly beneficial when implementing evidence-based care for large numbers of patients with a similar disease process, where current treatment is costly, has poor outcomes and is recognised professionally as being of sub-optimal quality – all of which apply in hip fracture.

Standardisation ensures high reliability, consistent, cheaper, higher quality care for the majority of patients, and – importantly – that the basics of care are not overlooked. Furthermore, standardisation enables monitoring and continuous improvement by amending standards in an evidence-based fashion, reductions in artificial variations in care (caused by slips, lapses or lack of knowledge) whilst improving focus on natural variation in care (caused by differences between patients) and identification of consistently poor performance, areas for future research and educational needs.

Standards for anaesthesia are currently available online (www.hipfractureanaesthesia.com), based on best available current evidence and consensus opinion, describing the rationale behind their formulation and identifying areas for further research. As developed, these standards also provide a method of understanding why individual anaesthetists have deviated from standard practice.

Orthogeriatricians are encouraged to engage anaesthetic colleagues in following these standards, undertaking research in improving them further and engaging in continuous quality improvement cycles, with the aim of optimising care in the critical early postoperative period. This is a mutually co-operative process, as anaesthetists and orthogeriatricians should also work together to measure and monitor pre-operative care, with the aim of optimising the patient pathway from fracture to early surgical fixation.

7.5 Postoperative Care

Much of anaesthetic involvement in the postoperative phase has been described above. Irrespective of whether the patient has been administered general or spinal anaesthetic (with/without sedation), the orthogeriatrician should expect to receive a patient back on the acute orthopaedic ward/hip fracture unit who is immediately ready for re-enablement (resuming activities of daily living) and suitable for rehabilitation to their former place of residence.

The 2012 AAGBI guidelines detail the management of common early postoperative complications, including pain, oxygenation, fluid balance, and delirium [5]. These are essentially continuations of the primary aims of anaesthesia in the hip fracture population, namely the avoidance of 'ischaemia' through appropriate pain, blood pressure, oxygen, fluid and blood management, so that the consequences of 'ischaemia' – delirium, heart pump or rhythm disturbance, acute kidney injury, delay in remobilisation – are avoided.

Gut disturbances are common after hip fracture surgery and often overlooked. Nausea and vomiting delay resumption of oral feeding. Constipation occurs in the majority of patients, particularly those who are dehydrated, not eating or dehydrated. Malnutrition is common especially in frail patients and the cognitively impaired and close attention to dietary intake is essential to patients' re-enablement.

The role of high dependency or intensive care remains uncertain after hip fracture. Certainly, it is never ethically justified to deny access to these facilities based on a hip fracture patient's age, and in any other group of patients with a similar 30-day postoperative mortality (or indeed mortality >1 %, for example, patients requiring emergency laparotomy), critical care facilities are much more routinely accessed. Indeed, planned admission is important in patients with a pre-operatively identifiable need for single/dual system support postoperatively, when this cannot be achieved to the same degree on an acute orthopaedic ward. For example, patients with COPD, acute lung injuries (infection, embolism) and acute left ventricular failure will benefit from critical care. Patients for whom critical care admission is planned have good outcomes compared to patients for whom critical care admission is unplanned, but this reflects the likely occurrence of intraoperative complications such as bone cement implantation syndrome, on table cardiac arrest or cerebrovascular accident, or massive haemorrhage.

However, adopting systems of orthogeriatric care allows a greater number of elderly patients with comorbidities to receive 'acute' medical care on acute orthopaedic wards after hip fracture surgery, rather than taxing precious critical care resources. Furthermore, orthogeriatric services are able to co-ordinate step down care, reducing the duration of critical care admission. Having managed the patient pre-operatively, orthogeriatricians may have a more pragmatic approach to *normalising* patients back to their previous physiological condition, in comparison to the more critical care approach of *optimising* organ function, although this assertion requires further research.

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Post-operative Management

8

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Older adult hip fracture patients presenting with a high degree of comorbidity and fragility are particularly vulnerable and are therefore at increased risk of subsequent complications. These patients, characterised by a high clinical and functional complexity, require a multidisciplinary approach. The main goals of the post-operative phase are early mobilisation and prevention of complications. To achieve these goals geriatric competencies are essential along with a well-coordinated team, sharing aims and protocols.

8.1 Orthogeriatric Models of Care

There are several orthogeriatric models developed to improve functional and clinical outcomes after hip fracture in elderly patients (Fig. 8.1) [1, 2]. All these models are based on the collaboration between the orthopaedic surgeon and the geriatrician, differing primarily on the healthcare professional that retains the responsibility for the management of the patients throughout the healthcare pathway. The more complex and sophisticated services, characterised by a multidisciplinary approach, have been demonstrated to produce better outcomes compared to the traditional or simplest ones. The early experiences were characterised by the presence of a geriatric consultant team having weekly or more frequent rounds to give recommendations and monitor treatment plans. The members of this team were usually not integrated and/or coordinated with the orthopaedic staff, and did not share their opinions and choices. Overall responsibility of the care was under the orthopaedic surgical staff. The

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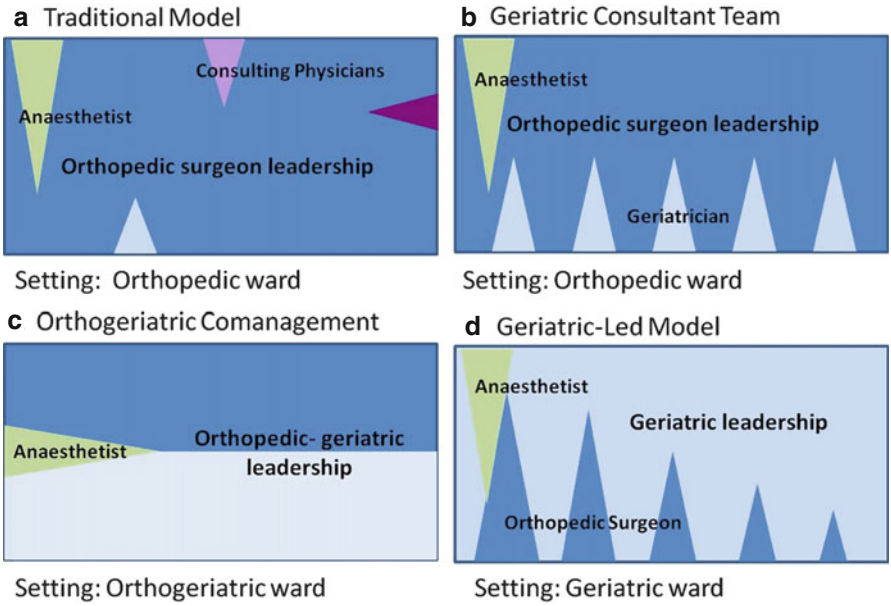

Fig. 8.1 Four models of in-hospital management of hip fracture elderly patients, characterised by an increasing involvement of the geriatrician and a decreasing participation of the orthopaedic surgeon. (**a**) Traditional Care in the Orthopaedic Ward: the surgeon is responsible for the overall healthcare, including medical queries, and different physicians may see the patient as consultants. (**b**) Geriatric Consultant in the Orthopaedic Ward: the overall responsibility of the healthcare pathway is under the orthopaedic surgical staff, but geriatrician assess the patients daily, preventing and managing complications. (**c**) Orthogeriatric Co-Managed Care: The orthopaedic surgeon and geriatrician share responsibility and leadership from admission to discharge. (**d**) Geriatric-Led Model: Patient is admitted to the Geriatric Ward and is under the leadership of the geriatrician; the geriatrician, orthopaedic surgeon and anaesthesiologist manage the patients together in the peri-operative phase; in the post-operative phase, the orthopaedic surgeon is a consulting physician that follows the patients until complete wound healing

implementation of a Geriatric Consultant in the Orthopaedic Ward model was shown to add some small benefits to the traditional model of care, by reducing the length of in-hospital stay and the number of medical complications, only when the multidisciplinary team was involved early in the process of care. These improvements were probably related to a quicker identification of common issues and complications. The main limitation of the Geriatric Consultant model is that it is not suitable for the fast track that distinguishes the current pathway of care for hip fracture older adults.

The Ortho-Geriatric Co-Managed model of care has evolved over the last 15 years with gradual improvements added with time, and it is now the most popular model worldwide. Basically the orthopaedic surgeon and the orthogeriatrician (a geriatrician skilled in the management of older adults with orthopaedic issues) share responsibility and leadership from admission to discharge. The traditional roles are maintained, with the orthopaedic surgeon assessing the trauma and fracture site and managing the fracture, and the geriatrician facing clinical issues, promoting early

mobilisation, coordinating discharge, and, assessing the risk of falls and further fractures. However decisions regarding surgical fitness, optimal timing of surgery, clinical, functional and discharge targets are generally shared. An interdisciplinary team including several healthcare professionals (anaesthesiologist, physiotherapist, clinical nurse, nutritionist and social worker) supports this co-direction. In the short-term, the Ortho-Geriatric Co-Managed Care model has been shown to reduce length of in-hospital stay, time to surgery, in-hospital complications and in-hospital mortality, compared to the traditional model [3–5].

More recently, Geriatric-Led Fracture Services, where the geriatrician is the primary attending physician for all patients from hospital admission to discharge, have been implemented. An interdisciplinary team, including different healthcare professionals, is integrated in these services, participating in the care of the patients. Particularly in the post-operative phase, the most relevant needs of elderly hip fracture patients are generally related to medical or geriatric issues, therefore, the contribution of the orthopaedic surgeon is limited and he/she could be involved as a consultant. For these reasons, this geriatrician-led model of care could be more advantageous in terms of cost-effectiveness [6]. An early experience of Geriatric-Led Fracture Service has been implemented at the Sheba Hospital in Tel Aviv in 1999 [7]. This experience is quite unique since the patient is managed throughout the acute and post-acute rehabilitative phases in the same setting under the responsibility of the geriatrician, with an overall high length of stay. In most recent experiences, patients are usually admitted to a dedicated Geriatric Ward directly from the Emergency Department [8] or immediately after surgical repair [9] and are early transferred to a rehabilitation setting, with the attention focused on reducing the time to surgery and acute in-hospital stay.

8.2 Early Mobilisation

The evidence supporting the beneficial effects of early and accelerated mobilisation after hip fracture are actually few, deriving from small studies, but they are substantially consistent. On the other hand, short- and long-term immobilisation is implicated in the pathogenesis of relevant clinical complications such as thrombosis, pneumonia, respiratory failure, and pressure sore. Therefore, shortening the time of bed rest contributes to reducing these complications as well as orthostatic hypotension and delirium [10]. Thus, early mobilisation including standing and ambulation within the first post-operative day is now a standard of care in the management of hip fracture patients. Early mobilisation impacts also the long-term functional status and improves the likelihood of achieving full recovery of ambulation [11]. Although pre-fracture functional status and baseline characteristics of the patients are the main predictors of functional and ambulation recovery after hip fracture, the mobility achieved in the first post-operative days is also related to long-term functional outcomes. Therefore, an intensive rehabilitative intervention, starting early after surgical repair, should be recommended in all hip fracture patients, albeit good quality studies demonstrating its efficacy are still lacking. Cumulated Ambulation

Score (CAS), which measures the ability to get in and out of bed, rise from a chair and walk around indoor with walking aid during the first three post-operative days, is a simple and reliable test that could be used to assess early mobility [10].

Achieving the goal of early mobilisation requires a stable surgical repair that allows the patient to bear weight as tolerated, as well as effective pain control and fluid management protocols that ensure volume adequacy and avoid orthostatic hypotension. With rehabilitation programmes addressing all critical issues of the post-operative phase, almost 80 % of subjects, able to walk before fracture, achieve the ability to walk with aids within the first two post-operative days [12]. As previously noted, adequate pain management and avoidance of post-operative hypotension prevention play a key role in early mobilisation.

8.2.1 Pain Management

Standardised pain management protocols include the administration of intravenous acetaminophen every 6–8 h combined with oral or parenteral opiates. Nerve blocks (including femoral nerve or lumbar plexus block and continuous epidural block) seem more effective in reducing pain during rehabilitation [13] and could offer advantages in early mobilisation. When comparative studies investigating the effects of opiate and regional nerve blocks on pain at rest have been undertaken, no significant differences were found. However, regional nerve blocks have been demonstrated to reduce opiate consumption, which has been associated with several adverse effects in elderly patients. Adequate pain management interventions are essential to ensure that patients are able to recover their functional abilities. In the peri-operative period, pain levels should be regularly checked, in order to ensure that the patient is feeling comfortable whether in bed, sitting, or standing.

8.2.2 Post-operative Hypotension and Fluid Management

Irrespective of the type of anaesthesia, a significant drop in blood pressure can take place early in the post-operative phase, with a further drop occurring while the patient is taking part in rehabilitation, during weight-bearing and in the standing position. In some cases, this may produce symptomatic hypotension, reducing participation in rehabilitation. Several factors may contribute to post-operative hypotension in older adults. These include:

- the effect of ageing that decreases the ability to compensate and maintain pressure homeostasis when the body is stressed,
- anaemia due to acute blood loss,
- dehydration secondary to poor oral intake of fluids,
- the effects of anaesthetic agents,
- the side effects of drugs frequently used in the post-operative phase (e.g., opiates and antiemetics).

Strategies for preventing post-operative hypotension include medication adjustment and fluid management. All antihypertensive drugs should be checked and stopped, starting in the pre-operative phase, with the exception of beta-blockers and those with rebound effects like clonidine. Beta-blockers should be continued during the peri-operative phase, however their use is no longer recommended in naive patients, as suggested by earlier studies since, although the pre-operative introduction of beta-blockers can reduce myocardial complications, it may increase the rates of stroke and mortality, possibly due to hypotension [14]. Antihypertensive drugs discontinued before surgical intervention should be resumed in the post-operative period based on the clinical status and blood pressure values. In some cases, it may be advisable to resume these pharmacological agents only after discharge.

Isotonic intravenous fluids are recommended during the pre-operative, intraoperative and post-operative phases. During surgery, the anaesthetist administers intravenous fluids, on the basis of his clinical judgement and according to clinical signs (e.g., heart rate and blood pressure). In the post-operative phase, the administration of about 1.5–3 l of crystalloids is usual practice to attain and maintain intravascular volume [15]. Nevertheless, fluid management should be tailored and individualised, considering vital signs, oral fluid intake and cardiovascular status. In general, even patients with acknowledged ventricular dysfunction benefit from intravascular volume restoration, since the risk of dehydration and hypotension are likely to exceed the risks of excessive volume administration. The only exceptions are:

- patients with severe renal failure or on dialysis that require a cautious and controlled fluid administration, and the control and measurement of fluid balance
- patients with severe heart failure or previous episodes of acute pulmonary oedema.

8.3 Post-operative Medical Complications

In older adults, medical complications after hip fracture repair are very common and may significantly affect outcomes, by increasing length of stay, delaying recovery or even influencing long-term outcomes. Major complications affect about 20 % of hip fracture patients [16, 17] but up to 50 % of patients may require pharmacological interventions due to clinical issues arising during the first post-operative days (Fig. 8.2). The predominant causes for short-term mortality after hip fracture are infectious and cardiac diseases [18]. In some cases, in-hospital complications are strongly related to prevalent and pre-existing organ dysfunction. For example, cardiovascular diseases may predispose patients to acute heart failure, while chronic lung diseases may increase the risk of chest infections [16]. Different scores have been proposed to predict the risk of post-operative complications after hip fracture. Indeed, patients with the highest pre-fracture comorbidity and disability are those at greater risk of developing clinical complications postoperatively [19]. Therefore,

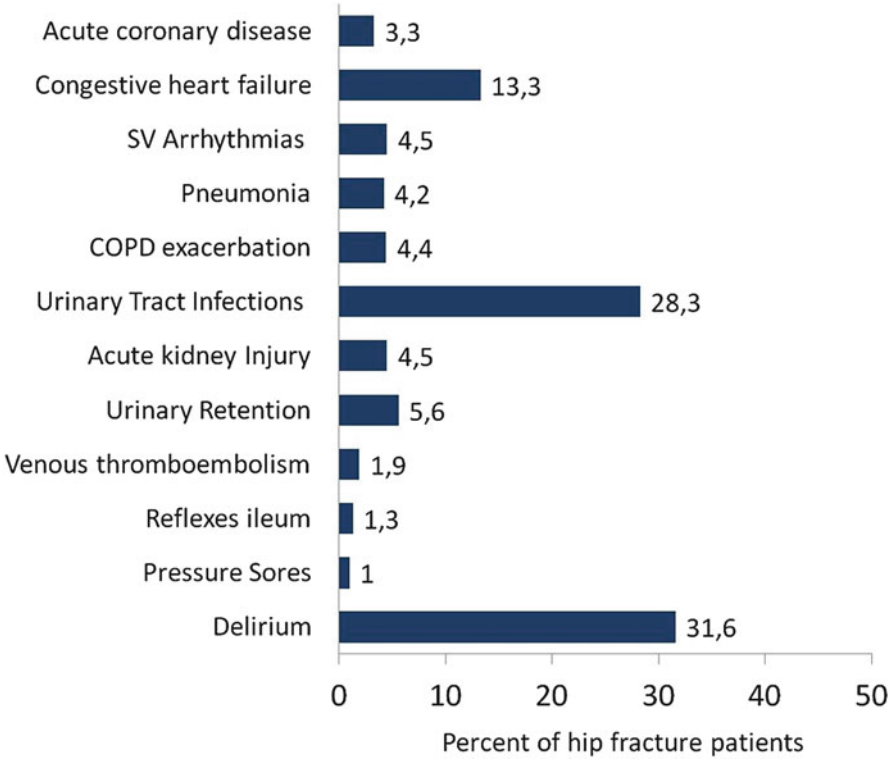

Fig. 8.2 Rate of post-operative medical complications (Data refer to a cohort of 930 consecutive patients admitted to ASMN Hospital (Reggio Emilia, Italy) over 3 years (2012–14). Irrespective of the severity of the complication, about 50 % of patients required some pharmacological treatment due to medical issues)

patients characterised by a higher degree of comorbidity and vulnerability should be strictly monitored during the post-operative days, with attention particularly focused on signs and symptoms of cardiovascular disturbance or infections.

8.3.1 General Measures to Prevent Medical Complications

8.3.1.1 Early Intervention

Several studies found an association between surgical delay and the risk of complications [17, 18], and one meta-analysis reported a significantly reduced incidence of pneumonia and pressure ulcers in patients undergoing surgery within 24–48 h from admission [20]. Therefore, time to surgery appears to be one of the most influential and potentially modifiable risk factor for post-operative complications. In this context, implementing the practice of early surgery in frail older people with pre-fracture functional impairment represents one of the best strategies to improve overall outcomes [21].

8.3.1.2 Standardised Approaches and Protocols in the Post-operative Phase

In the post-operative phase, a number of issues should be regularly checked, and all patients should undergo standardised procedures. The best way to face the complex needs of older adults presenting with hip fracture, to improve the quality of the interventions, to minimise errors and omissions, and to reduce post-operative complications is to:

- define check lists, individualised for each healthcare professional, that should drive healthcare decisions
- standardise and implement specific protocols for the most common issues

Tailored and individualised interventions based on patients' characteristics, specific needs or clinical instability should be an integral part of daily healthcare, but the overall post-operative management should be as highly standardised as possible. In this context, protocols, based on the best available evidence, must be developed, shared and implemented by the multidisciplinary team, taking into account local resources. A minimum set of standardised protocols that should be implemented in the orthogeriatric setting include the following

- prophylaxis of venous thromboembolism
- antibiotic prophylaxis
- urinary catheter utilisation
- pain control
- skin care and provision of air-filled mattresses
- constipation and stool impaction prevention
- delirium prevention
- post-operative haemoglobin monitoring and blood transfusions
- malnutrition detection and correction
- monitoring of vital physiological parameters
- providing supplemental oxygen when appropriate
- early mobilisation.

In addition, depending on the clinical status, intravenous therapies should be replaced by oral formulations as soon as possible.

8.3.1.3 Caloric Supplementation

Routine nutritional assessment should be a standard procedure in the management of older hip fracture patients, as some of them may be already malnourished on admission. In addition, many patients may undergo a deterioration of their nutritional status during hospital stay, due to increased energy expenditure related to metabolic stress, and to reduced food intake related to lack of appetite, nausea and psychological factors. It has been estimated that, in the post-operative period, a quarter of patients consume less than 25 % of meals offered by hospital, and about half of patients consume between 25 % and 50 % of meals [22]. Several studies have

linked protein and energy malnourishment with adverse clinical outcomes in the acute setting. The negative effects of undernourishment include muscle wasting and weakness, impaired mobility, pulmonary complications, pressure ulcers, and impaired immune response, further predisposing to increased post-operative infections and mortality [23]. Irrespective of pre-fracture functional status, patients with a post-operative dietary intake less than 25 % have a higher number of complications [22]. Oral nutritional supplementation may be a suitable approach to enhance energy and protein intake. A recent meta-analysis concluded that oral nutritional supplementation in elderly patients after hip fracture surgery promotes early rehabilitation, reduces complications and decreases infection rate [24]. Given the difficulty many patients experience in meeting energy requirements in the early post-operative phase, even patients who were normally nourished pre-fracture may well benefit from oral nutritional supplements [25]. Finally, more aggressive nutritional interventions, such as tube feeding or parenteral supplies, should be reserved only for patients with a low level of consciousness or to malnourished patients unable to eat.

8.3.1.4 Management of Postsurgical Anaemia

Post-operative anaemia is extremely frequent, related to blood loss during surgical procedure and haemodilution, and is associated with reduced ambulation and functional independence. Recent guidelines based on randomised-controlled trials [26] recommend a restrictive threshold for transfusion, not greater than 8 g/dl of haemoglobin, in post-operative patients. It has been suggested that blood transfusions may be harmful to patients, by reducing the recipient's immune response and thereby increasing the susceptibility to infections [27]. However, transfusion protocols should be based also on other clinical features of patients. Particularly, the presence of cardiac or renal diseases, a low pre-injury haemoglobin level, or specific abnormalities of vital signs may influence the decision to transfuse despite a haemoglobin value greater than 8 g/dl. For instance, a more liberal transfusion strategy has been shown to increase overall survival patients from residential nursing homes [28].

8.3.1.5 Vitamin D Supplementation

A high proportion of hip fracture patients present with vitamin D deficiency [29] at the time of fracture. Hypovitaminosis D has been related to increased risk of post-operative medical complications [30] and poor functional recovery [31]. Thus, optimisation of the vitamin D level should start early after admission.

8.3.2 Prevention and Management of Specific Complications

8.3.2.1 Delirium

Delirium is a common complication that affects about one third of elderly hip fracture patients in the peri-operative period. It has a detrimental effect on functional and clinical outcomes, producing longer length of hospitalisation and slow and incomplete recovery. It is still not clear if delirium may affect long-term survival or

recovery [32]. Hyperactive delirium may be easily diagnosed, being characterised by psychomotor agitation, interfering with patients' care and safety. On the other hand, the hypoactive variant, characterised by a decreased level of consciousness and apathy, may be grossly under-diagnosed. It should be acknowledged that some patients may present with a mixed variant of delirium, fluctuating between hyperactive and hypoactive states. Therefore, all patients must be daily screened and assessed, starting in the first post-operative day, using standardised tools. Both the geriatric nurses and the physicians should be involved in the early detection of delirium.

Patients at risk of developing incident post-operative delirium can already be identified at hospital admission, since a number of risk factors have been described. Pre-fracture cognitive impairment is the strongest risk factor, followed by body mass index/albumin and prevalent multiple comorbidities [33]. Delirium in the frail elderly can represent the first symptom of an underlying/undercurrent complication, such as an infection, coronary syndrome, urinary retention, constipation or dehydration. Therefore, once a patient presents with a new episode of delirium, it is absolutely mandatory to undertake a comprehensive clinical assessment, appropriate laboratory diagnostic work-up and other specific diagnostic tests.

The early detection and prompt correction of clinical/laboratory abnormalities and risk factors is probably the most effective approach to prevent delirium in hip fracture elderly patients. The preventive intervention should be multi-component, and, usually, non-pharmacological, and should include:

- monitoring of vital physiological parameters,
- avoiding of surgical delay by supporting early surgery,
- reduction of immobilisation and bed rest,
- oxygen supplementation,
- hydration,
- nutritional support,
- early detection and correction of metabolic/laboratory abnormalities,
- medication review, including restriction of drugs with anticholinergic properties.

This approach requires a multidisciplinary team and is part of the orthogeriatric model of care. This multi-component intervention has been demonstrated to decrease by 40 % the incidence of delirium compared to the traditional care approaches [34], and to be cost-effective in hip fracture patients [35]. Since pain is one of the main triggers for post-operative delirium, effective analgesia is essential in prevention strategies. Acetaminophen and nerve blocks should be preferred to opiates, which may increase the risk of delirium.

The type of anesthesia (particularly neuraxial versus general anesthesia) does not appear to affect the incidence of delirium, but deep sedation has been associated with a higher risk of post-operative delirium [36]. Thus, the use of intra-operative monitoring of depth of anesthesia and the choice of a lighter sedation are likely to be effective in reducing post-operative delirium.

Pharmacological prevention of delirium through administration of low dose of neuroleptic drugs is still a matter of debate. Current evidence does not support the routine use of antipsychotics, albeit, in some trials, they demonstrated reduced incidence of post-operative delirium, particularly in orthopaedic patients at higher risk [37].

Once delirium has occurred, it should be tackled through a multifactorial approach, not dissimilar from preventive strategies. Non-pharmacological procedures should be always implemented and exacerbating factors should be identified and addressed. In case of agitation that can hamper the healthcare or rehabilitation, or even be dangerous for patient and caregiver, pharmacological treatment with antipsychotics is usually employed. Notably, antipsychotics do not treat delirium but simply reduce symptoms. Antipsychotics should never be used in the hypoactive variant. These pharmacological agents should be used at the lowest effective dose, dosing regimens should be individualised for each patient, and, the treatment effects should be monitored daily in order to correct the dose or discontinue the therapy when appropriate. The antipsychotics commonly used are: haloperidol (0.25–2 mg oral or intramuscular), risperidone (0.5–2 mg oral), quetiapine (25–100 mg oral), olanzapine (2.5–10 mg oral). QT prolongation contraindicates all these drugs. Benzodiazepines should be avoided in patients with delirium, except for subjects with severe agitation and violent inclination in which short-acting formulation (e.g., midazolan 1–5 mg intramuscular or intravenous) may produce a rapid tranquillisation. In patients with sleep deprivation, the drug of choice is trazodone (25–100 mg oral).

Some patients experience a more subtle cognitive disorder, affecting a wide range of cognitive domains, particularly memory and executive function. This condition, dissimilar from delirium, is generally designated as post-operative cognitive dysfunction (POCD) and it may not be evident during the first post-operative days. Compared to delirium, POCD shows a less acute onset, is characterised by normal consciousness, and may last weeks to months. For an accurate diagnosis, neuropsychological testing is required but a pre-fracture evaluation is usually lacking in hip fracture patients for comparison. There are many risk factors for POCD: advanced age, pre-existing cardio-vascular disease and mild cognitive impairment. POCD is generally reversible, albeit in some patients with persistent dysfunction, the apolipoprotein E4 genotype has been found, suggesting a link with the development of dementia [38].

8.3.2.2 Cardiovascular Complications

Ischaemic heart disease and cardiac failure account for more than one third of early deaths after hip fracture [39]. The incidence of cardiac complications after hip fracture is quite variable in epidemiological studies, depending on the diagnostic criteria considered. Patients with a history of cardiac disease, stroke or peripheral vascular disease are at high risk of developing cardiac complications in the post-operative phase [40]. These subjects should be accurately monitored after surgery. In most of the cases, hip fracture patients with acute coronary syndrome or with ST elevation do not experience typical chest pain; they may present with delirium,

congestive heart failure or may even be asymptomatic. The routine measurement of troponin and ECG assessment are thus mandatory for the diagnosis. In some studies [41] troponin changes have been found in a high rate of patients without clinical symptoms or new signs of ischemia in the ECG, however, currently troponin assessment should be reserved for patients with suspicious symptoms or risk factors. In high-risk subjects, antiplatelet drugs should not be stopped preoperatively or should be re-started early after surgery.

Heart failure is another important post-operative complication, related to surgical stress, blood loss, transfusion or disproportionate fluid administration. The onset may be either typical with dyspnoea or insidious with change in functional status, reduction of food intake or delirium. Frequently, within the pre-operative drug review, diuretic agents are discontinued in order to reduce the risk of dehydration and hypotension. In patients with ventricular dysfunction, diuresis may be loop diuretic dependent. Therefore it may be advisable, in some patients, to continue, or discontinue only for a short period of time these pharmacological agents. Urine output measurement is critical for haemodynamic assessment in the early post-operative days. Oliguria could be related to either inadequate volume restoration (most frequent in the first 24–48 h after surgery) or heart and renal failure. Thus, divergent interventions, such as extra fluid or diuretics administration, require patient-specific decision-making. Measurement of the N-terminal fragment of brain natriuretic peptide (NT-proBNP) has been recently proposed to evaluate post-operative cardiac dysfunction [42], but it has a decreased specificity in elderly patients.

Supraventricular arrhythmias and, particularly, new onset or uncontrolled atrial fibrillation, are also frequent in the post-operative phase (about 6 % of patient) [43]. Hip fracture patients who develop atrial fibrillation within 7 days after surgery have a 2 times higher risk of death within 1 year compared to those who do not [43]. Atrial fibrillation may be a marker of greater vulnerability, rather than a complication primarily increasing mortality. Atrial fibrillation may cause exacerbation of heart failure, poor exercise tolerance and thromboembolic events including stroke. Beta-blockers can reduce the risk of this arrhythmia, but this beneficial effect should be balanced against the risk of drug-induced hypotension.

8.3.2.3 Infections

Fever occurs frequently during the post-operative phase, and it can either indicate the presence of an infection or be produced by a non-infective cause. Many patients show an increase in body temperature in the absence of other features indicating infection, as a consequence of peri-operative stress in response to tissue injury (usually within 2 post-operative days). For this reason, several authors warn about the risk of excessive laboratory (e.g., blood and urine cultures) or radiologic (e.g., chest x-rays) work-up being cost-ineffective and producing patient discomfort [44]. For example, blood cultures in hip fracture patients presenting with early post-operative fever, but no other indicators of sepsis, are very rarely positive [45]. On the other hand, in elderly patients with hip fracture several conditions may predispose to infection: specific comorbidities, malnutrition, and drugs or other factors compromising immune function.

Pneumonia and urinary tract infections are the most common infections, and their prompt identification and treatment is crucial, since a missed diagnosis may have severe detrimental consequences. Respiratory infections alone account for 35 % of post-operative deaths [39]. Clinical judgement, based on the presence of signs and symptoms of infections and available clinical/laboratory data, is the only guide to choose between starting a diagnostic procedure and antibiotic therapy or having a "wait and see" approach. It should be also highlighted that infections in frail older adults may occur without fever, presenting with insidious onset symptoms, such as fatigue and delirium. Although large studies are missing, serum procalcitonin level may represent a helpful diagnostic marker, supporting clinical and microbiological findings, for a more reliable differentiation of infectious fever from non-infectious fever, in early post-operative days [46]. An increased level of procalcitonin also supports the decision of starting antimicrobial therapy, and the changes in procalcitonin concentrations are established as a useful approach for monitoring the clinical response to therapy.

Pneumonia and exacerbation of chronic lung disease occur in about 4 % of elderly hip fracture patients. Several risk factors have been identified; these comprise disorders of the central nervous system, treatment with dopamine antagonists and the use of medication that reduce alertness. Measures and interventions to prevent pneumonia include:

- oral hygiene,
- control of gastroesophageal reflux,
- avoidance of excessive sedation,
- early ambulation,
- respiratory exercises improving the patient's ability to take deep breaths.

Urinary tract infection has been reported in up to the 40 % of patients undergoing hip fracture surgery, and is associated with prolonged length of hospital stay and increased incidence of delirium [47]. Urinary catheter is the single most important risk factor for this type of infection. Therefore, it should be removed as soon as possible, ideally within the first post-operative day.

Surgical site infection is the third most frequent cause of infections. It is less frequent compared to other infections, occurring in 1–2 % of patients, but is an important cause of morbidity and mortality. Preventive measures include peri-operative antimicrobial prophylaxis using cefazolin or other antimicrobial agents according to local guidelines, a number of hygiene measures minimising microbial inoculums, and clinical optimisation of the patients. Modifiable patient-related risk factors are malnutrition and uncompensated diabetes. In particular, elevated blood glucose levels in the peri-operative period increase the risk of surgical site infections, even if an exact threshold of risk has not been identified [48]. Furthermore, patients without a history of diabetes but showing stress hyperglycaemia (with glucose levels greater than 220 mg/dL) have a higher risk of surgical site infection [49]. In order to achieve and maintain a good control of glycaemia in the early post-operative phase, fast acting insulin is preferred also in those patients using oral diabetic agents before hospital admission, to limit the risk of hypoglycaemia or other metabolic derangements associated with oral diabetic agents.

8.3.2.4 Other Complications

This overview describes the overall constellation of clinical complications presenting in hip fracture older adults but, to be fully comprehensive, a number of other complications should be acknowledged (Table 8.1). Frail patients are characterised by an age-associated decline in physiological reserve and function across multi-organ systems. Thus, almost every organ is vulnerable, and hip fracture patients are at risk of multiple adverse health outcomes. Some subjects may present with a transient worsening of renal function, particularly those with

Table 8.1 Standardised procedures and prevention/management protocols to be implemented for selected medical complications in hip fracture older adults

Complication	Main goal(s)	Strategies prevention/management
Delirium	Prevention	Identify high risk patients on admission Check daily risk factors Correct (when possible) modifiable risk factors Remove delirium-causing medications Correct clinical/laboratory abnormalities Control pain limiting opiates usage Reduce immobilisation and encourage time out of bed Pharmacological prevention for patients at very high risk
	Early detection and management	Assess patient daily using a standardised tool Seek for underlying causes Remove (when possible) underlying causes Implement prevention strategies (see Prevention) Pharmacological intervention to reduce symptoms
Postoperative hypotension	Prevention	Discontinue or reduce doses of antihypertensive drugs and diuretics Limit the use of hypotensive pharmacological agents Transfuse patient according to established haemoglobin thresholds Administer isotonic intravenous fluids pre-, intra- and post-operatively
Coronary artery disease	Prevention	Check for risk factors Identify high risk patients on admission Continue anti-platelet drugs in peri-operative period (in high risk patients)
	Early detection	Check for atypical signs/symptoms of ischemia Measure troponin and ECG in patients with typical or atypical signs/symptoms Monitor troponin regularly in high risk patients
Heart failure	Prevention	Continue beta-blockers Continue loop diuretics if possible (alternatively discontinue them shortly and resume rapidly) Manage fluid administration carefully checking pulmonary status and for early signs/symptoms of acute failure

(continued)

Table 8.1 (continued)

Complication	Main goal(s)	Strategies prevention/management
Pneumonia	Prevention	Nutritional supplementation Avoid excessive sedation Maintain adequate oral hygiene Control of gastro-oesophageal reflux Detect swallowing disorders and modify food consistency Early surgical repair and ambulation
	Early detection	Check daily for typical and atypical signs/symptoms Laboratory tests and/or chest x-rays in patients at high risk or with clinical signs/symptoms Measure procalcitonin in selected high risk patients
Urinary tract infection	Prevention	Remove urinary catheter within the first postoperative day Optimise diabetes control
	Early detection	Check daily for typical and atypical signs/symptoms Laboratory tests and/or urine culture in patients at high risk or with clinical signs/symptoms Measure procalcitonin in selected high risk patients with signs/symptoms of urinary sepsis
Surgical site infection	Prevention	Peri-operative antimicrobial prophylaxis according to guidelines Hygienic measures in the operating room Hygienic measures in the management of surgical site minimising the risk of microbial inoculums Improve malnourishment with nutritional supplememtation Optimise diabetic control maintaining glucose level < 220 mg/dl
Acute kidney injury	Prevention	Identify patients with chronic kidney disease on admission Monitor peri-operative glomerular filtration rate Manage fluid administration preventing dehydration and volume overload Avoid nephro-toxic drug use, including NSAID and certain antimicrobial agents
Urinary retention	Prevention	Avoid anticholinergic medications Manage constipation Early detection and prompt treatment of urinary infection Promote early mobilisation

Table 8.1 (continued)

Complication	Main goal(s)	Strategies prevention/management
Constipation	Prevention	Promote early mobilisation Use laxative when appropriate and following a shared protocol Limit the use of pharmacological agents causing constipation, including opiates
Pressure ulcers	Prevention	Use special beds and equipment to relieve pressure in patients at risk Improve malnourishment and use nutritional supplements Reduce time to surgery and promote early mobilisation

prefracture impairment of glomerular filtration [50]. The appropriate management of fluid input and output may prevent both prerenal acute kidney injury and volume overload. Nephrotoxic drug use, including NSAID, must absolutely be avoided in order to reduce the risk of acute kidney injury. A close monitoring of renal function in the early post-operative days should be undertaken, bearing in mind that creatinine level overestimates glomerular filtration rate due to the age-related loss of skeletal muscle mass. Estimation of kidney function with the Cockcroft-Gault method may be useful, being more accurate. Electrolyte imbalances, especially hyponatremia and hypokalaemia, are described frequently, and should be promptly corrected.

Urinary retention is common among hip fracture patients, and is related to urinary infection, prostatic enlargement in males, underlying bladder dysfunction (e.g., from diabetic neuropathy) and opiate use. Some studies suggest that removal of an indwelling catheter too early could favour urinary retention [51]. However, to prevent urinary infections and promote early mobilisation, indwelling catheters should be removed as soon as possible and, if necessary, patients should be managed through voiding methods, including intermittent catheterisation.

Common gastrointestinal complications after hip fracture surgery include dyspepsia, constipation and paralytic ileus. Preventive strategies for constipation include laxatives, increased fluid intake, increased dietary fibre intake, and appropriate mobilisation. Post-operative upper gastrointestinal stress ulcer bleeding has been documented in up to 4 % of patients [52], especially in those with a previous history of gastroduodenal ulcer. Treatment with proton pump inhibitors is therefore indicated in the peri-operative period.

The incidence of pressure ulcers is still around 5–7 %, even with the widespread dissemination of nursing protocols, based on aggressive skin care and on the use of special bed equipment to relieve pressure. A short time to surgery, early mobilisation and protein-caloric supplementation are important strategies reducing the occurrence of pressure ulcers.

8.4 Final Remarks

The management of elderly patients with hip fracture in the post-operative phase requires a comprehensive orthogeriatric approach. Frailty and comorbidity in combination with the hip fracture and surgical repair procedures lead the patients to a vulnerability that cannot be managed by traditional care models. Currently, the orthogeriatric management for patients presenting with a fragility fracture is the standard of care, all over the world, in order to prevent complications, where possible, or manage them appropriately when they occur. This innovative model of care has also demonstrated a significant reduction of length of hospital stay [53]. Recently, some authors raised concerns about the potential detrimental effects of an excessive shortening of in-hospital stay on survival after discharge [54]. For acute conditions, such as hip fracture, healthcare needs do not cease after the acute phase, as most patients require a post-acute phase for further clinical stabilisation and rehabilitation. These patients' susceptibility to complications may last several days after surgical repair. Therefore the discharge destination should match the stability and vulnerability of the patient, his/her rehabilitation program and goals and the pre-existing level of independence, to ensure long-term positive clinical outcomes. Discharge planning based on discharge needs, patient social support, patient and family desires is a crucial point in the acute management, and it should be defined and commenced on admission, and revised in the early post-operative phase.

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The Nursing Role

9

Karen Hertz and Julie Santy-Tomlinson

9.1 Introduction

Over the past decade, the evolution of orthogeriatric specialist care has become a key feature of improvements in care delivery for patients following hip fracture. For this reason, this chapter will focus specifically on the care of the patient following fragility fracture, with a spotlight on hip fracture. It will focus particularly on how nurses can provide skilled, high quality, compassionate and age-sensitive care to meet the needs of older people whilst minimising the complications of injury, hospitalisation and surgery, facilitating rehabilitation and reducing/preventing functional decline. Many aspects of nursing care of the orthogeriatric patient are considered in other chapters, particularly Chap. 8. They will be referred to again here to ensure a comprehensive overview of the nursing role.

9.2 The Nature of Nursing

Hospitalised patients in need of orthogeriatric care have a series of highly complex health care needs, many of which can be met by skilled, compassionate nursing. The International Council of Nursing's [10] description of nursing captures some elements of orthogeriatric care: "…*encompassing autonomous and collaborative care of individuals of all ages..... includes the promotion of health, prevention of illness and the care of ill, disabled and dying people*". Nursing also includes advocacy, promotion of safety, leadership and participation in shaping health policy. In the trajectory of care for

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individuals receiving inpatient care, the unique contribution of the nursing team is that nurses spend the most time with patients. Nursing teams in both secondary (hospital) and primary (community) settings are best able to engage with individuals' and families' specific experience of immediate and subsequent care through close relationships with them. Understanding the recovery experience from the perspective of the patient enables the nursing team to plan and provide care that is holistic and patient-centred. The nursing team has an oversight of care across hours, days and sometimes weeks, enabling practitioners to act in a coordinating role within the multidisciplinary team.

Some of the individual experience of fragility fracture is illuminated in patient testimonies. Nobo Komagata [14] describes her thoughts following her own hip fracture: "*I thought that the fracture would heal in three months and that I would be able to resume my normal life after that. But it was not at all like that. I had to go through a lot more than I anticipated in terms of treatment and also psychologically*. [……] *Once I regained the mobility*, *it's easy to forget what I went through. However*, *I often look back and feel that even the ability to walk is such a great gift. I once accepted the possibility of not being able to walk on my own for the rest of my life. As I can walk again*, *I should use the gift appropriately*". Through qualitative research several authors have now been able to explore experiences which are often described as difficult and painful [2], leading to significant decrease in quality of life and fraught with restrictions and insecurity [30]. Compassionate nursing recognises this and is able to mitigate it.

Orthopaedic trauma services have historically evolved to treat all adult patients irrespective of age and following all types of musculoskeletal injury. This fails to recognise the complex needs of patients who have sustained a fracture, are older, frail and have significant co-morbidity. Such complexity requires highly skilled nursing that is tailored to the needs of the older person. Both skilled orthopaedic and elderly care nursing are essential in providing safe and effective care. Few patients find themselves nursed in the acute phase of care in specialist orthogeriatric units but, all too often, in trauma-orthopaedic wards and, in the rehabilitation phase, in general rehabilitation units or supported by standard community nursing services.

Complexity of care need is generated by multiple interlocking problems related to both breadth (range) and depth (severity) of health care need [27] related to three facets; the person, the fracture and the care environment – all of which have a significant bearing on patient care outcomes (Fig. 9.1).

The sharing of care between orthopaedic surgeons and orthogeriatricians can become fragmented and less effective if the care is not managed or coordinated effectively. Nurses are integral contributors to the orthogeriatric team [21] because of their role as care co-ordinators [8, 28]. Team coordination is often led by a specialist nurse or coordinator including; hip fracture nurse specialists, elderly/elder care nurse specialists, trauma nurse coordinators, nurse practitioners and advanced nurse practitioners.

Many nurses working in orthogeriatric settings are better prepared educationally for the care of adults with musculoskeletal problems than to meet the complex needs of older people. Multiple specialist 'orthogeriatric' nursing skills are needed as well as fundamental adult nursing skills. There is, consequently, an important education and skills gap. Competence in nursing is fluid and reflects developments in all aspects of professional practice as demonstrated in the work of Benner [4], who introduced the idea that expert nurses develop skills and understanding of care over

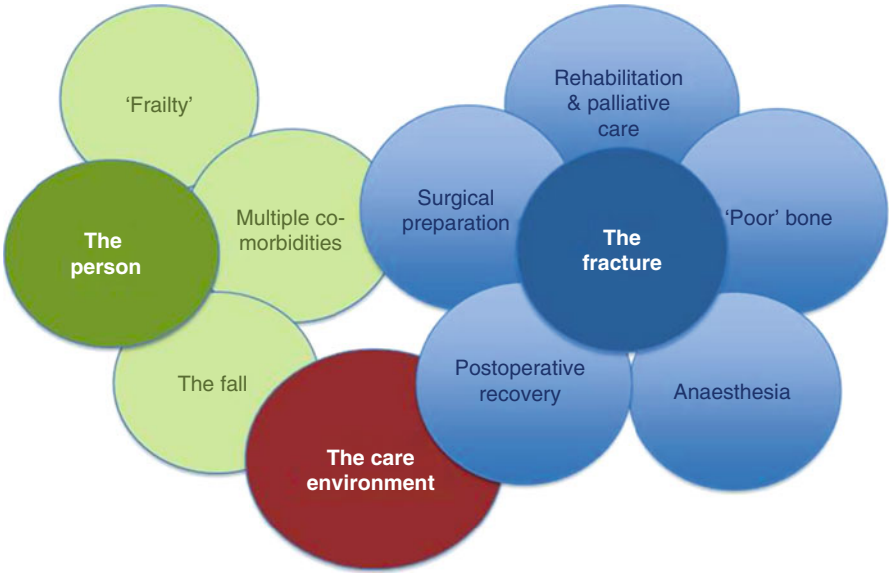

Fig. 9.1 The complexity of nursing care needs for hospitalised patients with hip fracture

time through a sound educational base as well as a multitude of experiences. The complex nursing care requirements of orthogeriatric patients means that they need to have their care led by those who are experts in the field and have an intuitive understanding of what is required. Multidisciplinary collaborative working has supported the development of advanced practice nurses (or allied health professionals) who are variously described as clinical nurse specialists, nurse practitioners or physicians' assistants. They have a variety of different skills that are complementary to the multi-disciplinary team and enhance patient care. Care should be overseen by those who are at least proficient and have several years' experience of working with older patients following fracture. Proficient nurses perceive and understand patients' care needs holistically and from individual perspectives, having learnt from their experience to know what to expect in certain situations. They oversee care provided by others who are less proficient in order to ensure its quality as well as give care themselves in order to maintain their proficiency and improve their knowledge and skills. Specialist nursing qualifications in orthogeriatric care do not currently exist, so nurses are obliged to be reflective self-led learners who are able to extend their own knowledge of both caring for patients following trauma and the complex care of older people together through reflection.

9.3 Nursing Care and Nurse-Sensitive Indicators

Quality indicators within the standards that underpin hip fracture audit have already had a significant impact on the quality of medical and surgical care. However, these currently only briefly consider nursing indicators. It is essential that indicators of

the value of nursing care are identified and ways to measure them developed. The overall contribution of health care delivery is often measured in terms of health status, outcomes, readmissions rates, length of stay, complication rates and mortality [9], but these do not necessarily help to capture the specific contribution of nursing. Length of stay, in particular, can be a misleading measure for success given concerns about decreased levels of expert nursing care when patients are discharged or transferred to less specialised settings too early.

Nursing is broad and complex and the nursing profession has traditionally had difficulty in articulating its unique benefits. Indicators of nursing care quality include nurse-sensitive patient outcomes such as patient comfort and quality of life, risk outcomes and safety, patient empowerment and patient satisfaction [9]. More specific indicators include healthcare-associated infection, pressure ulcers, falls, drug administration errors and patient satisfaction [12, 15]. Information is currently provided that relates to patient safety and seldom focuses on other aspects of clinical effectiveness and the impact on quality of care or patient experience. In orthogeriatric care a starting point might be to work on the development of nurse sensitive indicators for pain, delirium, pressure ulcers, hydration and nutrition, constipation, prevention of secondary infections and venous thromboembolism (VTE). Whilst many of these complications are discussed in other chapters, it is important to include evidence-based nursing management strategies that co-exist with medical models of care; reducing the risk of developing complications, aiming to reduce the risk of morbidity and mortality, whilst improving recovery, maintaining functional ability and improving patient outcomes and experiences. Pain management, nutrition, hydration, remobilisation, rehabilitation and motivation (Fig. 9.2) are all central to prevention of complications for patients following hip fracture and these are all nursing care priorities.

Although this chapter is concerned with nursing interventions in orthogeriatric care generally, it is impossible to ignore the fact that, of all fragility fractures, hip fracture is the most significant injury: it is the most common reason for admission to an orthopaedic ward, accounts for much orthopaedic bed occupancy and a large portion of the total cost of all fragility fractures. It is also the most expensive fracture in terms of volume and unit costs. Complexity of patient needs, prevalence, number of bed days and cost means that the focus of inpatient care tends to relate predominantly to this category of injury. However, the principal skills and knowledge needed to look after hip fracture patients well apply across the management of all older patients with fractures and include all fundamental aspects of nursing care for the adult as well as highly specialised interventions for older people [16, 17].

9.4 Pain

Pain in older people is often under-reported by patients and ignored by health care professionals. Older people are, therefore, at risk of unmanaged or undermanaged pain resulting in higher risk of delirium, impaired mobility, chronic pain and poorer long term functional ability [4]. Cognitive impairment increases the risk of pain not

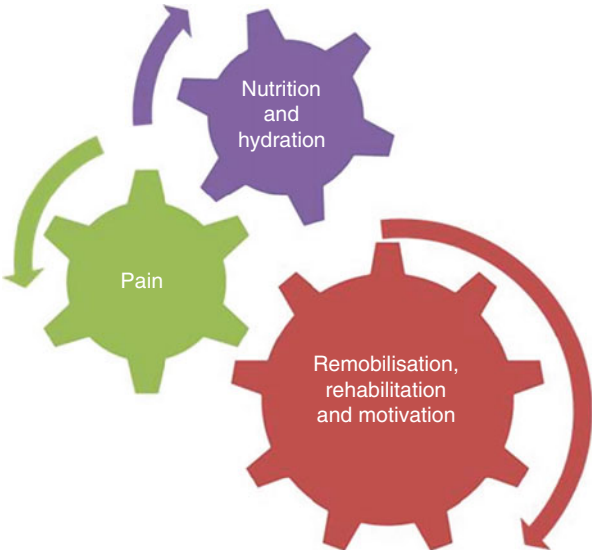

Fig. 9.2 Fundamental nursing aspects of the prevention of complications in hospitalised patients with hip fracture

being recognised. The individual and highly variable nature of pain and an individual's response to it make accurate assessment a central aspect of nursing care to facilitate individualised pain management and monitoring. Later on, if pain is poorly controlled mobilisation will be delayed, increasing the risk of the complications of prolonged immobility leading to increased dependency and associated rise in the risk of delirium.

Verbal reports of pain are valid and reliable in patients with mild to moderate dementia or delirium, but the assessment of pain in a patient with more severe cognitive impairment may be more difficult. However, many studies have shown that cognitively impaired and acutely confused patients receive less analgesia than their unimpaired counterparts. The use of an assessment tool to help staff understand the individual needs of a person with dementia such as the 'This is me' tool [1], encourages relatives and carers to share individual patient information, characteristics and behaviour that enables staff to better understand pain experience and needs. For pain assessment to be effective it must be carried out frequently and recorded accurately as an essential aspect of regular patient assessment when vital signs are being recorded, when medication is being given or when other care is being provided. The aim of pain management should be to give sufficient pain relief to allow fundamental nursing care to be performed with least distress to the patient, including changes of position, movement and transfers. Reassessment and appropriate administration of analgesia should be central to routine care.

Responsibility for managing pain varies according to the role, competence and skill level of the nurse. Every registered or licensed nurse should undertake frequent, accurate pain assessment and administer prescribed analgesia, whilst

observing its impact and any side effects and reporting these to the interdisciplinary team. As nurses become increasingly responsible for more advanced patient care interventions, non-medical prescribing will permit nurses to assess pain and to formulate a plan for pain management in collaboration with the patient, their carers and the care team. Advanced practitioners can often prescribe a range of medications including opioid and non-opioid analgesics to enable a faster response to patient needs, but this requires enhanced nursing skills. Administration of nerve blocks pre-operatively for patients with hip fracture is becoming increasingly common, with advanced and specialist nurses having a role in the administration either in the ED or in-patient units. They minimise the need for opiates, which have multiple risk factors in older and frail patients, and have been shown to have a significant positive effect on the pain experience [25].

9.5 Delirium

The nursing team spends the most time with patients so are most likely to recognise the signs of delirium discussed in Chap. 8. Good communication with patients, family and carers can help practitioners to recognise subtle changes that suggest underlying causes. If a person with delirium is distressed or considered a risk to themselves or others, and verbal and non-verbal de-escalation techniques are ineffective or inappropriate, the team should discuss with the patient and/or family medication and other methods to maintain safety such as low beds and higher levels of supervision. At-risk patients and their carers need information about delirium and what they might experience along with reporting changes and inconsistencies in behaviour to the nursing team [23].

There are a number of nursing interventions also thought to prevent delirium [23] as well as contribute to effectiveness of care from other perspectives:

- An environment that helps to re-orientate patients; large-face clocks and calendars, well-lit areas with clear signage to provide clues about the location and time of day.
- Gentle re-orientation of patients by providing introductions and explanation of location. Family and friends should be encouraged to visit as often as possible and be supported in modifying their own communication.
- Dehydration, hypoxia and constipation prevention and management.
- Supported mobilisation to enable patients to feel more in control.
- Recognition and management of infections.
- Regular assessment of pain.
- Ensure that dentures fit correctly and encourage patients to eat.
- Resolve any reversible causes of sensory impairment especially related to hearing and visual aids.
- Facilitating sleep and rest.

Many of the interventions listed represent good management of all older people so should be an integrated part of nursing care in the orthogeriatric setting.

9.6 Pressure Ulcers

Pressure ulcers are serious complications of immobility, hospitalisation and surgery and can affect up to one third of hip fracture patients [5]. Those who sustain a pressure ulcer require significantly more nursing care and have longer hospital stays with increased costs of care and greater use of health care resources following discharge [6]. Given the exceptional risk of tissue damage in patients with hip fracture, prevention and management of pressure ulcers are central to nursing care effectiveness and patient safety. Their prevention is also a largely nursing issue, although a team approach is needed to manage risk factors effectively [22].

Assessment of the skin should take place on admission followed by frequent reassessment [17]. Pressure ulcers can develop rapidly in vulnerable patients, so prompt and repeated assessment of risk using an appropriate and validated tool is central to identifying those intrinsic and extrinsic factors that may lead to pressure ulcers in individual patients. Identification of specific risk factors can then assist in planning and delivering appropriate interventions for prevention that manage or modify those factors [24]. Examples of intrinsic and extrinsic factors relating to many patients with hip fractures are considered in Table 9.1.

Prevention strategies should be individualised to the patient's skin condition and risk factors and based on assessment and planning tools and agreed guidelines and pathways [13]. Interventions should include:

- Head to toe skin assessment on each nursing shift.
- The use of pressure relieving and redistributing support surfaces on beds and chairs in the ED, intraoperatively and in ward and rehabilitation settings.
- Specific attention should be paid to bony prominences; off-loading of heels is particularly important, as these are particularly prone to deep tissue injury.
- Frequent re-positioning should be carried out based on an assessment of the individual's tissue tolerance to pressure, specifically including use of the 30° tilt to ensure off-loading of bony prominences [7].
- General skin care: careful washing and drying of the skin (especially following incontinence or significant perspiration) and the use of emollient therapy to help promote the skin barrier function and maintain skin integrity [26].
- Effective management of pain to promote movement and mobilisation.
- Nutrition and hydration support.
- Carefully selected appropriate support surfaces on beds and chairs. Foam support mattresses designed to redistribute pressure and reduce friction in patients at medium risk of pressure ulcers should be standard in all orthopaedic units. For patients with hip fractures whose risk is always high to very high, pressure reducing equipment such as alternating pressure mattresses should be used for all patients until their mobility has improved enough for them to be able to change their own position.
- Once patients begin to remobilise, the above principles should also be considered for seating and sitting in a chair for long periods avoided.

Table 9.1 Common pressure ulcer risk factors for patients following hip fracture and surgery

Extrinsic
Pressure – bony prominences – especially heels
Shear
Friction
Skin moisture
Intrinsic
Immobility
Surgery
Ageing, dry and damaged skin
Concurrent medical conditions: e.g. diabetes, cardiovascular, respiratory, neurological
Malnutrition
Dehydration

9.7 Hydration, Nutrition and Constipation

Fluid management in older people can be difficult as they may self-regulate fluid intake in an effort to control incontinence or urinary frequency and to manage difficulties in accessing toilet facilities. Close monitoring of fluid balance is an essential aspect of nursing care to prevent or identify renal injury [11] and patients' acceptance of fluids and nutritional supplement drinks is often poor. Nursing interventions to promote adequate fluid intake include:

- Accurate administration of prescribed fluids.
- Avoidance of long periods of fasting. Difficulties in ascertaining likely time to surgery and cancellations are common in many units so interdisciplinary commitment to ensuring that older patients are prioritised is essential.
- Assisting patients with oral fluids that meet patient preferences and monitoring fluid intake and output.
- Appropriate toilet signage, regular toilet assistance and other measures to enable patients to maintain continence.
- Close observation of vital signs and other indicators of health deterioration.

Nutrition is fundamentally linked to all recovery outcomes and is the responsibility of the whole care team but the nursing team is central to adequate dietary intake because of their 24-h presence in the in-patient setting. Effective communication amongst all members of the team should be aimed at maximising nutritional intake in close collaboration with patients and families. Limiting the duration of preoperative fasting is an important priority [19]. Communication infrastructure sometimes does not allow sufficient clarity of theatre scheduling to allow nurses to accurately assess the likely time of commencement of surgery and often all patients on an operating list are fasted from a specific time to ensure the safety of the first person on the operating list.

It is crucial that all staff understand the importance of adequate nutritional intake and that attention is given to helping people to eat at meal times. Routine nursing care must include an assessment of nutritional status on admission, assistance with nutritional intake following admission, nurse-based strategies to improve calorific intake and, where appropriate, referral for dietetic advice.

Constipation can be acute or chronic and is a significant but common complication for patients following fracture and during periods of ill health and immobility. Prevention should be considered early in the care pathway. Prevention of constipation from a nursing perspective should involve:

- Regular assessment of bowel function including frequency and consistency of defaecation.
- Providing and encouraging a fibre-rich but palatable diet.
- Careful but early use of prescribed aperients.

9.8 Healthcare Associated Infection

Prevention, recognition and management of infection is the responsibility of the whole MDT but is central to 24-h nursing care that often includes co-ordination of care provided by other team members. Nurses in leadership roles can be instrumental in ensuring adherence of staff to infection prevention guidelines.

9.8.1 Pneumonia

Nursing interventions aimed at preventing pneumonia reflect general effective care for the orthogeriatric patient and include:

- Universal precautions for prevention of infection.
- Adequate pain relief (with regard for lack of respiratory resilience in older people) to facilitate coughing, deep breathing and mobility.
- Early and regular mobilisation and encouraging activity out of bed.
- Awareness and prevention of aspiration risks.
- Encourage patients to sit in a chair for meals.
- Assessment of swallowing by a speech and language therapist if there are signs of difficulties.
- Provision of thickener in drinks or modified diets as appropriate.
- Monitoring of dysphagia and swallowing and cough reflexes.
- Education of family/carers about the risk of pneumonia and preventive strategies.
- Reporting of any signs and symptoms of developing pneumonia to medical staff.

Patients with pneumonia can become critically ill very quickly. Nurses need to closely monitor the patient to detect further deterioration. Adequate nutrition is central

to supporting recovery and enteral feeding may be needed whilst bearing in mind that nasogastric feeding increases the risk of aspiration. Hydration, early mobilisation, encouraging deep breathing and coughing, regular changes of position, chest physiotherapy and nebulisers to moisten secretions can also assist in recovery.

9.8.2 Urinary Tract Infection

Nursing management strategies for prevention, risk reduction and recognition of UTI include:

- Insertion and removal of catheters under aseptic conditions.
- Using a closed drainage system.
- Compliance with standard infection prevention precautions when inserting, handling and removing catheters and related equipment.
- Meticulous perineal hygiene.
- Removal of indwelling urinary catheters as soon as possible.
- Reducing the risk of dehydration by maintaining adequate fluid balance.
- Early mobilisation to reduce urinary stasis.
- Monitoring for signs of developing infection, particularly; delirium, fever and tachycardia.
- Any suspicion of infection should instigate obtaining a clean urine sample for microbiological analysis and referral to medical staff.
- Frequency of micturition, incontinence, pain or burning may be present if there is no catheter in situ; catheter-associated UTIs are often present without specific symptoms, so infection should be suspected whenever there is any deterioration in a patient's general health status.

9.9 Venous Thromboembolism

Following hip fracture there is a particularly high risk of venous thromboembolism (VTE). Whilst the prevention and medical management of VTE is considered elsewhere in this text (see Chap. 8), it is important to stress the nursing role in prevention of this common cause of preventable death. VTE risk should be assessed as part of general nursing assessment processes. This is often conducted on admission and when the patient's condition changes, using a risk assessment tool.

General nursing measures that contribute to the prevention of VTE include:

- Maintenance and restoration of mobility.
- Supporting early mobilisation and leg exercises to activate the calf muscle pump.
- Maintaining adequate hydration.
- Provision of patient and carer information about the causes, prevention and need to comply with prophylaxis, especially on discharge/transfer.
- Observation of patients for the signs and symptoms of deep vein thrombosis and pulmonary embolism.

Nursing intervention in VTE prophylaxis focusses on mechanical measures, particularly the use of graduated compression 'anti-embolic' stockings. Stockings can contribute to lower limb compartment syndrome, skin ulceration and common peroneal nerve palsy and should not be used in patients with cardiac or vascular disease, fragile skin or limb shape or deformity preventing correct fit.

Guidelines for the safe use of compression stockings include making sure that stockings are correctly fitted, checking to make sure the fit is not affected by changes in leg shape due to oedema and ensuring stockings are removed regularly for hygiene purposes, assessment of neurovascular status of the limb and checking for skin problems [20].

9.10 Consideration of Palliative Care for Patients Following hip Fracture

It is estimated that 18–28 % of older hip fracture patients die within 1 year of fracture. Of those who survive, between 24 and 75 % will not return to their previous level of independence [18]. Although palliative care originally focused on patients with cancer, it is now considered an approach that should be made available for people at the end of their lives for non-malignant as well as malignant disease. Palliative care is defined by the World Health Organisation [29] as:

> …an approach that improves the quality of life of patients and their families facing the problem associated with life threatening illness, through the prevention and relief of suffering by means of early identification and impeccable assessment and treatment of pain and other problems, physical, psychosocial and spiritual. Palliative care affirms life and regards dying as a normal process, and intends neither to hasten nor to prolong death. Using a team approach palliative care addresses the needs of patients and their families, including bereavement counselling if necessary.

This philosophy of care allows for physical, psychological, social and emotional care for patients, their families and carers when the patient with a hip fracture is frail and does not have the physical resilience to survive the trauma of the fracture. Effective models of care for patients with hip fracture actively lend themselves to the inclusion of patient-centred palliative care when appropriate. Typically, palliative care is provided by an interdisciplinary team who focus on the assessment and treatment of pain and other symptoms whilst ensuring that care is enhanced by patient-centred communication and decision-making across the continuum of care settings, from hospital to home.

Identifying patients for whom a palliative care approach is most appropriate is difficult. Many patients presenting with hip fracture also have multiple comorbidities that can additionally limit life so palliative care should be considered. However, many recover well from surgery and have good functional outcomes and subsequent quality of life. Appropriate models of end of life care are currently a matter of considerable discussion and debate. Additionally, palliative care is often not integrated into routine orthopaedic care, so this is a matter for continuing deliberation [11].

It is the responsibility of the orthogeriatric or hip fracture team, through good communication with patients, their families and carers, to identify people who have been physically declining pre-fracture and for whom the fall, fracture, surgery and hospitalisation experience may lead to the hastening of end of life. A team approach is needed to include the patient and family in making decisions that ensure on-going care and treatment is appropriate to the patient's needs. This may or may not include surgical intervention. If a hip fracture complicates or precipitates a terminal illness, surgery should be considered as part of a palliative care approach in order to minimise pain and other symptoms, not necessarily to regain functional ability [21]. Surgery provides significant pain relief that will then not only allow nursing interventions to be undertaken more comfortably, but will facilitate transfer from an acute orthopaedic unit to either home or to another care setting in keeping with the patient's and/or carers' end-of-life wishes.

9.11 Continuing Care

One of the fundamental goals of orthogeriatric care is to discharge the patient from hospital to either independent or supported living in their own home or to alternative accommodation where appropriate post-discharge care can be provided permanently or temporarily. The support of patients returning to a community setting or moving to residential care following discharge is a matter not often considered in detail in the literature. Prior to discharge, issues that need to be considered include: the prevention of future falls, the continued management of bone fragility and secondary fracture prevention. A matter often not considered in detail is the need for continued progress towards optimum achievement of rehabilitation. Post-discharge services vary significantly locally, nationally and globally and the availability of specialist nursing resources is even more of a significant issue than in the hospital setting.

Conclusion

Nurses play a central role in the interdisciplinary team approach to orthogeriatric care. Their 24-h presence in the hospital setting enables them to act as coordinators of care. Nurses provide skilled, high quality, compassionate and age-sensitive care to meet the needs of older people whilst minimising the complications of injury, hospitalisation and surgery and facilitating rehabilitation and reducing/preventing functional decline. Important aspects of that care relate to pain management and the prevention of complications including delirium, malnutrition, pressure ulcers, healthcare associated infection, constipation and venous-thromboembolism. Nurses also have a central role to play in ensuring that needs for ongoing interdisciplinary care and end of life care are met.

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Rehabilitation Following Hip Fracture

10

Suzanne Dyer, Joanna Diong, Maria Crotty, and Catherine Sherrington

10.1 The Principles of Rehabilitation Programmes After Hip Fracture

After a hip fracture operation, an older person's recovery is enhanced if they are provided with an optimistic, well-coordinated rehabilitation programme. Recovery after hip fracture starts on admission when the patient and family receive realistic information on the likely course and time of discharge. The earlier patient goals and expectations can be explored and information on barriers or supports for recovery of independence identified, the more likely it is that an individual will retain a sense of control and self-efficacy which is likely to be associated with better outcomes [1, 2]. Consistent information on the planned rehabilitation programme is important as most people will have a recovery pathway which extends for several months across hospital and community settings [3].

Following an acute stay on an orthogeriatrics ward and secondary prevention treatments for osteoporosis, a rehabilitation pathway should be established. Rehabilitation involves diagnosing and treating impairments, preventing and treating complications, slowing loss of function and where this is not possible, compensating for lost functions (e.g., prescribing walking aids, pick up sticks, additional home help) [4]. Several systematic reviews and meta-analyses have demonstrated that

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rehabilitation programmes improve outcomes for patients after hip fracture compared to simply letting time take its course [5–7]. However, the components of recovery/rehabilitation programmes vary, including the length of time and the settings where programmes are delivered (home, inpatient units, outpatients). Standard management of hip fracture patients also varies between different countries. An audit has shown that while 70 % of hip fracture patients receive orthogeriatrician assessment and 92 % a falls assessment in the UK, these figures were only 27 % for orthogeriatrician assessment and 4 % for falls assessment in a tertiary hospital in Beijing [8].

In clinical practice the cornerstone of a rehabilitation approach is a team of various disciplines (physiotherapy, occupational therapy, nutrition, social work, psychology, medicine) who meet regularly, set goals, review progress towards these goals with the patient and assess outcomes. Where skilled therapists are not available, the chance of recovery is maximised if the following elements are incorporated into the clinical approach:

- Assessment: identification of problems to be addressed, which involves understanding the premorbid level of functioning and understanding the current comorbidities (e.g. delirium)
- Goal setting: identifying what can be improved and what cannot. In particular, assessing what level of mobility and independence in dressing and showering is likely to be achieved in the short, medium and long term. Similarly, identifying what informal and formal supports are available to help recovery
- Treatment: intervening to improve medical and functional problems (such as pain, vitamin D deficiency, undernutrition, depression)
- Evaluation: reviewing the effectiveness of interventions and review (i.e., reassessment)
- Planning: organising support services; providing self-management strategies for patients and carers

The World Health Organization (WHO) International Classification of Functioning, Disability and Health (ICF) framework provides a standardised framework for the classification and description of health, functioning and disability [9]. It moves away from the idea that disability is simply the consequence of disease or ageing towards an approach that acknowledges factors created by the social environment and it attempts to explicitly identify barriers and facilitators to social inclusion. Functioning and disability are seen as multidimensional concepts, relating to:

- body functions (physiological and psychological functions of body systems) and structures (anatomical parts of the body such as organs, limbs and their components) of people;
- activities people do and the life areas in which they participate;
- factors in people's environment (physical, social and attitudinal) which can be barriers or facilitators to functioning.

If this approach is applied to a person who suffers a hip fracture, their disability will be assessed and ranked according to the ICF framework components of health domains (e.g. seeing, hearing, walking, memory) and health-related domains (e.g.

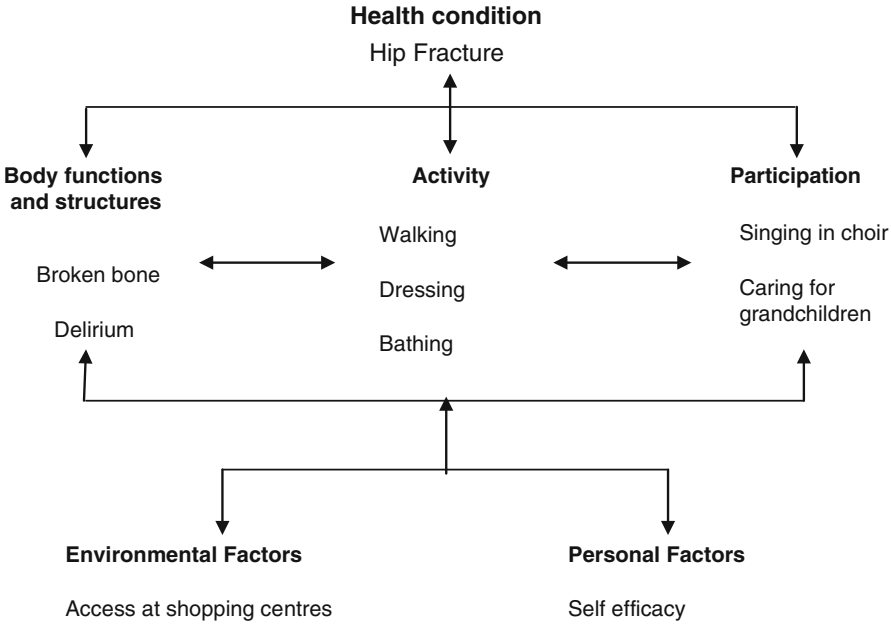

Fig. 10.1 Interactions between the components of the World Health Organization (WHO) International Classification of Functioning, Disability and Health (ICF) framework (*Source*: WHO 2001 [9])

their ability of access transport, their level of education and social interactions). Figure 10.1 shows an individual's functioning or disability as a dynamic interaction between health conditions and contextual factors, which encompass both environmental and personal factors [9].

10.2 What Is Known About the Pattern of Recovery Following Hip Fracture?

Talking to people with hip fractures and their families and providing realistic information on approximate expected recovery trajectories allows them to plan. However, it is complex for clinicians to apply evidence from cohort studies to individual patients as the cohorts are heterogeneous and patients have received varying amounts and types of rehabilitation.

Cohort studies suggest that following hip fracture, only 40–60 % of people who survive are likely to recover their pre-fracture level of mobility [10–12]. Up to 70 % may recover their level of independence for basic activities of daily living [10, 12, 13], but this is variable and less than half of all people experiencing hip fracture may regain their ability to perform instrumental ADLs [10, 14]. In Western nations, approximately 10–20 % of patients are institutionalised following hip fracture [10, 15–17]. The extent to which these outcomes can be improved with greater access to rehabilitation services is not clear.

In a large cohort study where the investigators collected extensive information on recovery for 2 years post-fracture, Magaziner et al. described the sequence of recovery across eight different functional abilities following hip fracture [11]. Upper extremity activities of daily living, depression and cognitive function were the earliest areas to recover and reached maximum recovery within 4 months. Most recovery of gait and balance occurred in the first 6 months, with maximum recovery occurring by 9 months; recovery of instrumental ADLs (such as shopping, preparing meals, house cleaning and handling money) took up to a year. It also took approximately a year for recovery of lower limb function, approximately 10 months for chair rise and walking speed and just over 14 months for walking 3 m without assistance. However, more than half of all patients could not walk 3 m without assistance at this time. It seems that the majority of patients who recover their pre-fracture walking ability or ability to perform basic activities of daily living (such as showering and dressing) do so within the first 6 months after fracture [18], but the role of long-term therapy in recovery pathways is yet to be well investigated.

10.3 Factors Associated with Poor Outcomes After Hip Fracture

Some types of patients with hip fracture appear to be at particular risk of poor outcomes – these include male patients, people living in supported accommodation, those with poorer mobility pre-fracture and those with depression or dementia [13, 18, 19]. People with dementia are also less likely to receive rehabilitation [19, 20]. Although mortality following hip fracture has been found to be higher in men than women, recovery of mobility has been reported to be unaffected by gender [19, 21].

Delirium is very common after hip fracture and although it is associated with poorer outcomes, routine assessment by rehabilitation staff remains uncommon [18]. In one prospective study delirium was still present in 39 % of people with hip fracture at discharge from hospital and in 32 % 1 month after fracture [22]. Even after controlling for pre-fracture physical and cognitive frailty those people who suffered delirium were twice as likely to have poor functional outcomes (in terms of mobility and recovery of activities of daily living) than those without [22].

Those who are older are more likely to have poorer mobility, need assistance at home, lose their ability to go outside on their own, cook their own dinner and be unable to prepare their own breakfast [19, 21]. Although a systematic review of nutritional interventions found only weak evidence to support the effectiveness of protein and energy feeds in older people recovering from hip fracture [23], low food intake post-operatively, poor nutrition and malnourishment pre-operatively are associated with worse recovery of mobility and function [24, 25]. Amongst nursing home residents, the factors most strongly associated with death or new total mobility dependence is being aged over 90 years, having very severe cognitive impairment and receiving non-operative management of the hip fracture [26]. Longer lengths of stay, re-hospitalisation, older age, chronic or acute cognitive deficits and

depressive symptoms while in hospital are also predictive of poorer recovery of mobility and activities of daily living [18].

10.4 Key Elements of a Rehabilitation Pathway

After the immediate post-operative period, a rehabilitation pathway should be followed that includes the elements addressed in Table 10.1. In particular, there is a need to assess frailty, establish goals to maximise mobility and other aspects of function, provide occupational therapy services to assess the requirement of aids and determine strategies to support and improve on independence in activities of daily living [27]. Medication management should ensure all prescribed medications are necessary, minimise the use of antipsychotics and sedatives and ensure adequate pain management. Osteoporosis should be treated as appropriate and falls prevention strategies reinforced with both patients and families.

10.5 What Exercise Programmes Should we Recommend to Help with Recovery of Mobility?

It is widely recognised that a vicious cycle can occur after a hip fracture where pain and hospitalisation result in disuse atrophy of muscles and general deconditioning which increases the risk of immobility and new falls and fractures [28]. While national clinical guidelines recommend providing balance and strengthening exercise [29, 30], it is often unclear how much should be provided, what components of a rehabilitation programme are crucial and how long this programme should be provided for.

A meta-analysis by two of the present authors of randomised controlled trials examining the impact of structured exercise programmes on mobility outcomes, demonstrated that exercise can make significant improvements in overall mobility following hip fracture [6]. We have updated this review for the present chapter without finding additional articles. The overall effect size for all studies in the meta-analysis as identified by systematic review was relatively small (Hedges' g standardised mean difference (SMD) of 0.35, 95 % confidence interval 0.12–0.58). However, between individual studies the effect size varied widely ($I^2 = 67\,\%$, $p = 0.000$), from studies that did not demonstrate any significant improvement in mobility, to studies with very large effects (e.g., Sylliiaas et al. 2012 with a SMD of 1.52, 95 % CI 1.06–1.97, or Hauer et al. 2002 with SMD of 1.0, 95 % CI 0.18–1.82) [31, 32]. The characteristics of the studies included in this meta-analysis, and an additional study that demonstrated a significant effect on mobility but could not be included in the meta-analysis [33], are shown in Table 10.2. Our meta-regression suggests that including progressive resistance exercise training in exercise programmes and those that are delivering the programme in settings other than the hospital alone, increases the effectiveness of a programme (SMD increased by 0.58 and 0.50, respectively) [6]. As shown in Table 10.3, the programmes that continued

Table 10.1 Key elements of a typical rehabilitation pathway, based on the Alberta Hip Fracture Restorative Care Pathway [27]

Category of care	
Frailty	Undertake frailty assessment, instigate interventions as appropriate, involve patient in establishing goals to maximise function and achieve safe discharge
Activities of daily living	Ensure progression in recovery of pre-fracture level of independence, aiming for further improvement depending on tolerance
	Provide occupational therapy to assess need for aids and develop strategies to improve independence
	Demonstrate safe transfer using aids and equipment as appropriate
	Ensure there is adequate support in the home environment in terms of assistance from a caregiver or service
	Recommend the family consider a medical alert system as appropriate
	Bathing and grooming: Encourage and support independence, bathing and grooming out of bed with assistance if necessary
	Dressing: Support getting out of bed and dressed daily, using dressing aids as necessary
	Toileting: Encourage regular toileting to promote continence, toileting should be in the bathroom, not using bedpans or urinals
	Eating: A high protein/calorie diet should be continued and meals taken in a chair or dining room. An oral nutritional supplement should be considered
Mobility	Consider conducting an assessment of mobility/activities of daily living to enable monitoring of recovery of mobility (eg. the Timed Up and Go test, Barthel Index of Activities of Daily Living)
	Exercise incorporating strengthening, balance and functional components should be continued after discharge
	Walking with or without an aid for at least 50 to100 m should be undertaken thrice daily, or as appropriate depending on pre-fracture mobility
	Capacity to walk the distance required to attend meals in the home setting should be demonstrated
	Ensure ability to manage stairs if necessary and to mobilise safely outside the home in all weather conditions, uneven surfaces, kerbs etc.
Medications	A review of all medications should have been undertaken on admission, polypharmacy should be addressed
	Use of sedatives and antipsychotics should be minimised or ceased and doses should be regularly reviewed
	Medication should be adequate for pain control to enable optimal independence in activities of daily living

Table 10.1 (continued)

Category of care	
Cognitive and mental status	Strategies to prevent and treat delirium should be continued, including ensuring appropriate use of vision and hearing aids, fluid enhancement, orientation, optimising mobility, and non-pharmacological sleep supporting strategies. Behaviour monitoring should be undertaken if necessary
	Activity should be encouraged for those with dementia or depression, in terms of ambulation, exercise and social participation
	Caregivers should be provided with support and access to community resources as appropriate
Prevention of further falls/fractures	Osteoporosis management should be considered, if this hasn't already occurred, and continued post-discharge
	Fall prevention strategies should be instigated and the use of hip protectors considered

after discharge and were effective were programmes conducted over 12–24 weeks. It is uncertain how much the greater effectiveness of programmes delivered outside the hospital, compared to in hospital alone, is due to a longer duration of the intervention. Regardless, it is clear that exercise programmes must continue to be delivered long after discharge from hospital, ideally for 3–6 months.

Details of the components of the exercise programmes that have demonstrated to be effective at improving mobility in randomised controlled trials are summarised in Table 10.3. Only one of these studies was of an exercise programme delivered completely in an in-hospital (rehabilitation) setting [33]. This study added progressive resistance training in the form of additional early post-operative, high-intensity bilateral quadriceps muscle strengthening to conventional physiotherapy. A significant improvement in the Elderly Mobility Scale ($p < 0.026$, Table 10.3), leg extensor power of the fractured leg (mean difference (MD) 11.80, 95%CI 2.93 – 20.67), and functional reach (MD 1.30, 95%CI 0.11–2.49) was reported at 16 weeks, which was 10 weeks after the end of the intervention [7].

All other studies that demonstrated a significant improvement in mobility outcomes provided exercise programmes after discharge (Table 10.3). The most effective exercise programme implemented twice-weekly sessions with a physiotherapist in an outpatient clinic for the first 3 months, then once weekly for a further 3 months [31, 43]. This was supplemented with exercises once a week at home. The exercise programme involved prolonged progressive resistance training, fitness warm-up and lower limb strength exercises, compared to a control group of the participant's usual lifestyle, without any restrictions placed on the amount or type of exercise undertaken. This programme significantly improved patient's mobility after 3 months [43], but the magnitude of the effect was even greater after 6 months [31]. While the strength of effect in this study may partly be due to a comparison against patients with no structured exercise programme, two other community-based programmes of progressive resistance training in small groups also demonstrated large effects in comparison to alternative programmes [32, 34]. Long-term provision of exercise

Table 10.2 Characteristics of trials of structured exercise reporting impact on mobility outcomes included in meta-analysis

Study	Setting	Sample size	PEDro	Primary outcome[b]	Characteristics of intervention
Binder (2004) [34]	H&C	90	7	Modified PPT	High-intensity progressive resistance
Hauer (2002) [32]	H&C	28	6	Tinetti's POMA	High-intensity progressive resistance
Latham (2014) [35]	H&C	232	6	SPPB	Home based exercise
Mangione (2005) [36]	C	41	5	6 min walk distance	Resistance or aerobic exercise
Mangione (2010) [37]	C	26	7	6 min walk distance	Home based resistance
Mitchell (2001) [33][a]	H	80	5	Elderly Mobility Scale	High-intensity progressive resistance
Moseley (2009) [38]	H	160	8	PPME	High-intensity weight-bearing
Resnick (2007) [39]	H	208	6	Self-efficacy WES	Exercise plus or Exercise only[c]
Sherrington (1997) [40]	C	42	5	Gait velocity	Weight-bearing
Sherrington (2003) [41]	H	80	7	PPME	Weight-bearing
Sherrington (2004) [42]	C	120	7	6 m walk time	Weight-bearing or non-weight-bearing
Sylliaas (2011) [43]	C	150	8	6 min walk distance	Progressive resistance
Sylliaas (2012) [31]	C	95	8	6 min walk distance	Prolonged resistance
Tsauo (2005) [44]	C	54	4	Walking speed	Home-based physiotherapy

Study	Comparator	Dose (hour)	Supervised	Group exercise	Balance	Progressive resistance	Follow-up (weeks)
Binder (2004) [34]	Low-intensity non-progressive	81	Y	Y	Y	Y	24
Hauer (2002) [32]	Placebo motor activity	81	Y	Y	Y	Y	12
Latham (2014) [35]	Attention control	72	Y	N	Y	N	24
Mangione (2005) [36]	Education	12	Y	N	N	Y	12
Mangione (2010) [37]	Attention control	12	Y	N	N	Y	10

Table 10.2 (continued)

Study	Comparator	Dose (hour)	Supervised	Group exercise	Balance	Progressive resistance	Follow-up (weeks)
Mitchell (2001) [33][a]	Usual care	6	Y	N	N	N	6
Moseley (2009) [38]	Usual care	112	Y	N	Y	N	16
Resnick (2007) [39]	Usual care	9	Y	N	N	N	8
Sherrington (1997) [40]	Usual care	14	N	N	Y	N	4
Sherrington (2003) [41]	Non weight-bearing	8	Y	N	Y	N	2
Sherrington (2004) [42]	No intervention	60	N	N	Y	N	16
Sylliaas (2011) [43]	No intervention	32	Y	Y	N	Y	12
Sylliaas (2012) [31]	No intervention	53	Y	Y	N	Y	12
Tsauo (2005) [44]	Bedside exercise	30	N	N	N	N	12

C Community only, *H* Hospital only, *H&C* Hospital and community, *N* No, *PPT* Physical Performance Test, *POMA* Performance Oriented Mobility Assessment, *PPME* Physical Performance Mobility Examination, *SPPB* Short Physical Performance Battery, *WES* Walking Exercise Scale, *Y* yes

[a]Study data not reported in format suitable for meta-analysis

[b]Data on any measure of overall mobility in each trial were extracted as the primary outcome of mobility in this study

[c]Only 2 out of 3 comparison groups examined exercise interventions

[d]Meta-analysis of studies of structured exercise programmes reporting impact on mobility outcomes, as identified by systematic review of MEDLINE, EMBASE and CINAHL and CENTRAL database search records from inception to March 2016, methods as per Diong et al. [6] NB. Other negative studies that are not included in the meta-analysis exist, see Diong et al. [6]

programmes through outpatient clinics for whole populations may not be feasible, even in developed countries, as this would require an enormous expansion of rehabilitation services with associated costs. Greater provision of community exercise options in liaison with health professionals may help to meet this gap, as has been recommended for people with neurological impairments [46]. Supervised exercise programmes may present access difficulties for people in remote locations so home exercise or tele-rehabilitation options may be required.

A home-based exercise programme of simple, functionally oriented tasks with minimal supervision had a moderate effect on improving physical function [35]. In this programme, a physical therapist taught the exercises and used cognitive and behavioural strategies to enhance attitudes and beliefs about the benefits of exercise

Table 10.3 Characteristics of interventions in included studies that demonstrated effectiveness of exercise on mobility outcomes

Study	Participants	Exercise type	Setting Adherence	Effect size SMD (95% CI)	Duration (wks)[a]	Frequency (pw)	Session time (min)	Total dose (h)	Control group Adherence	Duration (wks)[a]	Frequency (pw)	Session time (min)	Total dose
Comparison to alternate exercise programme													
Binder (2004)	People ≥65 years, living in community, physically frail	Standard physical therapy, then high-intensity programme with progressive resistance added after 3 months	Community rehabilitation, small groups (2–5) led by physical therapist, indoors	0.83 (0.37, 1.28)	24	3	45–90	81	Home based, low-intensity non-progressive, plus monthly group sessions & weekly 10 min calls	24	3	NR	U

Hauer (2002)	Women aged ≥75 years, recent history of injurious falls	High-intensity progressive resistance training of functionally relevant muscle groups (70–90% max workload), progressive training of functions such as walking, stepping or balancing, started on discharge Additional physio 2 × wk for 25 min	Hospital and community. Small groups (4–6) led by therapeutic recreation specialist Adherence: 93% (SD 14)	1.00 (0.18, 1.82)	12	3	135[b]	81	Group based, placebo motor activity e.g. flexibility exercise, calisthenics, ball games, and memory tasks Adherence: 97% (SD 6) Additional physio 2 × wk for 25 min	12	3	60	36

(continued)

Table 10.3 (continued)

Study	Participants	Exercise type	Setting Adherence	Effect size SMD (95 % CI)	Duration (wks)[a]	Frequency (pw)	Session time (min)	Total dose (h)	Control group Adherence	Duration (wks)[a]	Frequency (pw)	Session time (min)	Total dose
Mitchell (2001)[c]	People ≥65, mobile ± aid pre-fracture, AMT score ≥6	Early post-op, high-intensity bilateral quadriceps muscle strengthening (6 × 12 reps knee extension) progressive from 50% (wks 1+2), 70% (wks 3+4) to 80 % (wks 5 & 6), plus conventional physiotherapy	Rehabilitation unit, supervised Median no. sessions completed (11, range 10–12)	18 (16, 20) vs 17 (15, 20)[d]	6	2	0.5[e]	6	Conventional physiotherapy	U	5	20	U
Comparison to no structured exercise													

Latham (2014)	≥60 years, functional limitation, able to sit to stand without mobility aid, discharged from rehab ≤20 months of baseline	Home based exercise, repeating simple functional tasks, using Thera-bands for resistance plus standing exercises using steps of varying height and weighted vests (based on INVEST [45] and Sherrington and Lord [40]). Included cognitive and behavioural strategies addressing exercise, fear of falling and goal setting	Home based exercise taught over 3–4 visits of approx. 1 h by physical therapist, with 4th if necessary plus monthly phone calls	0.48 (0.19 – 0.76)	24	3	1	72	Attention control, cardio-vascular nutrition education by registered dieticians, frequency of contact matched to intervention group	—	—	—	—

(continued)

Table 10.3 (continued)

Study	Participants	Exercise type	Setting Adherence	Effect size SMD (95% CI)	Duration (wks)[a]	Frequency (pw)	Session time (min)	Total dose (h)	Control group Adherence	Duration (wks)[a]	Frequency (pw)	Session time (min)	Total dose
Sylliaas (2011)	People ≥65 years, living at home, ≥23 on MMSE, completed intervention arm of Sylliaas 2011 (12 wks programme)	Progressive resistance (3 × 15 reps at 70% 1-RM wks 1–3, then 80% with reducing reps maintained at ≥8, increased 3-weekly), started 3–6 months after fracture. 10–15 min bike or treadmill warm-up, then standing knee flexion, lunge, sitting knee extension and leg press. Knee flexion and lunge with loading if tolerated Plus advice to walk 30 min per day if tolerated	2 × weekly in outpatient clinic, supervised by physiotherapist, 1 × weekly home based	0.58 (0.23, 0.92)	12	3	45–60	32[g]	Usual lifestyle, no restrictions on exercise activities	—	—	—	—

Sylliaas (2012)	People ≥65, living at home, ≥23 on MMSE	Prolonged resistance training (at 80% 1-RM, increased 3-weekly), from 6 to 9 months post-fracture. 10–15 min bike or treadmill warm-up then standing knee flexion, lunge, sitting knee extension and leg press. Knee flexion and lunge with loading if tolerated Plus advice for 30 min walking daily if tolerated	1 × weekly in outpatient clinic with physiotherapist, 1 × weekly home based (knee flexion and lunge)	1.52 (1.06, 1.97)	24[f]	2	45–60	53[g]	Usual lifestyle, no restrictions on exercise activities	—	—	—	—

AMT Abbreviated Mental Test, *h* hour, *equiv.* equivalent between both trial arms, *h* hours, *min* minutes, *MMSE* Mini-Mental State Examination, *pw* per week, *NR* not reported, *1-RM* one-repetition maximum, *SD* standard deviation, *SMD* standardised mean difference, *U* unclear, *wks* weeks

[a]Weeks, calculated as 1 month = 4 weeks (thus 6 months = 24 weeks)

[b]Including breaks

[c]Identified in systematic review but does not contribute data to meta-analysis of mobility outcomes

[d]Exercise vs control group for Elderly Mobility Scale at 16 weeks, median (interquartile range), reported p = 0.026

[e]Estimated

[f]12 weeks plus previous 12 week programme of Sylliaas 2011

[g]Determined based on average session time of 52.5 min

and to overcome fear of falling during three home visits of one hour (Table 10.3). Monthly telephone calls were also made by the therapists and an additional visit was provided if necessary. The participants were provided with a DVD of the programme to watch and a DVD player if necessary. Participants performed the exercises independently in their own home three times a week for 6 months, supported by a monthly telephone call from the physical therapist. The intervention also included a cognitive-behavioural component in order to improve adherence. A secondary analysis of this trial indicates that self-efficacy may partially mediate the effects of this intervention on longer-term functional outcomes [47].

10.6 Rehabilitation Teams' Role in Supporting Older People to Adjust to Disability

Clinicians need to support patients' adjustment to residual disability when providing rehabilitation to older people with fragility fractures. Hip fractures are common and many older people in the community hold a fear that a hip fracture will precipitate a move into a residential aged care facility. In an Australian time trade off study performed with community-dwelling women who were at risk of hip fracture from a randomised controlled trial on the effectiveness of wearing hip protectors, 80 % said they would rather die rather than suffer a hip fracture requiring relocation into a residential aged care facility [48]. The participants of this study commonly believed that they were living on "borrowed time" having survived beyond usual life expectancy and recognised the very high value they placed on their health as a major contributor to their quality of life. They perceived any threat to their ability to live independently in the community as potentially catastrophic.

When individuals experience changes in their health states, they often alter their internal standards, their values and concept of quality of life (QOL) which is sometimes described as a "response shift" [49]. After a hip fracture, many people are left walking with an aid, with restrictions in the use of public transport, hobbies and roles, so a significant loss of quality of life may occur. Maximising functional recovery is important but providing adequate support for older people to make "response shifts" and adjustments and to identify ways to compensate for changes is equally important e.g. by acknowledging losses in mobility but providing access to alternatives.

Summary Points

- Following an acute stay on an orthogeriatrics ward and secondary prevention treatments for osteoporosis, a rehabilitation pathway is generally established which includes: (i) follow-up medical checks; (ii) chronic care interventions (including disease management and falls prevention) and (iii) access to community services, including aged care support services and allied health therapies.

- Recovery time for different function domains varies from less than 6 months for many activities of daily living and cognitive function to over a year for walking 3 m without assistance.
- Structured exercise programmes should continue beyond the hospital setting, include progressive resistance training and be continued for at least 12 weeks.
- Exercise programmes should support patients to build their confidence to undertake exercise programmes post-discharge.
- Where possible a chronic disease self-management approach should be used with patients and families to promote self-efficacy and adherence to falls prevention strategies, osteoporosis treatment and exercise programmes.

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Multi Professional Team: Coordination and Communication

11

David R. Marsh

The various chapters of this book make it clear that many disciplines have important contributions to make to high-quality care for elderly fracture patients. However, their involvement alone does not guarantee success. We say "many hands make light work", but we can also say "too many cooks spoil the broth"; there is plenty of scope for confusion and inefficient use of precious resources. Obviously, the key to efficient multidisciplinary working has to be coordination and communication between the various players. How can this be achieved in a fracture unit that is attempting to adopt an orthogeriatric approach?

There are many guidelines from countries all round the world that describe how the various players in multidisciplinary teams looking after fragility fracture patients can best coordinate their efforts. An up-to-date catalogue of these can be reviewed on the Fragility Fracture Network website [1] (select a region and then choose the Fragility Fracture Care Guidelines option). The Geriatric Fracture Center model developed in the USA was fully described in 2014 in a comprehensive publication [2], which advocates standardised order sets – slightly more specific than the guidelines and protocols more typical in Europe.

Whichever approach is taken, implementation in a particular fracture unit requires agreement, embodied in some sort of handbook or memorandum of understanding that is endorsed by the leaders of the various disciplines *in that hospital*.

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The UK National Hip Fracture Database website has a resources section [3], which includes a model orthogeriatric handbook for an individual hospital and also contains:

- suggested job plans for orthogeriatricians and specialist nurses in orthogeriatrics
- links to publications describing different models of orthogeriatric care
- model business cases and links to publications demonstrating cost-effectiveness

11.1 The Steering Group

Within a hospital, the process often starts with representatives from each clinical area and discipline getting together to form a steering group that reviews the whole pathway for elderly fracture patients. Once the collaborative arrangements have been agreed and disseminated among all the relevant colleagues, it is important that the steering group continue to have regular meetings, which combine discussion of strategy, quality improvement work and clinical governance.

In practice, the initiation and leadership of such a steering group requires the existence of just a few champions – people who have realised how much better and more cost-effective the multidisciplinary approach can be, especially for hip fracture patients, which are the most numerous and costly patient group. They may be orthopaedic surgeons, geriatricians, anaesthetists, nurses – anyone involved in hip fracture care in fact – who are activists, determined to change the way things are done in their hospital. The Fragility Fracture Network exists precisely to generate and develop such champions, by linking them with like-minded people from all over the world.

Although the steering group itself needs to be kept to a manageable size in order to have efficient meetings, it is important that wider audiences be engaged on an occasional basis, to raise the general level of knowledge and commitment among all the healthcare workers involved in fragility fracture care. If the fracture unit opts to take part in a hip fracture database, as described in Chap. 1, then discussion of the data in regular unit meetings (clinical audit, mortality and morbidity reviews etc.) is the ideal way to achieve this.

11.2 Orthogeriatric Ward Rounds

One of the core activities that comprise a multidisciplinary service is the orthogeriatric ward round. Here again, we are using the term ‘orthogeriatric’ to cover the principle of involvement of senior physicians with expertise in frailty and the practical issues associated with elderly patients. The pattern of such ward rounds is very variable: there may be one or more formal ward rounds per week, seeing the patients at the bedside; there may be quick handover discussions or trauma meetings first thing in the morning; there may be longer, more formal MDT meetings, where discharge plans are discussed in some detail.

In any event, it is not ideal if the geriatrician or other physician is left to go round the patients on their own, leaving suggestions in the patients' case notes. Much more is gained if the junior surgeons and specialist nurses who are responsible for the day-to-day ward-care of the fragility fracture patients accompany them. Such activity is highly educational and, if the rationale behind the decisions is understood, the required actions are much more likely to be carried out properly.

11.3 Specialist Nurses

Many successful orthogeriatric services depend crucially on the input of nurses, as described in Chap. 9. The training of nurses with a special interest in elderly fragility fracture patients is one of the most worthwhile investments possible. They may come from either an orthopaedic or a geriatric background and their role on the fracture ward may be labelled as 'Hip Fracture Nurse', 'Elderly Trauma Coordinator' or many other possible names. The point is that they work permanently on the fracture ward but are closely linked to the geriatrician or other physician who is medically responsible for the patients.

Of course, they do not act alone; they lead all the nurses on the fracture ward in the management of elderly trauma patients. Because – unlike the junior doctors who are rotating between clinical assignments for training – they are there permanently, they rapidly build up a deep knowledge of the needs and likely complications under the guidance of the senior physician.

Their autonomy varies greatly between countries; in the UK, for instance, many are authorised to order investigations and prescribe drugs. However it is an unfortunate fact that, in those countries where the shortfall in geriatricians needed for orthogeriatric care is most acute – and growing rapidly as hip fracture numbers increase – the health service culture is not favourable towards nursing autonomy. Nursing organisations such as the International Collaboration of Orthopaedic Nursing [4] are trying to change this.

For purposes of this chapter, the important point about nurses on the fracture ward is that they are naturally the main people to link between other professionals' input to the fragility fracture patients because, as a body, they are there with the patient all the time. For the same reason, they have a leading role in ensuring that the patients' relatives and carers are kept fully informed.

11.4 Other Key Players

Anaesthetists are a critical group for fragility fracture patients. In many hospitals, anaesthetic input to trauma lists is provided by a rota involving many anaesthetists, none of whom feel any enthusiasm for frail elderly clients. However, as Chap. 7 makes clear, these patients constitute one of the most challenging and interesting groups. The existence of an interested anaesthetic champion makes a huge difference and the benefits are considerable. The relationship between the anaesthetists and the orthogeriatrician is crucial – when the latter says "this patient is as good as

she's going to get and any more delay in surgery will be dangerous", the anaesthetist believes them far more readily than they would a surgeon saying the same thing. Every effort should be made to recruit an anaesthetist to the steering group of the multidisciplinary team; the potential pay-off is, as described in Chap. 7, a standardised approach to hip fracture patients that the team can work to, making everyone else's work that much simpler.

As discussed in Chap. 10, the quality and quantity of rehabilitation makes a difference to the patient's final result. In countries where there is a speciality of rehabilitation, it is important they be involved and in good communication, particularly with the orthogeriatrician. In other places, it is the geriatrician who leads rehabilitation; in others, it remains the responsibility of the orthopaedic surgeons. Whichever medical speciality is leading, a key role is played by the physiotherapists. Although all team members, especially nurses, contribute to the recovery of activities of daily living, the physiotherapists have a special role in delivering strength and balance training. This is essential to regain mobility, but also contributes greatly to the reduction of future fracture risk by helping to prevent falls. The difficult problem is how to move seamlessly from the post-operative physiotherapy delivered as an inpatient to the longer-term outpatient falls prevention, which ranks alongside osteoporosis treatment as one of the two pillars of secondary prevention.

11.5 Documentation

Although, as stated above, it is desirable for team members to be physically together whenever possible, for instance on ward rounds, there also needs to be documentation that ensures transmission of information when this has not been the case. The traditional model, whereby doctors record in case notes, nurses record in nursing notes and physiotherapists record in their own notes is not appropriate for the clinical record in a multidisciplinary team system. Integrated orthogeriatric services now almost invariably use a single multiprofessional record of one kind or another.

Furthermore, in many cases the use of proformas increases efficiency of recording information and has the advantage of reminding staff of what needs to be done. The ultimate expression of this is the great variety of Integrated Care Pathways (ICP) available for the management of hip fracture patients. Many assessment proformas and ICPs are available for download from sites such as the UK National Hip Fracture Database, in its resources section [3].

The proformas assume special importance when the fracture unit is participating in an audit process, such as a Hip Fracture Audit Database. The proformas should then be designed so that they exactly resemble the data-inputting screen of the database. This then allows a less clinically-skilled person to input the data, preserving the time of skilled staff for other work.

For the orthogeriatrician, the Comprehensive Geriatric Assessment, as described in the Silver Book [5] of the British Geriatrics Society is a comprehensive way of identifying patients with frailty and predicting likely peri-operative complications.

11.6 Leadership in Co-managed Care

The orthogeriatric concept implies shared responsibility between orthopaedic surgeon and geriatrician or other physician. Obviously, the operative procedure is the responsibility of the surgeon and an early, high quality operation is enormously important in getting the patient firmly on the road to recovery. For this reason, most opinion is that the best place for the hip fracture patient to be initially admitted to is the trauma ward. However, most of the other problems that need to be addressed to deliver good and cost-effective all-round care are medical or social. The orthogeriatrician is best-placed to lead that process and coordinate the input of other disciplines, aimed at achieving an early and effective discharge.

Experience in the UK suggests that the job plan for an orthogeriatrician needs to contain 8 h of dedicated clinical time per week for every 100 hip fractures per year. This works out at about one full time consultant for a fracture unit seeing 400 patients per year. More is required if they are asked to look after all fragility fractures. Part-time input from several is more flexible than full-time input from one, in terms of covering holidays and other absences.

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How to Implement a Fracture Liaison Service

12

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12.1 Introduction

For those over 50 years old, 1 in 3 women and 1 in 5 men will suffer from a fragility fracture [1–3]. In fact, fragility fractures are so common that worldwide it is estimated a fragility fracture occurs every 3 s [4]. With an ageing population, the

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burden of osteoporosis is set to increase and this will only exacerbate the problem. In addition to the obvious human cost, the economic costs of fragility fractures are substantial. In Europe costs are estimated to already exceed €37 billion each year [5], in the United States $20 billion per year [6] and in China are expected to reach $12.5 billion by 2020 [7].

A key measure for reducing the incidence of fragility fractures is identification and treatment of osteoporotic patients [8]. A number of studies have demonstrated that a fragility fracture significantly increases the risk of follow on fractures, and so individuals who have suffered a first fragility fracture are a key high-risk patient group. Despite the apparent ease with which first fragility fracture patients can be identified, and effective drugs that significantly reduce the risk of re-fracture, there still remains a significant care gap [9]. In reality, the majority of patients presenting to health care professionals with a fragility fracture are not tested or treated for the underlying cause of osteoporosis [5, 7, 10]. Estimates suggest that only 20 % of fractured patients are assessed and treated appropriately. As a consequence of this care gap avoidable fractures are common and contribute to a significant burden on patients, families, carers, health care services and society as a whole. National and international guidance [11, 12] as well as systematic reviews [13, 14] recommend the FLS service model to reliably close this care gap.

12.2 FLS the Solution

Fracture Liaison Services, commonly known as FLS, are coordinator-based, secondary fracture prevention services implemented by health care systems to ensure patients presenting with a fracture are systematically managed for osteoporosis and falls risk [11, 13–16]. An FLS provides a structure for routine assessment and management of fragility fracture patients. An FLS is made up of a committed team of stakeholders and employs a dedicated coordinator to act as the link between the patient and the orthopaedic team, the osteoporosis and falls prevention services, and the primary care physician. The FLS can be based in secondary and/or primary care health care settings and requires support from a medically qualified practitioner, be they a hospital doctor with expertise in fragility fracture prevention or a primary care physician with a specialist interest (Fig. 12.1).

However, despite the proven efficacy of FLS, there remains a chronic insufficiency in the number of established FLS present in countries across the world [12]. In Europe, 19 of 27 countries estimated presence of FLS in less than ten per cent of their institutions [17]. In the Asia Pacific region, nine out of sixteen countries report that 0 % of their hospitals have an FLS [18]. In the remaining seven countries (which include including China, Japan and Australia) the percent of hospitals with an FLS varied between 1 and 25 %. Only Singapore reported widespread establishment of FLS in their hospitals (>50 %) [19]. Importantly, where FLS models are in place, there is a significant variability in service design making it difficult to measure service performance and assess potential for patient benefit [14]. Working from the strategy that setting a standard in health care and measuring services against these

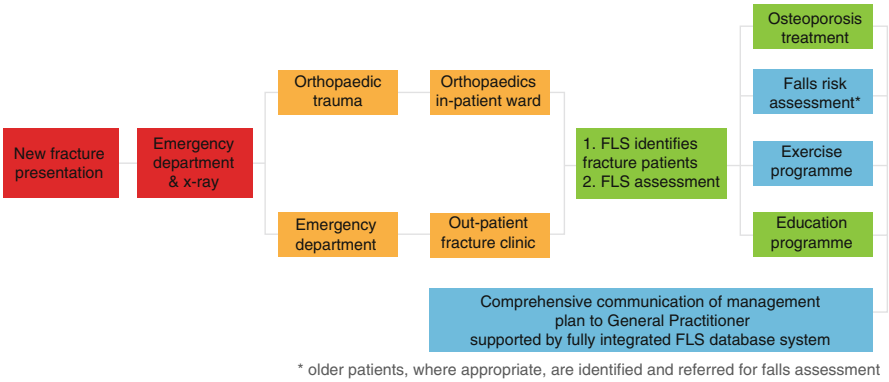

Fig. 12.1 An example of a UK hospital-based Fracture Liaison Service

standards is a powerful tool to improve patient management, the International Osteoporosis Foundation (IOF) Capture the Fracture® (CTF) programme has developed criteria and standards for secondary fracture prevention. The CTF programme provides standards and assesses FLS against these standards in order to collect homogenous data points and provide consistent measurement of performance worldwide. A study in 2013 showed that the single framework and criteria set are able to benchmark services across the various different health care systems in the world [15].

12.3 How to Implement an FLS

Implementation of an FLS can be seen through four interlinked stages: Establishing secondary fracture prevention as a policy priority; a successful financial proposal; FLS implementation; and FLS improvement and sustainability (Fig. 12.2).

The key steps for a successful financial proposal are to determine the medium and long-term benefits of the service for both health and social care systems savings. The benefits require the expected annual number of fragility fractures for the site to be calculated. The numbers who would then be identified, investigated, initiated on therapy and adherent to therapy are then used to estimate the number of fragility fractures avoided. The usual fracture groups are hip fractures, other inpatient fragility fracture patients, patients managed in the trauma outpatient setting and finally vertebral fractures. Such a calculator has been developed in the UK for the National Health Service by the UK National Osteoporosis Society. With the expected number of patients an FLS would see annually and the type model of service delivery for identification, investigation, initiation and monitoring, the resources needed to run the FLS can be derived and also inform the costs of the FLS. The service model for the FLS should be informed by the IOF CTF Best Practice Framework (see below). Following this framework helps ensure the chosen service model works for the patients seen by the FLS. The FLS is likely to require resources

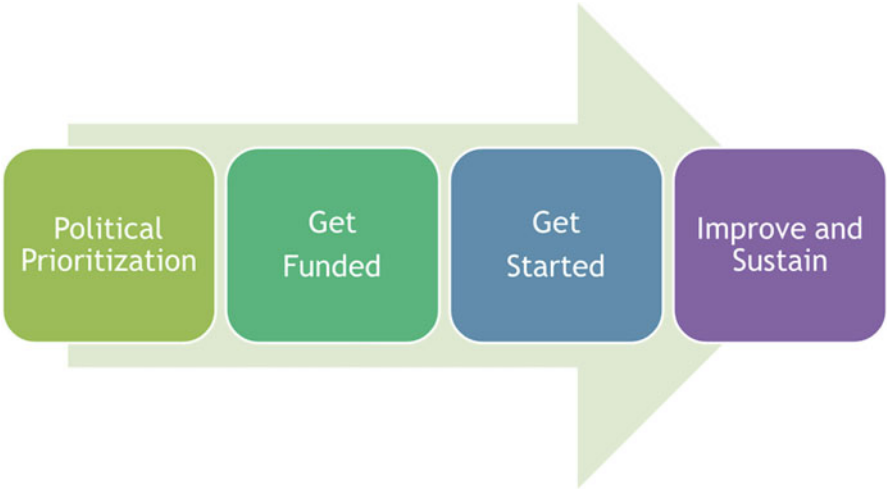

Fig. 12.2 Stages to implement an FLS

for specialist practitioners, administrators, information technology, provision of estates, densitometry, blood investigations and training.

To progress from the initial intention to setup an FLS locally to a competitive business proposal requires in itself careful project management (see table below).

Plan
Establish a multi-disciplinary FLS project team which will likely include the following individuals in your hospital or health system:
Lead Clinician for Osteoporosis
Orthopaedic surgeon with interest in hip fracture surgery
Geriatrician
Radiology or nuclear medicine specialists
Relevant specialist nurses, physiotherapists and Allied Health Care Professionals
Representative of hospital or health system pharmacy group
Representative of local primary care physicians
Representative from hospital or health system administration responsible for new services
Conduct a baseline audit to establish care gaps for fragility fracture sufferers:
Number of women and men aged ≥50 years presenting with a fragility fracture
Proportion of women and men aged ≥50 years receiving post-fracture osteoporosis care in accordance with relevant clinical guidelines (BMD testing and osteoporosis medications)
Review any data from previous local audits of fragility fracture care
Design prototype FLS service model to eliminate the management gap:
Write specific and time-dependent aims and objectives
Identify how to capture fragility fracture patients
Write case-finding protocols for the appropriate setting, e.g. inpatient ward, fracture clinic, diagnostic imaging, etc.

Ensure all members of multi-disciplinary FLS project team endorse the prototype FLS model
Ensure management protocols are approved by appropriate local and national organisations before FLS clinics are initiated
Discuss all documentation and communication mechanisms with relevant stakeholders
Engage hospital or health systems management to fund pilot phase
Do
Implement prototype service model
Collect audit data throughout pilot phase
Study
Analyse improvement in provision of care from audit
Refine prototype service model to improve performance further
Act
Implement changes and monitor performance improvement
Repeat PDSA cycle through continuous ongoing audit and review

Implementation of an FLS requires careful management. The aim is to optimise the secondary fracture prevention from identification to monitoring in one patient group (e.g. patients presenting to the outpatients or hip fracture patients) and then, when running successfully, extend to other patient groups. Effective project management is key to the success of this phase, and this is a different skill set than skills required to achieve a competitive financial case for funding an FLS. Consideration needs to be given to recruitment and training of staff, as there is often a general paucity of FLS experienced practitioners. There are several national programmes accross the world providing educational courses on secondary fracture prevention and FLS implementation [20]. Additional work may be required to develop clinical pathways where patients will be identified, including arranging DXA scanning, taking blood samples to exclude secondary causes of osteoporosis and increase the scope of FLS based on fractures types starting with hip fracture then incorporating other fracture types (non-hip patients, then outpatients and finally vertebral patients), as illustrated in Fig. 12.3. Once the initial FLS is running, there are several ways to expand it:

(i) Implement an FLS Centre of Excellence with subsequent expansion to other localities

Have a centre of reference then use it as a model for other centres within the same region/country. The FLS coordinator should act as a country champion and should promote international standards to run an effective FLS.

(ii) Gradually increase the intensity of the FLS model from Type B (2i) model to Type A (3i)

In 2013, a systematic review on post-fracture models of care provided a useful framework for classification [13]. FLS models were classified according to their level of identification, investigation and initiation (called the 3i's) of fragility fracture patients and were summarized in four types from A-D. Type A models deliver the 3 i's; Type B models deliver the 2 i's (identification and

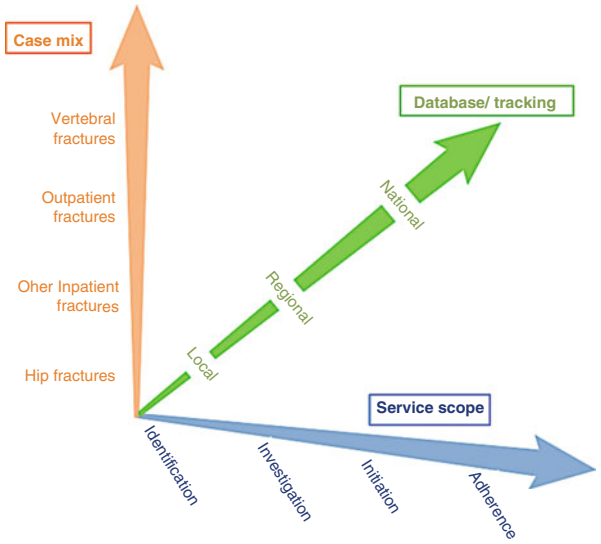

Fig. 12.3 Steps to implement an FLS

investigation); Type C models deliver 1 i (identification); Type D models are the lowest level when no proactive case-finding occurs. The more intensive the models of post-fracture care are, then the more effective they become. A Type B model can be easily expanded to a Type A model within the same infrastructure. The Ganda systematic review reported that FLS significantly reduces repeat fracture rates [13].

(iii) Enhance the intervention based on patient identification from regional/provincial healthcare administrative databases or other electronic medical record systems

Find cases of vertebral fractures through diagnostic imaging. Vertebral fractures are associated with a 2–5 fold increase in future fracture risk reducing quality of life and increased morbidity and mortality [21–23]. They are the least diagnosed fractures in terms of osteoporosis assessment and treatment [24–26]. A significant number of individuals undergo diagnostic imaging in hospitals for conditions other than osteoporosis. This presents an opportunity for case-finding of vertebral fractures [27].

(iv) Implement a region wide Type A (3i) model of FLS

This is the fastest way to expand: from the outset to maximise health gains in the shortest time-frame possible

(a) Sustaining an FLS.

Sustaining an FLS requires regular reviews of the number of patients identified, time to assessment, treatment rates for bone and falls interventions, time to monitoring assessments for bone and falls events and interventions, participant satisfaction and experience questions and participation in national and/or international peer review and/or audit programmes.

12.4 Capture the Fracture® Programme

12.4.1 Description

To support and promote the use of effective models of care across the globe, the IOF launched the CTF programme at the IOF European Congress on Osteoporosis and Osteoarthritis in Bordeaux, France in March 2012. This expert-led and evidence-based programme aims to reduce secondary fractures by facilitating the implementation of FLS on a global level. A primary resource developed by CTF is the Best Practice Framework (BPF), which sets standards for FLS, serves as a benchmark for existing FLS and serves as a guidance tool for developing an effective FLS [15]. In an effort to engage the global medical community, CTF offers a Best Practice Recognition programme where FLS can submit their service to IOF for evaluation against the BPF standards in order to receive a gold, silver or bronze star in recognition of achievements. The FLS is then included in the showcase of best practice and plotted on the CTF Map of Best Practice that displays participating FLS and their respective achievement level (Fig. 12.4). To influence change, the map can be used as a visual representation of FLS available worldwide, their achievements, as well as the areas for opportunity and development in secondary fracture prevention.

Fig. 12.4 CTF Map of Best Practice

12.4.2 Best Practice Framework (BPF)

The BPF has been developed by a steering committee and shaped by input from leaders of established FLS throughout the world. It has developed internationally endorsed standards for best practice, will facilitate change at the national level to ensure FLS models are effective and work for their local population as well increase awareness of the challenges and opportunities presented by secondary fracture prevention to key stakeholders. The BPF sets an international benchmark for FLS, which defines essential and aspirational elements of service delivery and serves as the measurement tool for IOF to award 'Capture the Fracture® Best Practice Recognition' in celebration of successful FLS worldwide. The 13 globally-endorsed standards of the BPF are detailed below [15]:

12.4.2.1 Standard 1: Patient Identification

Fracture patients within the scope of the institution (inpatient and/or outpatient facility or health-care system) are identified to enable delivery of secondary fracture prevention. The intention of this standard is to ascertain the route by which fracture patients are identified. The standard recognises that some institutions will manage just inpatients, some will manage just outpatients and others will manage both in- and outpatients.

12.4.2.2 Standard 2: Patient Evaluation

Identified fracture patients within the scope of the institution are assessed for future fracture risk. The intention of this standard is to determine what proportion of all patients presenting to the institution or system with a fracture are evaluated for future fracture risk. As for the other standards, it is clear that some institutions will just manage inpatients, some will manage just outpatients and others will manage both in and outpatients. The standard recognises circumstances when the best practice is to bypass fracture evaluation and go straight to treatment protocols (e.g. for patients who are over 80 years old).

12.4.2.3 Standard 3: Post-fracture Assessment Timing

The post-fracture assessment for secondary fracture prevention is conducted in a timely fashion after fracture presentation. Timing of when subsequent fracture risk assessment is done is crucial. The assessment can performed by any qualified provider but must be tracked by the FLS coordinator and must contain appropriate post fracture assessment elements such as bone density testing, risk assessment or other assessment procedures relevant to the patient. This is to ensure a formal fracture risk assessment has been done.

12.4.2.4 Standard 4: Vertebral Fracture

The institution has a system whereby patients with previously unrecognised vertebral fractures are identified and undergo secondary fracture prevention evaluation. The majority of vertebral fractures are unrecognised or undetected. The aim of this

standard is to encourage the establishment of systems to identify vertebral fractures amongst patients presenting and/or admitted to the institution for any condition. Knowledge of vertebral fracture status in addition to bone mineral density (BMD) has been shown to significantly improve fracture risk prediction for secondary fractures.

12.4.2.5 Standard 5: Assessment Guidelines

Ideally, the institution's secondary fracture prevention assessment, to determine the need for intervention, is consistent with local/regional/national guidelines. The standard comprises two aspects. Firstly, the standard requires institutions to adhere to guidance that has been subject to peer review at a local, regional or national level. Secondly, the standard highlights an important leadership role that an effective FLS can play in supporting colleagues across the national health-care system. A well-established FLS should play a leading role in lobbying for, and drafting national guidelines on secondary fracture prevention.

12.4.2.6 Standard 6: Secondary Causes of Osteoporosis

The institution can demonstrate what proportion of patients requiring treatment for prevention of secondary fractures undergo further investigation (typically blood testing to assess for underlying causes of low BMD).

It is important to recognise why patients have osteoporosis. Assessment should follow an algorithm that screens for secondary causes.

12.4.2.7 Standard 7: Falls Prevention Services

Patients presenting with a fragility fracture, and who are perceived to be at risk of further falls, are evaluated to determine whether or not falls prevention intervention services are needed, and if so are subsequently referred to an established falls prevention service. The scoring of this standard is based on whether falls prevention services are available. The basic standard is when an assessment is performed, to determine whether a patient needs falls prevention services.

12.4.2.8 Standard 8: Multifaceted Health and Lifestyle Risk-Factor Assessment

Patients presenting with fragility fractures undergo a multifaceted risk-factor assessment as a preventative measure to identify any health and/or lifestyle changes that, if implemented, will reduce future fracture risk, and those patients in need are subsequently referred to the appropriate multidisciplinary practitioner for further evaluation and treatment. Going beyond treatment by medication, it is important to identify other needs for intervention that will reduce future fracture risk, including assessing for any underlying health or lifestyle risk factors that may contribute to future fractures. Identifying risk factors such as smoking, alcohol use, poor nutrition, lack of exercise, poor coordination, poor balance, etc., and referring the patient to the appropriate health-care provider for intervention will help to prevent future fractures.

12.4.2.9 Standard 9: Medication Initiation

All fracture patients over 50, not on treatment at the time of fracture presentation, are initiated or are referred to their primary care physician/provider for initiation, where required, on osteoporosis treatment in accordance with evidence-based local/regional/national guidelines. The standard is not a general measurement of the percentage of patients treated, but rather a measurement of the percentage of patients within the applicable guideline who are treated. The standard is cognisant that not all fracture patients over 50 years of age will require treatment.

12.4.2.10 Standard 10: Medication Review

Reassessment is offered for patients already receiving osteoporosis medications when they present with a fracture, including review of medication compliance, consideration of alternative osteoporosis medications and optimisation of non-pharmacological interventions. The intention of this standard is to assess whether the FLS reviews patients that have fractured whilst seemingly receiving treatment for osteoporosis, and what proportion of this sub- group of patients undergo thorough review.

12.4.2.11 Standard 11: Communication Strategy

The institution's FLS management plan is communicated to primary and secondary care clinicians and contains information required by and approved by local stakeholders. The goal of this standard is to understand to what extent the FLS management plan and communication of it to relevant clinical colleagues in primary and secondary care – has sought those colleagues' opinions on how best to suit their needs to ensure optimum adherence with FLS recommendations.

12.4.2.12 Standard 12: Long-term Management

The institution has a protocol in place for long-term follow up of evidence-based initial interventions and a long-term adherence plan. This standard ascertains what processes are in place to ensure that long-term management of fracture risk is reliably provided [9]. In health-care systems with an established primary-care infrastructure, local primary care must be involved in developing the processes that they will implement for this aspect of post-fracture care. In health-care systems that lack primary-care infrastructure, the FLS must establish effective feedback processes directly from the patient or carer and devise strategies to ensure follow up by the FLS.

12.4.2.13 Standard 13: Database

Ideally, all identified fragility fracture patients should be recorded in a database which feeds into a central national database. Having an effective database to underpin the service is vital as it enables benchmarking of care against the other FLS provider units throughout the country.

12.4.3 Recognition Programme

The BPF provides a means for excellence in secondary fracture prevention to be recognised globally. Applicants achieving Best Practice Recognition will be recognised by IOF in the following ways: (1) the applicant's FLS will feature on the CTF CTF map of Best Practice, including the health care system name, location, link and programme showcase, (2) the applicant will be awarded use of the IOF approved, CTF Best Practice Recognition logo for use on the applicant's websites and materials. Application for Best Practice Recognition provides applicants with an opportunity for their FLS to be peer-reviewed and to identify potential opportunities to further improve delivery of care and outcomes for patients. This programme provides a unique platform to share the best practices developed within your FLS with colleagues throughout the world, and so make a significant contribution to improving the care of fragility fracture sufferers worldwide.

Sites will independently complete a fracture service questionnaire and submit this to the CTF committee. The committee will complete a draft summary profile of the FLS, a scoring from both administrative and clinical perspectives which is determined by achievement against the BPF standards for four key fragility fracture patient groups – hip fractures, other inpatient fractures, outpatient fractures and vertebral fractures – and organisational characteristics. The draft summary profile will be fed back to the site with a request for further information should there be areas requiring clarification. On receipt of the site's response, a suggested final summary profile will be presented to the committee for approval. The site will subsequently receive the final summary; those achieving Best Practice Recognition will feature on the CTF website interactive map and be awarded use of the IOF approved, CTF Best Practice Recognition logo and certificate for use on the applicant's websites and materials (Fig. 12.4).

12.4.4 Results and Remarks

The BPF was designed to ensure that when an FLS is started, it meets recognised quality standards. The standards are around domains of fracture site (hip, non-hip inpatient, outpatient and vertebral fracture), depth of service scope (identification, investigation, initiation and monitoring) and organisational elements (Fig. 12.3). While an FLS is the recommended model to reliably close the care gap of secondary prevention there remains significant variability in the size and scope of services globally that is more than expected from local variations in health systems. There were marked differences by domain with secondary fracture prevention best delivered for hip fractures and least for vertebral fractures. The findings demonstrate that effective secondary fracture prevention in the vertebral fracture group remains suboptimal and continuing work is needed to close this care gap within established services. Strategies include training for radiology trainees and specialists using the IOF vertebral fracture educational programme, development of automatic vertebral

fracture assessment (VFA) tools to facilitate identification of incidental fractures, inclusion of VFA as part of the standard DXA assessment and clinical trials evaluating different methods of service delivery.

There were also differences in service scope with better standards for identification and substantially lower standards achieved for falls prevention, database and longer term medication adherence. While the FLS assessment is an ideal opportunity to identify patients who also require urgent falls intervention, the traditional model has been to refer patients into a distinct falls service. Data from the submitted services demonstrate that while there is near universal adoption of the minimal assessment set for the bone health, considerable variability remains for falls assessments with the potential of patients not being offered effective therapies to reduce falls risk. Despite the commonality of assessment questions, blood and imaging investigations, most institutions scored poorly on the database criteria. Data systems are important as they allow linkage across regions and countries can then demonstrate variability in patient outcomes, informing service design and commissioning. The national hip fracture databases are good examples of such existing systems. Sharing and implementating similar databases for non-hip fractures should be encouraged internationally [28–31]. Finally, medication adherence is a key issue across all chronic diseases. It remains a particular challenge in bone health, given the lack of beneficial symptoms, unwanted effects such as indigestion, co-morbidities such as dementia and the often complex administration regime to follow [32–34]. There remains little consensus on how best to identify the non-adherent patient in terms of using patient report, physician report, bone turnover markers [35, 36] and/or bone density tests [37]. Interventions to improve adherence have at best modest effects [38, 39].

Initial results of the programme have shown that it is possible to benchmark services internationally with a single tool despite the wide variations in national/local health systems and this supports the ongoing implementation of this programme with the ambition of results from all health systems globally [40].

Conclusion

A systematic literature review [14] found that the majority of effective systems for secondary fracture prevention employed a dedicated coordinator. The coordinator acts as the link between the orthopaedic team, the osteoporosis and falls services, the patient and the primary care physician. Coordinator-based, post-fracture models of care have successfully closed the secondary fracture prevention care gap in many countries throughout the world and are highly cost-effective [12]. CTF is a global programme developed by the IOF to facilitate the implementation of coordinator based, multidisciplinary models of care for secondary fracture prevention worldwide. IOF believes this is the single most important thing that can be done to directly improve patient care and reduce spiralling fracture related healthcare costs worldwide. The CTF programme has developed a best practice framework to benchmark FLS and ensure they are working effectively and will promote and facilitate its implementation for the management of fragility fractures.

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13 Management of Older People with Hip Fractures in China and India: A Systems Approach to Bridge Evidence-Practice Gaps

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13.1 Introduction

Hip fractures (HF) sustained by older people are common and often result from a minor fall in individuals with pre-existing osteoporosis, with significant consequences for themselves, their families and the healthcare system [1]. Hip fractures are a recognised surrogate for the burden of osteoporosis [2] and although they are less than 20 % of all osteoporotic fractures [3, 4], globally they account for the majority of health care expenditure, mortality and morbidity from osteoporotic or fragility fractures in men and women over the age of 50 years [2]. The incidence rates of hip fractures in people over 50 years vary considerably between different population groups. There is a linear increase of HF with age, with an exponential rise in later years of life. A study from Finland reported a HF in every fifth woman at 80 and every second woman at 90 years of age [5]. It is estimated that 1.66 million HF occurred world-wide in 1990 [7, 8] and this is expected to increase to 3.1 million in 2030 and 6.25 million in 2050 [3, 9], primarily due to the ageing population and increased longevity in China and India [10]. It is estimated that by 2050, nearly half the global burden of HF will be in Asia, a tsunami in the making [9]. Immediate steps are necessary to widely publicise these facts to global and national policy makers and disseminate best practices for osteoporosis and fragility fracture prevention and management of hip fractures [11].

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13.1.1 Current Knowledge on Burden of HF and Care in China and India

A survey in 2003–2006 by the Chinese Ministry of Health estimated that more than 69.4 million Chinese people over 50 years of age have osteoporosis and 687,000 were at risk of developing HF each year [12]. This might be an underestimate, as hip fractures in people over 70 years in Beijing increased 3.37 times for women and doubled for men in the years 1992–2006 [13]. The demographic projections for China forecast a population of 1.43 billion in 2020, with 469 million people over the age of 50 [12]. In the coming decades, the burden of HF in China will overwhelm healthcare facilities and have far reaching economic consequences.

A report on India in 2004 estimated an annual incidence of 600,000 osteoporotic hip fracture [8] and this was expected to increase significantly by 2026, as the share of people over 60 years rises to 12.4 % of 1.36 billion population [14–16]. Older people in India beyond the age of 70 years, irrespective of gender, have high prevalence of osteoporosis [17, 18] rendering them vulnerable to fragility fractures. There is limited data on epidemiology of HF in India, though it is a common health problem in the ageing population and seen frequently in orthopaedic practice [15].

13.1.2 Data

Data from high-income countries demonstrates significant morbidity and mortality following a HF in older people. The 30-day and 1-year mortality following a HF are 9 % and >20 % respectively [1, 19]. The length of stay in hospital following a HF is usually over 3 weeks and almost half of these older adults do not return to their usual place of residence [8]. Health service utilisation following a hip fracture increases for nearly 1 year and most costs are from long-term care [20]. There is very little published information on services for HF in older people in China and India.

There are both public and private sector providers of health services to older people in India. Surgical services at the district or secondary level of care are often limited to caesarean sections and abdominal surgery, and the burden of road traffic accidents utilises most of the limited orthopaedic service capacity. Lack of imaging equipment and implants are barriers to orthopaedic surgery in the districts. Geriatric patients with hip fractures are usually referred to tertiary care and travel average distances over 80 KM [21]. Many seek traditional bone setter care which is easily accessible and cheap [22]. Care in China is similar and most HF are managed in tertiary care centres and hospitals in urban areas. The ‘hokou’ system in China limits access of the rural population to urban hospitals and may be a barrier to operative care for HF.

13.1.3 Cost of Care

From a large cohort of hip fracture patients in the UK, Leal et al. estimated hospital costs to be £14,163 and £2139 in the first and second year following fracture respectively, demonstrating a strong economic incentive to identify cost-effective approaches for hip fracture prevention and management [23]. There is no reliable information on the cost of care for HF in India and one estimate suggests 2500–3000 USD [24]. Most of the costs are borne out of pocket as less than 10 % of the population have private health insurance and private insurers exclude older people by high premiums and limited benefits for pre-existing conditions. The Government of Indian insurance scheme for families categorised as below the poverty-line (BPL) does not provide sufficient cover to meet the costs of hip fracture surgery.

13.2 Integrated Care Pathway for Geriatric Fracture Care and Health Systems Requirements for Evidence-Based Practice

13.2.1 The 'Integrated Care Pathway'

The 'Integrated Care Pathway' (ICP) and hip fracture audits in the UK have led to significant improvements in care, lowering 30-day mortality, earlier discharge from hospital and cost reductions, as reported in National Hip Fracture Database (NHFD) and other reports [13, 14, 19, 25]. The ICP stipulates (1) prompt admission to an orthopaedic ward within 4 h, (2) surgery within 48 h of admission, (3) combined ortho-geriatrician (OG) care, (4) early post-operative mobilisation, (5) prevention of pressure sores, (6) medication for treating osteoporosis and (7) falls prevention [15, 16]. These treatment guidelines are now considered as international 'gold standards' for managements of older people with hip fracture [17]. The first two activities can be grouped as **P**rocesses of care, the following three as **P**ractices and the remaining two as **P**revention activities. The feasibility of achieving standards for each of these 3**P**s in the management of HF depends on local health systems, and the level of investments in health care. Contextual realities in emerging economies like China, India and Brazil are barriers to adoption of best practices in the management of HF in older adults. Pragmatic initiatives to utilise the principles of the 3**P**s, rather than the 'gold' standards will be the way forward to develop and implement locally relevant ICP for the management of older people with hip fractures. A systems approach is necessary to utilise the knowledge of good practice to develop contextually relevant and feasible implementation strategies for ICP.

13.2.2 Implementation of Best Practice

Effective translation of knowledge and implementation of best practice for HF needs more than just medical or technical intervention. Health systems' ability to cater to the needs for efficient care delivery is crucial. Political commitment for improved care for the geriatric population in general, and support for health systems strengthening and surgical service in district hospitals are vital concurrent activities. A stand-alone or otherwise known as vertical programme for improving HF care is unlikely to succeed without strengthening primary care for early identification of HF in older people, referral to nearest surgical facility, access to essential surgical and anaesthesia service within 2–3 h from home and an integrated tertiary care referral service for high risk patients. The care quality standards for HF adopted in the UK [26] were achieved by generating political priority, institution of best practice tariff (BPT) and using BPT attainments as a measure for HF care. The BPT offers additional payment for cases for which the care meets agreed standards that are monitored by the NHFD.

13.2.3 Knowledge Translation

Knowledge translation [KT] is defined as "the synthesis, exchange, and application of knowledge by relevant stakeholders to accelerate the benefits of global and local innovation in strengthening health systems and improving people's health" [27]. The World Health Organisation's Department of Ageing and Life Course has developed a guiding framework for the application of KT in ageing and health [28]. Effect of local context is considered an important barrier and facilitator to use of research evidence. Contextual relevance of the knowledge, desire of knowledge users to use research evidence, a climate conducive to link research to action and a political will for supporting evidence based care are essential facilitators for KT [28].

13.3 The Evidence for 'Gold' Standards and Barriers to Best Practice

The best practice guidance for HF care [26] has been discussed in detail in previous chapters. Exploring the evidence base and contextual relevance of these practices for countries with inadequate or sub-optimal health systems will inform on the feasibility of implementation and normalisation in a given context.

13.3.1 Early Hospital Admission

Admission of HF patients to an orthopaedic ward within 4 h after arrival in A&E is a process target in the UK [26]. There is no time target for transfer to A&E

following the injury. The Lancet commission on Global Surgery recommends access to a surgical facility within two hours as a measure of essential surgery coverage [29]. The pre-hospital delays to admission; the first delays [30] are influenced by the care-seeking behaviour [22], appropriate transport facility and distance to the hospital. The care-seeking process is influenced by a multitude of factors including lack of perception of the serious nature of the injury in the elderly, decision-making process to seek care, financial dependence of the elderly on their children, gender, community trust in traditional osteopaths, and lack of faith in government hospitals and out of pocket expenditure. An on-going study on care-seeking behaviour in India suggests delays from multiple hospital transfers and receiving traditional bone setter care prior to reaching surgical facility [22].

Trust in traditional osteopaths: *Many from our village are coming here* [*traditional bone setter*] *for treatment, even from far villages for healing of fractured bone. This place is very good than other places for bone fracture. Another boy had a fall from coconut tree. Here they applied plaster at multiple places and it healed within 5 days. These fractures are minor problem for healers here. Within two three days bones get joined.. ……Don't take your patient to hospital they will apply implant and it*[*fracture*] *won't be healed. ……..60 year old male hip fracture patient Key Informant Interview*

Multiple referrals: *After my fall, my son took me to Bhapur* [*Primary care hospital*] …… *and then to Khordha* [*District Hospital*] *where they took the photo* [*x-ray*] ….. *and advised me to keep the leg straight…and prescribed some tablets. We returned home …. and the pain increased….. So they took me to capital hospital* [*regional hospital*] ….. *then they referred me to Cuttack hospital*[*tertiary referral hospital*], *but we returned home…and finally we came to this hospital and they have put this traction….. Key Informant Interview with 72 year old female patient with HF in a private hospital*

Gender inequity for women during the decision making process is evident from the preliminary findings. Recent HF cohort data from a major hospital in India reports 53 % of HF surgery was in men, even though incidence of HF is higher in women [21, 31]. Women, especially widows with poor socioeconomic status, are mostly neglected.

An audit from a large tertiary care hospital in Beijing indicated that only two-thirds of HF patients were admitted to hospital within 24 h [32]. The fate of HF patients living in rural areas in China is unknown. Delays in hospital admission after HF is a contributor to increased peri-operative mortality [33]. An audit from India with a cohort of 1031 HF report that 86 % of patients present late to hospital with a mean delay of 18 days [21].

13.3.2 Early Surgery

The benefit of early surgery for HF is widely acknowledged. The economic benefit of reduced length of stay in hospital is undoubtedly clear and for the patient, it affords earlier pain relief and reduced risk of pressure ulcers, chest infection and worsening of co-morbidities. Quicker post-operative recovery along with earlier mobility contributes to improve quality of life. There is no clear evidence that surgery within 48 h reduces mortality [34]. There is no association between the time spent waiting for surgery and mortality [33, 35]. The reported association between late surgery and higher morbidity and mortality in patients with hip fracture is mostly explained by medical reasons for surgical delay, although some association between very delayed surgery and worse outcomes persists [36].

There are systems barriers to early surgery for HF in China and India. The HF audit from a major tertiary care hospital in Beijing reported only 8 % were operated within 48 h and 30 % were operated after a delay of 1 week [32]. Preliminary results from a prospective study in tertiary care facilities in India suggests only a quarter of HF are operated within 48 h and nearly half receive surgery after 1 week [37]. Another audit reports a mean delay of 3.7 days for surgery after admission and only 10 % being operated within 24 h [21]. Undiagnosed co-morbidities are a common cause of delay as they are often detected during the index admission for HF.

> "*After coming here* [*in hospital*] *blood pressure has been diagnosed for the first time*" *shared by 56 year old female patient during Key Informant Interview*

A public hospital in India achieved 60 % HF surgery rates within 24 h, demonstrating the feasibility for early surgery in low resource settings [32]. This study emphasises the need for leadership and advocacy by prominent actors to adopt best practices in HF care. The high burden of road traffic accidents and limited operating theatre capacity are barriers to prioritising HF surgery [37]. An initial finding of the care-seeking pathway study indicates the near absence of HF surgery in district hospitals. Most patients are referred to tertiary care causing congestion in these facilities and delays in surgery.

Studies are necessary to identify evidence to practice gaps, barriers and facilitators to protocol-based care for HF, care-seeking behaviours and contextual realities of the health systems for evidence-based practices [37]. Insights into these factors will facilitate context-specific management of older people with HF that is appropriate and adopted by stakeholders in India and China. This approach can improve outcomes and reduce mortality following a HF in older people [38]

13.3.3 Orthogeriatric Care

Orthogeriatric (OG) care is by far the most significant practice change to favourably influence HF outcomes. There is evidence that OG care reduces mortality [39, 40],

improves quality of life and increases the chance of returning to usual place of residence [41]. The challenge is providing OG care in the absence of trained geriatricians in China and India. Only 22 % of HF in a Beijing tertiary care hospital received OG care [32].

An older person with HF in India is cared for by the orthopaedic service, with minimal participation of physicians or geriatricians in pre or post -operative period, unless there is an acute medical problem or complication that requires physicians' care. Rarely if ever an older patient with HF is subjected to comprehensive geriatric assessment for functionality, cognitive status and frailty during the hospital admission. Collaborative OG care in management of older people with HF is non-existent from lack of physicians with geriatrics training in India. Geriatric services are available in few tertiary care centres and often these are not integrated with orthopaedic services. Physicians in primary care or secondary care lack the expertise and capacity to provide evidence based care for HF.

"Key Informant Interview with Consultant orthopaedics: There is a concept called ortho-geriatrics but we have nothing of the sort in our hospital. So the orthopaedics department and the Geriatrics-Medicine department are different so there is a ….gap".

13.3.4 Early Post-operative Mobilisation

Early post-operative mobilisation has obvious benefits, including prevention of pressure ulcer. Geriatric nursing training and the advantages of these practices have been discussed in previous chapters. The nurse: patient ratio is a barrier in India and innovation for task shifting is necessary to improve post-operative care and prevent pressure ulcers. Physiotherapy and nursing education should emphasise the safety and advantages of early post-operative mobilisation of older adults for HF.

13.3.5 Prevention and Treatment of Osteoporosis

Treatment of Osteoporosis, Fracture Liaison Service [FLS] and falls prevention: the benefit of these activities in preventing another fracture has been discussed in previous chapters. Limited DEXA scan facilities in India are a barrier to osteoporosis assessment [24]. Medication for osteoporosis is often inadequate, limited to calcium and Vitamin D tablets. Advice on falls prevention after a HF is often missing in China [32, 42]. The concept of risk prediction and 'capture the fracture' are non-existent, although there is an appetite for physicians and primary care providers to learn.

"*The prevention part if taken seriously can reduce replacement. Hip fracture is preventive if you can strengthen the bone condition of the patient. If osteoporosis can be prevented then a lot of cases of hip fractures can be prevented*"… *HCPs Key Informant Interview*

> ""*We need to educate the masses and also the Anganwadi works and PHC's and SHC's. Public lectures are not effective but advertising as mentioned are of definite help, Patient awareness is very important and has to be done from the school level itself*""… HCPs Key Informant Interview

13.4 Evidence –Practice Gaps in Hip Fracture Care and Outcomes

13.4.1 Data

There is a paucity of data on care processes to identify 'Evidence –Practice Gaps' (EPG) in India and China. A recent case-log audit in Beijing reveals significant gaps in HF Care compared to UK practices (Table 13.1) [32, 42].

13.4.2 Operative Treatment of Hip Fracture

Operative treatment is the treatment of choice for all hip fracture, excluding the terminally ill. Operative rates (among people who reach a health facility with surgical services) are 97 % in the UK [19], 92 % in China [32] and a low of 66 % in India [21]. The audit from India suggests that 20 % patients or their carers refused surgical intervention [21]. This is likely due to carer inability to meet out of pocket costs, low priority for elderly health care and gender inequity for inpatient care, especially for widows [22].

There appears to be a selection bias against hospital admission of high-risk HF patients in India and in China. Surgeons are keen to maximise bed utilisation and

Table 13.1 Six blue book standards for hip fracture care audit [32]

		JSTH %	UK NHFD 2012 %
Admission to orthopaedics ward*		n = 780	n = 59,365
	4 h	N/A	50
	24 h	66	100
	>24 h	34	0
Admission to surgery time		n = 702 %	n = 57,880 %
	48 h	8	83
	1 week	70	100
	>1 week	30	0
		n = 780 %	n = 59,365 %
Assessment by ortho- geriatrician		27	70
Pressure ulcer		2	3.7
Osteoporosis management		0.3	94
Specialist falls assessment		3.8	92

*In Beijing Jishuitan Hospital audit, refers to time from fracture to admission to orthopaedics ward; in UK NHFD, refers to time from admission to A&E to admission to orthopaedics ward

sick patients requiring prolonged hospital stay have lower priority. The care seeking behaviour study and the HF audit from the geographical region suggests a bias against surgical care for older adults [21, 22].

13.4.3 Mortality

There was no in-hospital mortality from HF in the Beijing audit [32] compared to a 8 % 30-day mortality in the UK [25]. The 1–year mortality after a HF is 3.8 % in China compared to over 28 % in the UK and 45 % in Australia [25, 42, 43]. The higher mortality, longer LOS in hospital, and frequent ortho-geriatrician assessment is expected in the UK (Table 13.1) due to a considerably higher mean age than amongst the Chinese hip fracture patients. Early and 1 year mortality for operated patients in India is 7 % and 10 % respectively [21, 31]. The data on mortality from HF in China and India are based on tertiary care hospital audits and does not capture the deaths in the community of the significant numbers of non-operated HF [21]. The dearth of case-mix HF data, including mortality in the community, thwarts proper appraisal of the burden of HF in the population and is a barrier to generating political attention for HF as a public health issue.

13.4.4 Pressure Ulcer

This is a measure for quality of care. The audit from India reports an incidence of 66 % and 21 % for non-operative and operated HF respectively. The incidence for pressure ulcers is 2 % in China (Table 13.1) and this may reflect good care or under-reporting or admission bias against sick patients as mentioned above (Sect. 13.4.2).

13.5 Bridging the Evidence -Practice Gaps, Systems Strengthening and Generating Political Priority for Hip Fractures

13.5.1 Bridging the Evidence -Practice Gaps (EPG)

It is essential to determine the EPG through gap analysis to inform relevant intervention strategies to reduce the gap. The following activities can provide data and guidance for implementation of ICP.

- Situation analysis of current management practices, infrastructure, referral processes and gaps in care.
- Using the theoretical framework of implementation science to investigate significant factors that will inform contextually appropriate modifications of best practices for effective knowledge translation and implementation.
- Assessing feasibility for an ICP approach to the management of HF through adopting the principles that impact outcomes [38].

- Qualitative studies to capture health care providers' perspective to inform behaviour change interventions to implement ICP for the management of older adults with HF [37].
- Hip fracture audit

13.5.2 A Case for Hip Fracture Audit

Regular compilation of data is crucial to document morbidity, health care utilisation, cost and mortality from HF. Audits like the NHFD and FFN-supported Hip Fracture Audit Database and district audits for essential surgery will generate data to monitor, evaluate and plan for HF care. Furthermore, as described in Chap. 1, participation in continuous hip fracture audit has, in itself, the potential drive up the standard of care.

13.5.3 Systems Approach to Implement Best Practices for HF in Emerging Economies

Early findings from studies by the author (SR) on knowledge diffusion and ICP for HF have underlined the need for a systems approach to improve management of older adults with HF in India and China [22, 32, 37]. Each of the 3**P**s for ICP requires a concerted plan, integrated within local health systems to ensure sustainability. A vertical approach to better one or more of the best practices without improving the health system will not produce the desired impact. For example, a push for OG care without simultaneous improvements in pre-hospital service and surgical capacity will not reap benefits. Advancing solutions with demonstrated efficacy in low-resource settings, building on existing and emerging national priorities, and developing a strong network of domestic and international allies are key to generating political priority and policy influence [45]. Promoting ICP and OG care for HF will trigger multidisciplinary practice and care pathways for other morbidities and contribute to strengthening local health systems.

> "*I think integrated care pathways for hip fracture managements are very well established in certain western countries and there is a need to establish it even in our hospital and I think rather than having too many stakeholders for the beginning, you can just have orthopaedic surgeons, anaesthetists and internist and these 3 or 4 people can make the quality and patients can be operated earlier because the earlier you operate, the outcomes will be better*". *KII with Orthopaedic Clinical lead*

13.5.4 Generating Political Priority for Fragility Hip Fractures

Effective translation of knowledge and implementation of best practice for HF needs more than just medical or technical intervention. Experience from successful global health programmes suggest that strategies to generate political priority are key in achieving and sustaining the systems for good practice. Generating political priority can be defined as the degree to which global or national leaders actively pay attention to an issue and provide resources commensurate with the problem. The success in establishing ICP and HF audit in the UK and achieving the BPT as an incentive for good care, is a stellar example of 'Generating political priority for fragility hip fractures care'. All the factors needed for political priority existed in the UK and a group of activists worked in cohesion with a well-defined strategy [44, 45]. Regional networks of professionals promoting collaborative multidisciplinary care can provide the impetus for change and generate political priority for fragility fractures.

13.5.5 Geriatric Care in India

A targeted programme for geriatric care was launched in 2010 under the aegis of the National Program for Health Care of the Elderly (NPHCE) to improve access to quality care in the public health system [46]. This flagship program is an example of success in generating political priority for the care of the elderly in India. The programme provides services at every level of health care, and investment for capacity building in human resource and infrastructure. The programme includes preventive and promotive care; management of illness, Health Manpower Development for geriatric services; Medical rehabilitation & therapeutic intervention; Developing appropriate training courses for medical and paramedical health professional in geriatric care; Promotional and encouraging basic, clinical, epidemiological and applied research in ageing and the health care of the elderly [46].

The NPHCE Program Implementation Plan (PIP) in India and activities up to District Hospital level [47] involves an identified District hospital, which will be strengthened for management of the elderly. It will have 10-bedded Geriatric Ward and run a Geriatric OPD on a daily basis. There will be a dedicated Physiotherapy Unit in all the District Hospitals with bed strength of 100 and above. Additional budgets have been sanctioned for appointing two Consultants in Medicine, six Nurses, one Physiotherapist, two Hospital Attendants and two Sanitary Attendants in each district hospital. Additional budget has been allocated for training staff in geriatric care. In due course, Geriatric Clinics will be established in primary care centres, along with home-base care for rehabilitative services at the door steps of such elderly patients. Primary Health Centre Medical Officer will be in-charge for coordination, implementation & promoting health care of the elderly. The ANM/

Male Health workers will be trained to provide home based care for health care of the elderly.

Health system targets for the care of the elderly
Expected Outcomes at the end of 12th five year plan (2012–17) [47]

- Additional 6400 beds in District Hospitals for care of the elderly
- Geriatric Clinics and Physiotherapy units in the District Hospitals and more than 2000 Geriatric clinics in CHCs/PHCs
- Free aids and appliances to elderly population
- Improvement in life expectancy and better quality of life of the elderly population

13.5.6 Orthogeriatric Care in India

The NPHCE initiative of expansion of geriatric service in the entire health system provides an opportunity for developing a practical model of orthogeriatric care with HF management and osteoporosis prevention as the proxy. The following policy and practice guidance may be of value in promoting orthogeriatric care in India.

1. Physicians in primary care should be trained to diagnose HF and promptly refer to appropriate care centres.
2. All HF patients should be co-managed by a geriatrician or a physician with geriatric training within the first twelve hours after a diagnosis is made. The geriatrician should complete a comprehensive assessment and initiate appropriate intervention to manage co-morbidities and pain.
3. All decisions related to surgery should be made collaboratively by orthopaedic surgeon, anaesthetist and geriatrician within the first 12 h.
4. The geriatrician should co-manage the patient throughout pre- and post-operative periods.
5. Introduce curriculum for OG care in graduate and post-graduate training programmes.
6. Periodic interdisciplinary continuing medical education programmes on OG care should be made mandatory for renewal of licensing for practitioners.

13.6 Priorities for the Global Fragility Fracture Community Towards Improving Care in Countries with Ageing Populations

Recent studies provide data on evidence-to practice gaps for management of HF in China and India. The qualitative studies on care seeking behaviour, knowledge translation and care pathways for HF suggest that the ‘gold’ standards as proposed by the international fragility fracture community are unsuitable for adoption in the current health systems in China and India. Contextually relevant guidelines,

adopting principles of best practices that are feasible within the existing health service, appears to be a suitable approach. A paradigm shift of international fragility fracture community is needed to consider promoting a systems and policy approach for countries with diverse population and great variation in health care. Supporting sector development approach to health systems strengthening for other global initiatives like essential surgical service [48], universal health coverage and lobbying for the Sustainable Development Goals to reduce disabilities will benefit HF care. The following activities are a guidance for the Global FF community to generate global political priority.

Problem definition Agree upon problem definition and Agreement on solutions for global application.

Positioning A coherent Ask (what is needed) and Framing of the cause that will make Politicians and Public listen.

Coalition building Allies within the health sector; allies beyond the health sector; civil society involvement.

Governance Effectiveness; Inclusiveness; Legitimacy [49]

13.7 Summary

A systems approach to bridge evidence-practice gaps to improve management of older adults with HF in India and China can be achieved by the following.

1. **Priority setting**
   The burden of RTA in India and China utilises most of the trauma care capacity and at present HF is not a priority. The surge of HF will occur with demographic transitions of population to >10 % over 80 years and significant numbers living over 90 years of age. Policy makers in these countries have to be informed on the impending health and social care requirements of a geriatric population, the cost for management of fragility fractures and the need for OG care.
2. **Compiling contextually relevant data to inform policy**
   Regional or national fractures registry and audit to monitor and evaluate care processes for HF management. The FFN HFAD, using its globally-approved minimum dataset, can provide information to compare and track regional, national and international care for older people with fragility hip fractures.
3. **Data to policy initiatives**
   Utilise data to influence policy for evidence based management of HF.
4. **District health systems strengthening**
   Comprehensive care for the elderly in district hospitals to include surgical care for HF and physician education on orthogeriatrics.

5. **Universal health coverage**
   Comprehensive health coverage to reduce the out of pocket expenditure for health care and to preventing impoverishment from health care expenditure.
6. **Medical Education**
   Inclusion of geriatrics in graduate medical education. Surgery and Physician training programmes to emphasise the value of coordinated multidisciplinary management.
7. **Geriatric training**
   Increase training to achieve adequate capacity to care for the increasing geriatric population.
8. **Best practice guidelines**
   Regional adaptation of guidelines for HF care to suit local context; dissemination of contextually relevant knowledge on best practices; use of OG principles in district hospitals and primary care; audit to monitor and evaluate care for older adults with HF.
9. **Prevention of fragility fractures**
   Sensitise care providers and community workers to identify older people at risk of fragility fractures, organise fracture liaison services and integrate osteoporosis care with community non-communicable disease management programmes.
10. **Global Surgery**
    Support WHO Essential and Emergency Surgery Care programme to provide surgical services in district care [48].

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The Psychological Health of Patients and Their Caregivers

14

Paolo Falaschi and Stefano Eleuteri

14.1 Why Is Psychological Status Important in the Management and Outcome of Hip Fracture?

Hip fractures are associated with reduced health-related quality of life (QoL). Bueckling and colleagues [1] have found a pre-existing need of care, limited function, cognitive impairment, and depression to be independent factors associated with lower QoL during a patient's post-surgical period. In order to assign a realistic value to osteoporosis and osteoporotic fracture treatment, it is important to understand the full impact that osteoporotic fractures have on QoL. In fact, QoL can predict mortality, as well as physical and psychological functioning [2]. Depression, delirium, and cognitive-impairment rates, at the time of hip fracture, have been estimated at between 9 % and 47 % (mean 29 %), between 43 % and 61 % (mean 49 %), and between 31 % and 88 % (mean 47 %), respectively [3]. Mental health status at the time of surgery has been reported as being an important determinant of outcome, with mental disorder associated with poorer functional recovery and higher mortality rates [4]. For example, functional decline can lead to disability and may lead to prolonged hospital stays, institutionalisation and even death [5]. It has also been suggested that pre-fracture dependence in ADL is a stronger predictor of further functional decline resulting in institutionalisation or death than pre-fracture dementia [6]. Furthermore, delirium is associated with lower functional outcome in both short and long term and recovery, increased length of stay, high risk of dementia and persistent cognitive deficits [7]. Delirium is also associated with other hospital-acquired complications that translate into higher rates of institutionalisation, greater need for rehabilitation and home healthcare services after discharge, increased mortality and health-care costs, as well as an additional burden on the patient, hospital staff, and family caregivers [8]. Another study [9] showed that delirium was independently associated with poor functional

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outcome 1 month after fracture even after adjusting for pre-fracture frailty. Also at the 6-month follow-up, it constitutes an independent risk factor for institutionalisation among hip-fracture patients who live at home before the fracture. In patients able to return to their own homes, delirium is a strong predictor of functional decline at the 6-month follow-up [10]. Regarding depression, literature showed that approximately one in five people who are not depressed at the time of their fracture become so after 8 weeks [11]. In a long-term study [12], functional healing was evaluated after 2 years in elderly cases with hip fractures, and depression was reported to have affected healing. A negative effect of depression on daily living activities emerged also at the end of a 6-month period. A patient's active participation in the rehabilitation process has a positive effect on healing. However, the presence of depression will disrupt this process because of reluctance, negative cognition and symptoms similar to psychomotor retardation. Depression in elderly hip-fracture cases was found to have affected daily living activity negatively. The psychological state of the individual who suffers from a hip fracture is highly relevant when determining how well that person may recover [13]. The affective responses to a hip fracture predict both psychological and physical functioning over time, providing a potential target for the enhancement of recovery from this debilitating injury [14]. It is also suggested that the effect of rehabilitation after hip fracture can be less effective if functions are restricted due to fear of falling (FOF) [15]. For all the aspects above mentioned, it seems important to take care of the HF patient psychological status.

14.1.1 Why Is Caregivers' Psychological Status Also Important?

Hip-fracture (HF) patients are among the most vulnerable of hospitalised patients. The associated caregiving rehabilitation task often falls to the lot of a member of the family. The majority of caregivers (86 %) are family members (predominantly women) also labelled 'informal caregivers' [16]. They fulfil their role for between 7 and 11 h a day on average and for anything up to 10–15 h when clinical conditions worsen [17]. Usually they have no professional assistance-procedure skills. Informal caregivers have to cope with physical, psychological and social stressors that affect their health status and quality of life negatively. The primary stressors experienced by informal caregivers are related to the severity of the patient's disease and the amount of time devoted to assisting him/her. Informal caregivers are an important resource for elderly patients suffering from hip fracture because they play a key role during their recovery. One important task is that of motivating the patients to adhere to their therapy programme. Elderly patients with a hip fracture may present with a complexity of other problems which may be challenging to both them and their carers. The level of family caregivers' mental health has been shown to be an important predictor of care recipients' institutionalisation [18], and a risk factor for care-recipient mortality. Objective primary stressors can affect various dimensions of burden differently: functional health has been found to be associated with time-dependent, physical and developmental burdens; cognitive status has been found to be associated with time-dependent burden. Patterns of change in family caregivers' mental health over time were also explored, while the relationships between family caregivers' mental health and recovery

outcomes of elderly hip-fractured patients were also examined. The findings suggest that, during the first year following patient discharge, family caregivers' mental health is associated with patients' post-fracture recovery, including recovery of physical functionality, reduced pain, and better health-related outcomes. These results also suggest that, when estimating recovery times and health-related outcomes of patients who have suffered from hip fracture, health-care providers should also consider the mental well-being of family caregivers. An understanding of the relationships between caregiver-related predictors and the recovery of elderly persons after hip-fracture surgery might provide a more holistic view of that recovery [19]. The perspective that tends to dominate much of literature is that care by family members is provided solely to older adults living at home. When caregivers are monitored over considerably long periods of time, it becomes evident that family caregiving responsibilities do not end with institutionalisation of the disabled relative. Instead, this key transition appears to affect the type and intensity of help provided. Unlike earlier studies that treated institutionalisation as an 'endpoint' in family caregiving, recent research has emphasised the continued involvement of relatives in care and the effects of nursing-home admission upon the stress and mental health of family members. There is a lack of literature addressing family caregiving for frail elderly people and its consequence on the life quality of family caregivers. The subjective responses of individuals to the environments in which they live play an important role in maintaining the status of their care recipients. High levels of depressive symptoms and low levels of life satisfaction in caregivers may also be associated with the low quality of the care provided to their frail care-recipients and even with maltreatment of the elderly [20]. Caregiver burden and its associated stress impact negatively upon caregivers' perceived general physical and mental health [21] and have been negatively correlated with the functional status of elderly family members 1 month after discharge following hip-fracture surgery [22, 23].

In a recent study, we found a correlation between the patient's psychological well-being and the caregiver's burden. At the 2-month follow-up, the outcome of ADL scores was negatively associated to caregiver burden ($p < .01$). Follow-up functional ability was higher in patients whose caregivers reported lower burden during their hospitalisation ($p = .03$). Interesting results regard the correlation existing between a patient's psychological well-being and his/her mood; greater psychological well-being corresponds, in fact, to lower likelihood of depression.

A mutual relationship seems, therefore, to exist between the patient's psychological well-being and the caregiver's burden, so that improvements in the state of health of the one boosts that of the other, and vice versa. This datum confirms the importance of using a bio-psycho-social approach when dealing with both patients and caregivers and evaluating the HF patient's and caregiver's psychological status [24, 25].

14.2 How Should the Psychological Status of Patients and Caregivers be Assessed?

In table 14.1, we illustrate the different areas we believe it is important to evaluate in order to obtain a complete assessment of HF patients and relative caregivers during the different stages of the illness and recovery.

Table 14.1 Areas to be evaluated in an integrative assessment in HF patients and caregivers, at different staging

Areas	Staging				
Patient	1	2	3	4	5
Quality of life	X		X	X	
Fear of falling			X		
Pain			X	X	
Activities of daily living	X		X	X	
Delirium	X	X			
Depression	X		X	X	X
Cognitive status	X				
Caregiver					
Psychological wellbeing	X		X	X	
Caregiver's burden	X		X	X	

1 = admission; 2 = discharge; 3 = 90 days follow-up; 4 = 1 year follow-up; 5 = 2 years follow-up

14.2.1 The Psychological Evaluation of the Patient

The recovery process that follows surgery varies on the basis of the patients' comorbidities, cognitive and functional status, and their psychosocial state. Well-being in this sense means more than health as such. It is important to evaluate different negative and positive dimensions to assess patients' psychological status when following a bio-psycho-social approach.

14.2.1.1 Quality of Life

Health-related Quality of Life (QoL) is recognised as an important measure of health status that may be used for evaluating disease and health care services [26]. It is a broad, multidimensional construct that includes domains such as physical, psychological, and social functionality [27] and which permits to identify specific aspects of QoL and target necessary intervention.

Some patients suffer from QoL [28] and wellbeing loss [29] while others move to nursing home facilities [30]. According to Rasmussen and colleagues [31], well-being and self-efficacy are resources for both health and illness to be taken into account when exploring ways of promoting possibilities of recovery. The importance of patients' perception of the care they receive has been highlighted in the literature over the past few years [32]. Without QoL data, the burden of osteoporotic fractures is likely to be underestimated [33]. The EQ-5D has been recommended for the assessment of QoL in elderly patients [34]. Although this instrument shows good psychometric properties in elderly patients, assessing the QoL of cognitively impaired patients is difficult. In people with mild and moderate dementia, this tests yield good validity and good-to-average test–retest reliability for the descriptive system, but not for the Visual Analogue Scale (VAS), which is a part of this questionnaire. Proxy assessment is, in some cases, the only way to gather information regarding QoL, when patients are unable to respond. Family caregivers have a

tendency to overestimate health limitations concerning less visible items (pain and anxiety/depression). Very frequently, health-care professionals rate patients at the same level for all five domains (some problems with everything). No consensus has been reached as to the most appropriate proxy to apply, but proxy assessment of EQ-5D seems, in our opinion, to be the best option when assessing QoL in patients with severe dementia. QoL should be assessed using the EQ-5D method upon admission to determine pre-fracture QoL and in post-admission 90-day and 1-year follow-ups. In patients affected by severe dementia, EQ-5D should be completed by a proxy, if one is available [35].

14.2.1.2 Fear of Falling

Fear of falling is linked to self-efficacy. Self-efficacy is the belief people have about their capability to perform certain tasks [36].

After hip fracture, older people have reported that their lives have changed physically, personally and socially [37]. McMillan and colleagues [38] conducted interviews 3 months after discharge from hospital and found that during hip fracture rehabilitation, older people struggled to take control of their future lives by trying to balance risk-taking and help-seeking. The interviewees were aware that, on the one hand, it might prove risky to move around and that they were afraid of falling but, on the other, they wanted to be active and were trying to do things. They were determined to regain independence. In order to make progress, some of the interviewees stressed the importance of giving information to patients and to include them in talks regarding their progress. In the patient follow-up, FOF should be assessed 90 days after admission.

14.2.1.3 Pain

In the HF patients, pain should be assessed, initially, during EQ-5D test; however, as we said before, the VAS used by EQ-5D is not reliable in cognitively impaired patients [34]. Therefore, VAS within EQ-5D rates overall body pain, while we are also interested in the pain at the site of the fracture. The Verbal Rating Scale (VRS) performs well in cases of patients with dementia, and it is more informative regarding fracture-site pain [39]. Liem and colleagues [35] agree that this test should be used on the second day after surgery – or, in cases of conservative treatment, the second day after admission – and at 90 days and 1 year after admission.

14.2.1.4 Activities of Daily Living

Activities of daily living (ADLs) are an important health outcome in the orthogeriatric population. Recovery of pre-fracture health and functional levels is one of the main goals in hip fracture management. Therefore, it is important to assess deterioration in functional level over time. The literature provides a vast selection of ADL measurement tools, but the Katz Activities of Daily Living Scale [40], is the most widely used. In many cases, it may prove difficult to assess pre-injury ADL's accurately at the time of admission. In such cases, we suggest consulting a proxy, who will typically be a family member, friend or caregiver. ADLs should be assessed upon admission to evaluate pre-fracture status. During patient follow-up, ADLs should be assessed after 90 days and 1 year after admission.

14.2.1.5 Delirium

Delirium in hip-fracture patients usually occurs during the 2–5 days following surgery. It is common in elderly hip fracture patients, occurring in 10–61 % of cases [41]. It can represent a difficult clinical condition to assess, as fluctuation of symptoms can lead to failure to recognise its onset [42]. Dementia and cognitive decline, measured by MMSE, were found to be independent risk factors for delirium [43]. The Confusion Assessment Method (CAM) [44] is a reliable and valid measure of delirium in the general medical and surgical population. The CAM focuses on four features: (i) acute change in mental status with a fluctuating course, (ii) inattention, (iii) disorganised thinking, and (iv) altered level of consciousness. It is a valuable test by which to assess delirium, should be assessed upon admission to evaluate the pre-fracture status and on discharge after acute hospitalisation.

14.2.1.6 Depression

Depression is the most common hip-fracture-related psychological disorder, although it is frequently difficult to assess it [45]. An independent relationship was found to exist between low functional capacity and depression symptoms in the elderly [46]. In elderly people who cannot walk well enough to perform daily living activities, social isolation often occurs and social isolation is in itself a risk factor for depression [47]. Therefore, we can say that a vicious circle of low ADL is created between pre-existing depression and an increase in depression that feelings of inadequacy when performing daily activities can produce. The Geriatric Depression Scale (GDS) may be a valuable instrument by which to assess depression [48]. Depression was observed more often in females and those who had lost their spouses [11]. Depression should be assessed upon admission to evaluate its pre-fracture status. During patient follow-up, it should be assessed after 90 days, 1 and 2 years from the date of admission.

14.2.1.7 Cognitive Impairment

Some studies suggest that cognitive impairment, found in 31–88 % of elderly patients experiencing hip fracture, is a predictor of poor functional recovery after hip-fracture surgery [13]. Furthermore, pre-fracture cognitive impairment is also associated [4] with higher mortality rates. The Mini Mental State Examination (MMSE) [49] may prove to be a valuable instrument for the assessment of cognitive impairment. Cognitive impairment should be assessed upon admission to evaluate the pre-fracture status.

14.2.2 The Psychological Evaluation of Caregivers

The increased risk of burnout identified among informal caregivers is closely related to their perceived level of burden, defined as a multidimensional response to negative appraisals and perceived stress [50]. Joint assessment of the dimensions of burden and well-being, that co-exist in caregivers' experience, allows for the identification of personal and relational resources that may be usefully included in interventions addressed to caregivers [16, 17, 50].

14.2.2.1 Psychological Wellbeing

The concept of subjective well-being (SWB) is multi-component by nature. It is affected by positive (i.e., happiness), negative (i.e., depressive symptoms) and cognitive components (i.e., life satisfaction). Its multiple components are affected by different sets of social determinants and develop differently at successive life stages [51]. High care-demand levels may affect multiple aspects of caregivers' lives, including free time, social life, emotional and physical health as well as personal development. These subjectively defined stressors are also called caregiver burden. Perceived caregiver burden may adversely affect their self-esteem and their sense of competency as a caregiver [20]. These might cause caregivers to suffer from higher levels of depressive symptoms and become less satisfied with their lives. In other words, multidimensional caregiver burdens may play a mediatory role in the association between objective primary stressors and caregivers' SWB. The Psychological General Well-Being Index (PGWBI) [52] can prove to be a valuable test for the investigation of patients' and caregivers' psychological wellbeing. Psychological wellbeing should be assessed after admission and at 90 days and 1 year after admission.

14.2.2.2 The Caregiver Burden

Informal caregivers have to cope with physical, psychological and social stressors that affect their health conditions and quality of life negatively [50]. Over the last 30 years researchers have paid special attention to the investigation and assessment of burden [51]. The Caregiver Burden Inventory (CBI) [53] provides information regarding both the Objective Burden (OB) – the time and commitment caregivers devote to caring activities daily – and the Subjective Burden (SB) – perceived lack of everyday opportunities, fatigue, physical problems, issues related to socialisation and participation, and how they feel toward the care-recipient. Caregiver burden is an all-encompassing term used to describe the physical, emotional, and financial responses of a caregiver to the changes and demands caused by providing help to another person with a physical or mental disability [54]. Increasing numbers of studies have examined the caregiver-burden phenomenon, the lack of support given to caregivers and interventions focused on relieving caregiver burden; this increase is probably due in part to greater evidence of caregiver burden being a determining factor in the quality of life (QoL) of caregivers. Several studies have revealed an association between the characteristics of patients and caregivers and caregivers' QoL, with caregiver burden serving as an important predictor of QoL. Caregiver burden has also been used as an outcome variable rather than a predictor [55], suggesting that caregiver burden and QoL are closely related. Thus, caregiver burden seems to be a potential moderator of the associations between patients' and caregivers' characteristics and caregivers' QoL. Some studies have shown that caregivers of elderly people suffering from hip fracture experienced multidimensional burden, including tiredness, emotional distress and role conflicts [21, 22]. Many caregivers assume the caregiver role with little or no preparation and have to learn to deal with several aspects of care in a very short time. Often caregivers do not know what to expect during hip fracture recovery. They face situations where they have to address

various care-related tasks, such as arrangement of rehabilitation services and assistive devices. These situations become more stressful when the caregivers have to juggle their own work and family lives. The care burden related to hip fracture, an acute injury, may decrease over time; however, it is often prolonged over 12 months or more [56]. Caregivers tend to experience the greatest stress during the first 2 months after fracture, the stress being associated with increased care demands and costs. Family caregivers of hip-fractured patients were reported as experiencing moderate burden [22]. Furthermore, the caregiver's burden was negatively related to the physical function of older patients with hip fracture. On the other hand, social support has been associated with a diminution of the caregiver burden [23]. The caregiver's burden should be assessed after admission as well as at 90 days and 1 year after admission.

14.3 How Can the Psychological Status Be Positively Influenced By the Orthogeriatric Team?

We have found that a mutual relationship seems to exist between the patient's psychological well-being and the caregiver's burden, so that improvements in the state of health of the one boosts that of the other, and vice versa. The correlation emerging between patients' psychological well-being and their caregivers' burden confirms the importance of using a bio-psycho-social approach towards patients and caregivers [24, 25]. Unfortunately, no specific researches have nowadays studied how the psychological status of the patient and of the caregiver can be positively influenced by the orthogeriatric team. Future studies are, therefore, needed to better understand which kind of practices should be used to improve the psychological health.

In the previous paragraphs, we showed the different negative and positive dimensions that it is important to evaluate, the staging we suggest and instruments we believe to be the most appropriate. The orthogeriatric team should take care of these aspects following a bio-psycho-social approach. The inclusion of a psychologist in the team could help in the assessment of the patients' and the caregivers' psychological wellbeing, using the tools we have detailed above, but also using psychological counselling. In the counselling, the psychologist could obtain also more qualitative data, in order to tailor the intervention to the resources and needs that emerge and give feedback to the patients and their caregivers on the problems and the strengths found in the assessment. A pilot study suggested, for example, the positive influence that a twice-a-week counselling, almost at the same time for about 45 min, had a positive influence on HF patients depressive and anxious symptoms. Even if long-term follow-up studies are necessary to evaluate whether good early results are sustained over a longer period, these data suggest that counseling can be useful in these patients [57].

The literature shows that these patients risk much longer and more frequent hospital stays than other adults. Comprehensive discharge-planning programmes, including early identification of those at risk, can alter these statistics. Upon

admission to care facilities, early multidimensional assessment can provide significant indications of how to address the entire course of patient treatment more efficiently. In our experience, the organisation of formative courses for caregivers and the implementation of a "caregiver help desk", with the collaboration of case manager nurses, could be additional tools that the orthogeriatric team could use to promote a comprehensive discharge-planning programme enhancing, in this way, the psychological health of HF patients and their caregivers.

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