

Orthogeriatrics in the management of frail older patients with a fragility fracture

S. Sabharwal¹ · H. Wilson²

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Abstract

Summary This review article examines the role of orthogeriatric management for frail older patients with a fragility fracture. The history of orthogeriatrics and its application in clinical practice around the world is reported, and an evidence-based evaluation for the effect of orthogeriatric management on patient morbidity and mortality is also provided.

It has been more than 50 years since the role of the geriatrician in the management of patients with a hip fracture was first described. The evidence that supports an orthogeriatric model of care has grown exponentially over the last decade. This evidence base is primarily related to hip fractures and demonstrates reduced morbidity and mortality rates amongst patients managed with a recognised model of orthogeriatric care. The societal and economic burden of hip fracture has led to health economic evaluations within this field, many of which have concluded that orthogeriatric management results in cost-effective clinical practice. Based on existing clinical and economic research, national clinical practice guidelines have been developed in several countries which recommend orthogeriatric participation in the management of older patients with a hip fracture. Compliance with such guidance has already demonstrated improved patient outcomes.

Although the pathogenesis and prognosis of other types of fragility fracture may be as poor, there is a dearth of clinical research that evaluates the effect of orthogeriatric management on such injuries. Looking to the future, orthogeriatric management is likely to become more widespread, and the robust collection and reporting of patient outcomes from national registries will provide a greater understanding of the impact of orthogeriatric models in the care of all frail older patients with any type of fragility fracture.

Keywords Fragility fractures · Frailty · Orthogeriatrics

Introduction to the history of orthogeriatrics

Orthogeriatrics has been defined as ‘medical care for older patients with orthopaedic disorders that is provided collaboratively by orthopaedic services and programs catering for older people’ [1]. The role of the geriatrician in the management of older orthopaedic patients with hip fracture was first described in 1963 in the UK by Michael Devas, an orthopaedic surgeon and later a key member of the British Orthopaedic Association and Bobby Irvine an eminent geriatrician, later president of the British Geriatric Society [2]. Early orthogeriatric management, including theirs in Hastings, based on joint post-operative care between orthopaedic surgeons and geriatricians appeared to demonstrate a shorter length of inpatient stay [2, 3]. However, perhaps owing to a paucity of high-quality evidence within the field, the effect of orthogeriatric management on clinical outcomes and survivorship was still debated 30 years after Devas and Irvine’s study was first published [4]. This scepticism was supported by institutional narratives from the Royal College of Physicians and the Department of Health’s Duthie Report in the UK that suggested a need for

✉ S. Sabharwal
sanjeeve.sabharwal@ic.ac.uk

H. Wilson
hwilson6@nhs.net

¹ Department of Trauma and Orthopaedics, Imperial College NHS Trust, Ground Floor Salton House, South Wharf Road, Paddington, W2 1NY London, UK

² Department of Geriatrics, The Royal Surrey County Hospital NHS Foundation Trust, Egerton Road, Guildford GU2 7XX, UK

more research in orthogeriatrics before recommendations on implementation of such a care model could be made [5, 6].

By the late 1990s, emerging evidence demonstrated a benefit to patient outcomes by implementation of an orthogeriatric model of care [7]. Furthermore, following the 1999 report from the National Confidential Enquiry into Perioperative Deaths (NCEPOD) in the UK which suggested a need for physician involvement in the care of older and high-risk surgical patients [8], impetus from key opinion leaders within their respective healthcare organisations resulted in the publication of the 2003 British Orthopaedic Association (BOA) and British Geriatric Society (BGS) Blue Book [9]. This document summarised evidence-based standards for older patients with fragility fractures, including the need for an orthogeriatric model of care. This was followed by the development of the National Hip Fracture Database in the UK to audit compliance with these standards as well as national 'Best Practice Tariff' financial incentive. These initiatives were associated with improvements in outcomes including a reduction in mortality rates [10, 11] (Fig. 1).

Australasia was one of the first regions outside of the UK to describe the principles of an orthogeriatric model of care when

in 1980 Richard Lefroy reported on a hospital's experience with combined orthopaedic and geriatric care of 82 patients with a hip fracture [12]. Reported models of orthogeriatric care in Europe and the USA were published in the 1990s and demonstrated improved clinical outcomes for patients [13, 14]. In the USA, the role of interdisciplinary management of patients with a hip fracture was shown to reduce post-operative complications, intensive care transfers and discharges to nursing homes [14]. Similarly, a Swedish study reported that patients with a hip fracture who were admitted to an orthogeriatric rehabilitation unit had less complications including a lower incidence of delirium [13]. Research in Finland published in 2002 concluded that orthogeriatric management allowed more patients with hip fracture with a background of dementia to return to the community [15], while the Sheba Model of orthogeriatric care in Israel demonstrated that over a 5-year study period, orthogeriatric management was associated with lower rates of morbidity and mortality in patients with fractures [16].

Currently, orthogeriatric management for patients with a fragility fracture is an expected standard of care within clinical practice guidelines around the world [1, 17, 18] with a strong evidence base to support its implementation [19]. Randomised

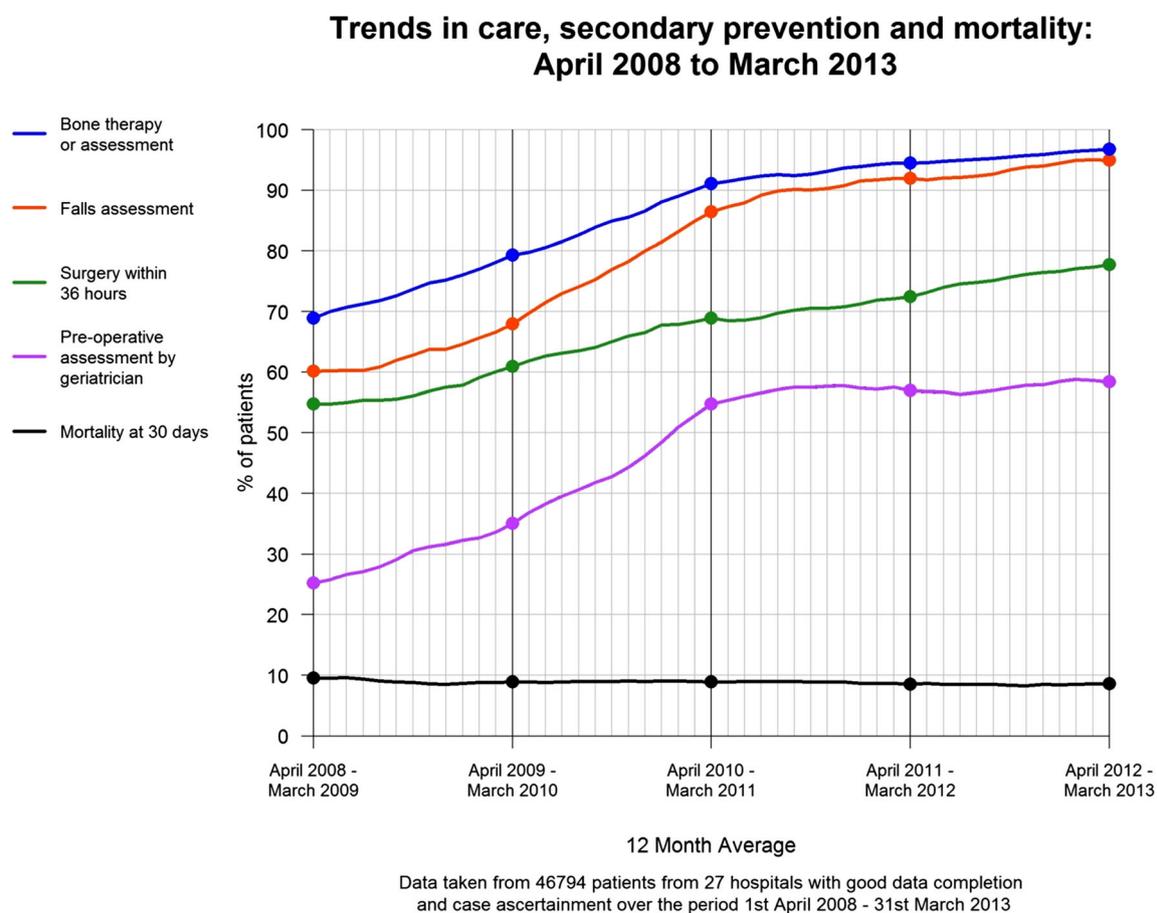


Fig. 1 Trends in the care and clinical outcomes of patients with a hip fracture in the UK (Copyright © National Hip Fracture Database 2013)

controlled trials examining the effect of orthogeriatric management in patients with a hip fracture have demonstrated reduced mortality rates [20] as well as institutional cost savings from reduced length of inpatient stay [21]. This narrative review will evaluate the role of orthogeriatrics in the management of frail elderly patients with fragility fractures and the evidence base that supports it.

Who are frail older patients and why does it matter?

Chronological measures of age have been the conventional means of defining who an older patient is in clinical medicine [22]. While many countries in the developed world define persons who are 65 years of age and above as elderly [23], this definition is challenged by the view that advances in health and social care have improved the health states of older people to the extent that defining elderly age by chronology alone does not accurately account for age-related decline in physiological, functional or social state [24, 25].

Frailty is characterised as an age-associated decline in physiological reserve and function across multi-organ systems, leading to increased vulnerability for adverse health outcomes [26]. The specific defining criteria depend on the frailty measure being used but may be generalised to four main domains: clinical, functional, socioeconomic and cognitive [27]. The role of a patient's health state on their clinical outcome is well-established in relation to hip fractures, with higher American Society of Anaesthesiology (ASA) scores demonstrating increasing mortality rates [28]. Pre-morbid functional and cognitive status also have a strong relationship with patient outcome [29], as does socioeconomic status [30]. When frailty characteristics are combined and observed as a single measure, it is an independent risk factor for falls, fracture and mortality [31].

Risk predictors such as the Nottingham Hip Fracture Score (NHFS) which has been validated for predicting 30-day mortality in patients with a hip fracture are important tools for determining prognosis and outcome [32]. More recently, frailty index measures, such as the Canadian Study of Health and Aging Frailty Index, have also been validated for predicting mortality in this group of patients [33]. Comparison of frailty measures with other assessment measures for patients with hip fractures, including the NHFS, has revealed that a patient's frailty index is a better predictor of mortality and length of hospital stay [34]. Prognostication is important in the management of frail older patients because it allows more vulnerable patients to be identified and selected for medical optimisation and can guide appropriate allocation of scarce healthcare resources such as orthogeriatric management, when they need to be reserved for the frailest patients who are most likely to benefit from them.

Why are fragility fractures important?

Fragility fractures have been defined as fractures that occur after minimal trauma, such as falling from a standing height or less, or after no identifiable trauma [35]. The pathogenesis of bone fragility is age-associated and occurs because at sites of bone remodelling, bone is resorbed at a faster rate than it is formed, which results in bone loss and structural damage. Menopause-related oestrogen reduction in women increases such bone remodelling, and this causes trabecular and cortical thinning, as well as porosity [36]. In men, there is no comparable abrupt cessation in production of testosterone; however, testosterone levels do gradually decline with age, and secondary causes such as hypogonadism often cause osteoporosis and fragility fractures at a younger age [37].

The most common site of fragility fractures are the hip, spine and wrist; however, they may occur in any bone within the appendicular or axial skeleton [38]. The incidence of these injuries in society is high, with approximately 50 % of women ≥ 50 years experiencing at least one clinically apparent fragility fracture in their lifetime [39]. A significant proportion of these patients will have permanent disability, require institutional care and experience fracture-related functional decline [39]. In patients with fragility fractures over the age of 60, approximately a quarter will suffer a subsequent fracture within 10 years [40]. Moreover, all fragility fractures are associated with increased 5-year mortality rates [41]. The high morbidity and mortality following fragility fractures results in significant financial costs highlighted by a study estimating that the cost of osteoporotic fracture care in the USA in 2005 was \$17 billion [42]. With the first fragility fracture being the strongest risk factor for a subsequent fracture [43], early commencement of secondary prevention is an important and cost-effective means of reducing subsequent fractures [44]. This aspect of management of patients with a fragility fracture further underlines the importance of an orthogeriatric model of care, because early bone health assessment, along with timely secondary prevention measures when appropriate, forms a significant part of the role of an orthogeriatrician [18].

What are the models of orthogeriatric care?

The BGS has described four models of orthogeriatric care [45] (Table 1).

The reactive consultation model, often described as the usual model of care, was the conventional approach, in which older patients with fractures were admitted under orthopaedic surgeons and referred for a geriatrician review on an ad-hoc basis. This model is no longer supported by BGS, perhaps owing to the fact that it conflicts with their defined role of an orthogeriatrician which is to safeguard the needs of all

Table 1 Types of orthogeriatric models of care and their impact on clinical outcomes

Model of orthogeriatric care	Characteristics of the model	Impact on mortality rate	Impact on length of stay	Other reported outcomes of the model
1. Reactive or usual model of care.	Patient admitted under orthopaedic surgeons with geriatrician review when requested.	Compared to an orthogeriatric liaison model and a joint care model: -Higher inpatient mortality rates [20, 46]	Compared to an orthogeriatric liaison and joint model of care: -Increased length of stay [47, 48]	No significant findings reported
2. Orthogeriatric liaison model of care	Patients admitted under orthopaedic team, Regular geriatrician review on the orthopaedic ward with multidisciplinary input on patient care.	Compared to a usual model of care: -Reduced inpatient mortality rates [46]	Compared to a usual model of care: -Reduced length of stay [48]	Compared to a usual model of care: -Reduced incidence of delirium in patients [49] -Reduced time to surgery [48] -Improved post-operative patient self-care, mobility and depressive symptoms [50]
3. Post-operative geriatric rehabilitation unit	Peri-operative care is provided by the orthopaedic surgeons on their ward with early post-operative discharge to a geriatric rehabilitation unit.	No significant findings reported	Compared to a usual model of care: -Reduced length of stay [51]	Compared to a usual model of care: -Enhancement of activities of daily living and mobility [51]
4. Joint model of care	Admission to a dedicated orthopaedic ward with shared responsibility for the patient by the orthopaedic surgeon and geriatrician.	Compared to a usual model of care: -Reduced inpatient mortality rates [20]	Compared to a usual model of care: -Reduced length of stay [47]	Compared to a usual model of care: -Reduced time to surgery [47] -Fewer post-operative infection and overall complication rates [47]

elderly patients admitted into the hospital with a fracture throughout their stay [45].

The orthogeriatric liaison model refers to regular geriatrician ward rounds and multi-disciplinary team meetings for patients with a fracture. This model provides most patients with a geriatric medicine review at some point during their stay, focusing on the acutely unwell and ensuring secondary prevention that is provided through a falls assessment and bone health assessment. However, the model often lacks continuity of care and regular review.

The third model of care involves peri-operative care of the older fracture patient by the orthopaedic and anaesthetic team with early post-operative discharge to a Geriatric Orthopaedic Rehabilitation Unit. The major draw-back of such a model is the lack of continuity of care with ward transfer often exacerbating pre-existing cognitive impairment and increasing the risk of delirium [52]. Furthermore, the absence of immediate peri-operative orthogeriatric care may limit the benefits that physician-led care offers patients at a stage when they are medically most vulnerable [53].

The joint care model between geriatrician and orthopaedic surgeon on a dedicated orthogeriatric ward is the current model of care endorsed by the BGS [45]. The current BGS guideline, the 2007 BOA/BGS Blue Book, is based on this model and sets out a number of standards of care. Specifically, in

relation to orthogeriatrics, these include admission to a dedicated orthopaedic ward with orthogeriatric medical support from the time of admission and through to the point of discharge with secondary prevention of osteoporotic fractures as well as multidisciplinary falls intervention and prevention [45].

This model is also supported at a national level by guidelines from the National Institute for Health and Care Excellence (NICE) [18]. A study of 494 patients in the UK reported that the joint model of care significantly reduced time to surgery and hospital length of stay [54]. Furthermore, a 2010 systematic review comparing existing models of orthogeriatric care found that the joint model of care had the lowest inpatient mortality rate, the shortest length of inpatient stay and the shortest time to surgery [55].

In the UK, NICE recommends that all patients with a hip fracture be offered a hip fracture programme from the time of hospital admission. This includes 'orthogeriatric assessment, rapid optimisation of fitness for surgery, early identification of individual goals for multidisciplinary rehabilitation to recover mobility and independence, and to facilitate return to pre-fracture residence' [18]. The specific components of most organisational orthogeriatric care pathways do vary, but generally, they include four main steps: pre-operative care, post-operative care, rehabilitation along with secondary prevention

of fragility fractures, and clinical and service governance of the care pathway. A summary of these steps, adapted from the 2007 BOA/BGS Blue Book and systematic review of an orthogeriatrics model of care by Martinez-Reig et al., is provided in Table 2 [45, 56].

Pre-operative assessment of frail older patients has become a focus of interest for both orthogeriatricians and anaesthetists. It requires skills in comprehensive geriatric assessment and recognising the significance of different co-morbidities

Table 2 Summary of steps involved in orthogeriatric care for frail elderly patients with a fragility fracture

Pre-operative care

1. Early radiological diagnosis: MRI/CT if plain radiographs are equivocal
2. Comprehensive clinical assessment for other injuries or medical illness
3. Appropriate pain management: consider regional analgesia procedures in the emergency department (ER)
4. Preoperative investigations: chest X-ray, ECG, full blood count, clotting studies, renal function, group and save
5. Assessment and documentation of cognitive baseline function at admission
6. Venous thromboembolism prophylaxis
7. Intravenous replacement/resuscitation to commence in ER
8. Safe and timely transfer from ER to an orthogeriatric ward
9. Identify and treat exacerbations of chronic medical conditions or acute medical illness with involvement of specialist medical review when appropriate
10. Liaison and clear communication between orthogeriatric team, orthopaedic surgeons and anaesthetists to plan for surgery within 36–48 h of admission

Post-operative care

1. Pain management guided by assessments of pain levels
2. Antibiotic prophylaxis completion according to local microbiology guidelines
3. Correction of post-operative anaemia in conjunction with local transfusion protocols
4. Routine systems examinations as part of clinical assessment
5. Regular assessment of cognitive function to detect and manage post-operative delirium
6. Assessment for pressure sores, nutritional status and renal function
7. Assessment and regulation of bowel and bladder function
8. Wound assessment and care: normally performed with surgical team
9. Early mobilisation: weight bearing status guided by surgical team
10. Falls assessment and blood tests to screen for osteoporosis

Rehabilitation and discharge planning

1. Multidisciplinary assessment of ongoing health, functional and social needs
2. Liaison or referral to outpatient rehabilitation, medical and social services
3. Commencement of treatment for secondary prevention of fragility fractures based on national or local guidelines
4. Communication of ongoing medical needs to general practitioner

Clinical and service governance of the care pathway

1. Contribute to national registry datasets
2. Participate in morbidity and mortality meetings with the orthopaedic surgical team
3. Conduct audit of ongoing clinical practice

together with any reversibility. Delay to theatre to enable optimisation of acute medical problems has to be weighed up against the effects of prolonging pain and immobility. An understanding of polypharmacy and the likely effects of medications in the peri-operative period are also essential. The Association of Anaesthetists of Great Britain and Ireland have published clinical practice guidelines, and this guidance details in great depth anaesthetic management for patients with a hip fracture, based on existing clinical evidence as well as expert consensus [57].

Which fragility fractures require orthogeriatric care?

Since the inception of orthogeriatrics, most of the published research in this field has examined its application to patients with a hip fracture, with research in this area growing exponentially (Fig. 2). This focus on hip fracture care is not surprising given that hip fractures cause significant patient morbidity and mortality, along with substantial healthcare costs [58]. However, other fragility fractures are common in frail older patients and may also result in substantial patient morbidity [59]. Furthermore, major trauma in frail older patients is increasing, and the vulnerability of this subgroup of patients is well recognised [60].

Vertebral osteoporotic fractures are common with advancing age and result in significant patient morbidity and mortality [61]. The benefit of orthogeriatric care for patients with this injury is lacking in the scientific literature; however, perhaps owing to the experiences of key opinion leaders within the field, the Australian and New Zealand Society for Geriatric Medicine (ANZGSM) has endorsed orthogeriatric care for patients with vertebral fractures [1], and a recent review on the future of orthogeriatrics in the UK stated that the role of the orthogeriatrician in the management of these patients was critical [62]. The evidence base for orthogeriatric management of other fragility fractures including the wrist, pelvis, sacrum and ankle is also lacking; however, the ANZGSM's position statement on orthogeriatrics supports the role of an orthogeriatric model of care for all patients with such injuries [1]. It is likely that future of orthogeriatrics will involve managing all older inpatients with fragility fractures. Although the rationale for geriatrician involvement in the management of frail older orthopaedic patients may appear logical, more research is required to provide an evidence base that justifies resource allocation in the same way that existing research supports the clinical benefits and cost effectiveness of orthogeriatrics for patients following hip fracture [63].

The impact of fragility fracture often continues after recovery from the acute episode with a high risk of functional decline, further falls, subsequent fractures, significant morbidity and increased all-cause mortality once the patient has been

Cumulative number of publications

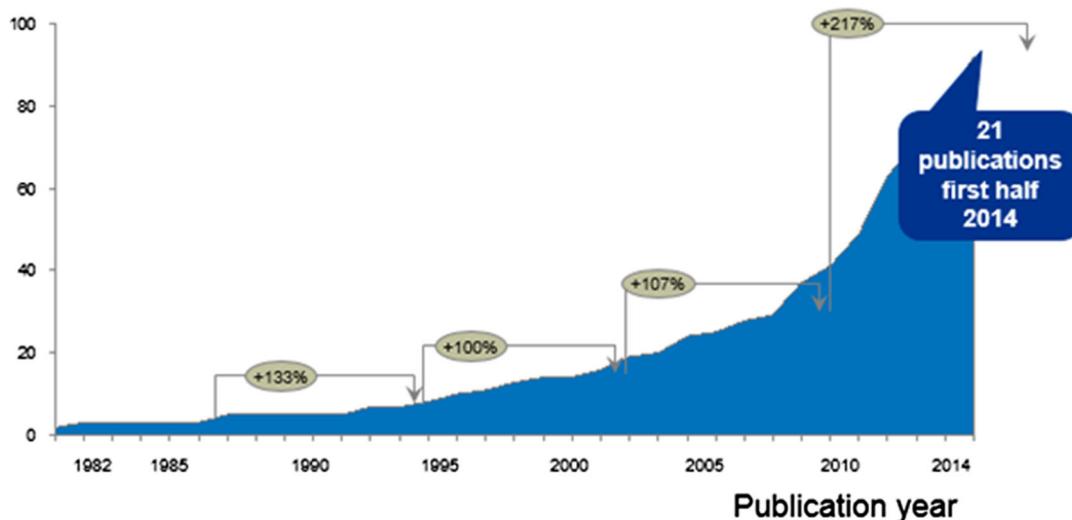


Fig. 2 Graph demonstrating year on year increase in orthogeriatric-related publications (taken with permission from Dr. Frede Frihagen, Department of Orthopaedic Surgery, Oslo University Hospital)

discharged from secondary care [40, 41, 64]. Discharge to the community should be preceded by a comprehensive geriatric assessment with a focus on preventing further falls and fractures [65]. This often requires ongoing community assessment with exercise programmes aimed to improve gait and balance [66] and may require follow-up in a medical falls clinic [67]. Inclusion of outpatient rehabilitation and clinical management in existing guidance for fragility fracture pathways is a domain that warrants consideration as orthogeriatric models of care continue to evolve.

What is the evidence base for orthogeriatric care?

The evidence base that evaluates orthogeriatric practice is large (Tables 3 and 4); however, the applicability of much of the existing research to clinical practice has been limited by the quality of the studies and heterogeneity between the trials [19, 72]. This heterogeneity includes generic differences in study methodology, outcome measures and the use of different models of orthogeriatric management. Looking towards future research that evaluates hip fracture management, it is possible that outcome measures will become more homogenous. Organisational consensus, such as that from The Editorial Society of the Bone and Joint Journal, which recently published agreed core outcome measures for hip fracture trials [73], should make evaluating and drawing conclusions from the collective evidence base in hip fracture research easier and allow the impact of interventions such as orthogeriatric management to be better assessed.

Despite the limitations of a significant proportion of existing studies, a number of high quality studies have been

published over the last 10 years, and these have been subject to meta-analysis of their outcomes which have provided important conclusions on the benefits of orthogeriatric practice in relation to the specific outcomes of interest [19].

Effect of orthogeriatric care on inpatient mortality

Inpatient mortality is a commonly used outcome measure but can vary significantly depending on a hospital's service configuration. Often, it may be directly related to length of stay and the ability to fast-track a dying patient to the community for end of life care. Inpatient mortality may be a useful surrogate marker of quality of care for evaluating the introduction of orthogeriatric management when discharge practices are unchanged but should be used with caution when comparing one service with another.

The largest study to date that examined the effect of orthogeriatric care on inpatient mortality was published by Fisher et al. in 2006 [46]. This hip fracture study compared a prospective cohort of 447 patients who received an orthogeriatric model of joint management with a retrospective control of 504 patients who received a reactive consultation model of geriatric management. The joint management group of patients had an inpatient mortality rate of 4.7 % compared to 7.7 % in the control group, and this was found to be statistically significant.

The largest randomised controlled trial that has evaluated the effect of orthogeriatric management on inpatient mortality included 319 patients with a hip fracture and was published in 2005 [20]. The intervention group received an orthogeriatric model of joint management, and the control group was managed by the orthopaedic surgeon in conjunction with a reactive

Table 3 Summary of evidence base related to impact of orthogeriatric care on inpatient mortality and long-term mortality (≥ 6 months following fracture)

Author (year)	Study design	Study size (<i>n</i>)	Inpatient mortality in control group (%)	Inpatient mortality in intervention group (%)	Long-term mortality in control group (%)	Long-term mortality in intervention group (%)
Fisher et al. (2006) [46]	Prospective observational study with retrospective cohort.	951	7.7	4.7*	-	-
Antonelli Incalzi et al. (1993) [68]	Prospective observational with retrospective cohort	503	18	8.4*	-	-
Vidan et al. (2005) [20]	Randomised controlled	319	5.5	0.6*	25.3	18.9
Stenvall et al. (2007) [51]	Randomised controlled	199	7.2	5.9	18	16
Friedman et al. (2009) [47]	Retrospective cohort study	314	2.5	1.6	-	-

*Significant difference between control and intervention

consultation model of geriatric management. The intervention group had an inpatient mortality rate of 0.6 % compared to the control group's mortality rate of 5.8 %, and this was also statistically significant. Although there is evidence to support orthogeriatric management in improving inpatient mortality rates, a few studies fail to demonstrate a statistically significant benefit [47, 51]. A recent meta-analysis of nine studies comparing an intervention group that received orthogeriatric management in the form of a liaison service, post-operative management or a joint model of care with a control group that received reactive geriatric consultation model of care found that there was a statistically significant improvement in inpatient mortality rates in the intervention group (relative risk 0.60, 95 % confidence interval 0.43–0.84) [19].

Effect of orthogeriatric management on long-term mortality

Long-term mortality for patients after hip fracture is often measured as death occurring between 6 months and 1 year following the patient's injury [19]. A large number of hip fracture studies have examined the effect of orthogeriatric management on long-term mortality, and interestingly while many show trends in improved long-term mortality rates, none appear to have demonstrated a statistically significant benefit. Vidan et al. conducted a randomised controlled trial that examined the benefit of a joint model of orthogeriatric care over a reactive consultation model, and although the 12-month mortality rate dropped from 25.3 to 18.9 %, this difference was not found to be statistically significant [20]. Stenvall et al. published the results of their randomised controlled trial that examined an orthogeriatric management intervention in 2007 and reported a drop from 18 to 16 % in 12-month mortality rate within the control group; however, their finding also failed to reach statistical significance [51]. Their study methodology was different in that the orthogeriatric intervention they evaluated was not a joint care model but a post-

operative geriatric ward model. Meta-analysis of Grigoryan et al. defined long-term mortality as death occurring at any time between 6 months and 1 year following the hip fracture. This study compared all models of orthogeriatric care against a reactive consultation model and found that overall, there was a statistically significant reduction in long-term mortality (relative risk=0.83, 95 % confidence interval 0.74–0.94) [19]. However, owing to the small number of studies that met their inclusion criteria and considerable heterogeneity between the trials, subgroup analysis was only possible for a model of orthogeriatric care that involved routine geriatric consultation on an orthopaedic ward without integration of care or shared responsibility. This analysis did demonstrate an overall significant reduction in long-term mortality rates (relative risk 0.78, 95 % confidence interval 0.65–0.95).

Effect of orthogeriatric management on inpatient morbidity

Post-operative complications for patients with a hip fracture include delirium, infection, acute kidney injury, pressure ulcers, thromboembolic disease and decompensation of co-morbidities such as diabetes, heart disease and respiratory conditions. Early orthogeriatric management is recommended in order to predict complications, prevent them where possible and manage them appropriately when they occur. The evidence base supporting orthogeriatric management is widespread in relation to reduction of morbidity in patients with hip fracture. Friedman et al. retrospectively reviewed 193 patients that received an orthogeriatric joint model of care and compared them with 121 patients who received a reactive consultation model. They found that there was a statistically significant reduction in post-operative infection, venous thromboembolism and cardiac complications within the joint care group [47]. The 2012 prospective controlled trial by Deschodt et al. compared a model of care that involved regular peri-operative orthogeriatric assessment with a usual model of care and found a statistically significant higher number of

Table 4 Summary of evidence base for effect of orthogeriatric care on length of stay, time to surgery and functional outcome

Studies that evaluated the effect of orthogeriatric care on length of stay				
Author	Study design	Study size (n)	Mean length of stay in control group (days)	Mean length of stay in intervention group (days)
Gonzalez-Montalvo et al. (2010) [21]	Quasi-randomised controlled	224	18	12*
Khasaraghi et al. (2005) [69]	Retrospective cohort study	510	8.1	5.7*
Studies that evaluated the effect of orthogeriatric care on time to surgery				
Author	Study design	Study size (n)	Mean time to surgery in control group (days)	Mean time to surgery in intervention group (days)
Leung et al. (2011) [48]	Retrospective cohort review	548	2.3	1.9*
Friedman et al. (2009) [47]	Retrospective cohort study	314	1.6	1*
Adunsky et al. (2011) [70]	Retrospective cohort review	3114	2.9*	3
Studies that evaluated the effect of orthogeriatric care on functional outcome				
Author	Study design	Study size (n)	Effect on short-term functional outcome (≤ 3 months post-injury)	Effect on long-term functional outcome (≥ 1 year post-injury)
Adunsky et al. (2011) [70]	Retrospective cohort review	3114	Improved Functional Independent Measure scores in intervention group	–
Shyu et al. (2008) [50]	Randomised controlled	162	Improved walking and self-care ability as well as fewer depressive symptoms	Improved walking and self-care ability as well as fewer depressive symptoms
Vidan et al. (2005) [20]	Randomised controlled	319	Higher recovery of activities of daily living and Functional Ambulation Classification in intervention group	No difference in recovery of activities of daily living and Functional Classification between groups
Deschodt et al. (2013) [71]	Meta-analysis	4435 (in 11 studies)	No improvement in functional outcome in intervention group	No improvement in functional outcome in intervention group

*Significant difference between control and intervention

episodes of delirium in the latter group, along with more cognitive decline at the time of hospital discharge [49]. Randomised controlled trial by Marcantonio et al. in 2001 compared the effect of regular peri-operative geriatric review of patients with hip fracture with a usual model of care, and the authors reported that their proactive geriatric consultation intervention reduced delirium by over one third [74].

Orthogeriatric management has also been attributed with reducing the incidence of falls and pressure sores after a hip fracture surgery [20, 75], and both orthogeriatric liaison as well as joint care models have demonstrated improvements in all-cause inpatient morbidity [19].

Effect of orthogeriatric management on time to surgery

Early surgery in patients with hip fracture is associated with lower mortality and morbidity rates [76]. This is the rationale for national guidance, such as the NICE guidelines, which recommends that surgery is performed within 36 h of admission to hospital [18]. Leung et al. performed a retrospective review of 548 patients with hip fracture who received either regular peri-operative orthogeriatric input or a usual model of orthopaedic care [48]. The time to surgery was 17 % shorter, and the 12-month mortality rate was 8.9 % less in the intervention group, with both outcomes achieving statistical significance. Another retrospective review reported that a joint orthogeriatric model of care reduced the mean length of time to surgery by 13.3 h [47]. Although evidence exists that suggests that orthogeriatric care can actually increase the time to surgery [70], evaluation of the evidence base as a whole through meta-analysis has revealed that overall, orthogeriatric involvement significantly reduces the time patients with hip fracture wait for surgery (standardised mean difference -0.10 , 95 % confidence interval -0.22 to 0.02) [19].

Effect of orthogeriatric management on length of stay in hospital

The incidence and financial burden of hip fractures are underlined by the fact that they are reported to be the second most common cause of hospitalisation in elderly patients in Canada [77]. Many factors affect length of stay including previous level of functioning and peri-operative complications [78]. A decline in function and independence often results in frail older patients requiring a permanent increased level of support or institutionalisation [79]. Recognising those who will benefit from slow-stream rehabilitation and those who have reached a plateau requires experience working with older people and a multidisciplinary approach. Length of stay for patients following hip fracture is often reported as an outcome measure of interest [19] because reductions in length of stay may reflect proactive care and improved clinical outcomes

[80]. However, length of stay should be matched to discharge destination and pre-existing levels of independence to ensure that reduction in length of hospital stay does in fact relate to improved clinical outcomes.

A 2010 quasi-randomised study in Spain compared a joint orthogeriatric model of care with a reactive consultation model [21]. A joint model of care reduced the inpatient length of stay by 33 %. A 2005 US study that compared a multidisciplinary hip fracture pathway, which included orthogeriatric care, with a usual model of care in a retrospective review of 510 patients also reported a reduction in the length of hospitalisation by approximately 30 % [69]. Grigoryan et al. reviewed 18 hip fracture studies that evaluated length of stay as an outcome after implementation of an orthogeriatric care model and found a significant reduction in the duration of hospitalisation (standardised mean difference -0.25 , confidence interval -0.44 to -0.05) [19]. Subgroup analysis of regular geriatrician review, geriatrician led care and joint care models also revealed significant reduction in the length of hospitalisation for patients. Despite persuasive statistical evaluation suggesting that length of stay can be reduced, it should be noted that this analysis did not account for institutional case mix from the included studies in terms of pre-morbid health, and social or functional state.

Effect of orthogeriatric management on long-term functional outcome

Loss of functional independence is a recognised long-term sequela of hip fracture [81]. Functional outcomes are particularly poor for those already resident in a nursing home [82]; however, deterioration in health-related quality of life is common amongst all patients [83]. Early reporting from the Sheba model of post-operative orthogeriatric care in Israel demonstrated a twofold chance of successful rehabilitation when their model was applied compared to a reactive geriatrician consultation model [84]. Prospective randomised study of Shyu et al. in Taiwan demonstrated that after introducing an orthogeriatric liaison service, patients with hip fracture had significantly better activities of daily living (ADLs) scores, were more likely to recover to their previous level of walking ability and also had fewer depressive symptoms [50]. The evidence supporting long-term functional improvement is weak, and a meta-analysis of 11 studies failed to demonstrate an improvement in long-term functional outcomes after implementation of an orthogeriatric model of care [71].

What is the financial burden of orthogeriatric management?

Globally, an ageing population and scarcity of healthcare resources mean that health services are increasingly required to

consider treatment alternatives that are cost-effective [85, 86]. Della Rocca et al. performed a cost analysis on a retrospective cohort study that compared co-management of patients with hip fracture by geriatricians and surgeons with a usual reactive model of orthogeriatric care [87]. They found that on average, the co-management hip fracture group saved \$13,737 per patient with trends towards improvement in 1-year mortality. Miura et al. examined the cost of implementing a geriatrician led hip fracture service in the USA and reported that it was not only cost saving but cost effective [80]. Ginsberg et al. performed a cost utility analysis comparing their Sheba model of orthogeriatric management to a reactive orthogeriatric service and concluded that joint care was more cost effective providing additional quality-adjusted life years at a reduced institutional cost per patient [88].

What is the future of orthogeriatric management?

The applicability of orthogeriatric services, particularly with reference to a joint model of care, has dramatically increased over the last decade, as the evidence base to support it has grown, and as a result, national guidance has recommended its implementation [18]. As the uptake of orthogeriatrics increases, the capability for generating more robust research into its effects on patient outcomes is likely to improve. Furthermore, the availability of data from national audit projects such as the National Hip Fracture Database in the UK [89] will allow prospective epidemiological research to be conducted evaluating the effect of compliance with national guidance on morbidity, mortality and treatment costs. The study of long-term functional outcomes in patients with hip fracture following orthogeriatric management and the study of the effect of orthogeriatric management on frail older patients with other fragility fractures are two research domains that should be developed.

It is also important to recognise that differences in health systems and social conditions will generate different models of care. Many countries do not have geriatricians, and older patients are managed by internists and other medical specialists. Furthermore, pre-operative assessment may be undertaken by emergency physicians or anaesthetists, and physiatrists or rehabilitation specialists may oversee post-operative care as well as falls assessment and intervention. Bone health review may be undertaken by several different specialists including endocrinologists and rheumatologists. However, it is crucial that those managing frail older patients with fragility fractures are experienced in the principles of orthogeriatric clinical practice. Over the last decade, orthogeriatricians have developed to become proficient in pre-operative assessment, optimising patients for theatre, liaising with families and setting expectations, managing post-operative care to reduce complications, working within the multi-disciplinary team to

ensure comprehensive geriatric assessment including falls risk assessment and bone health assessment whilst understanding and weighing up the evidence with the priorities of the individual patient. Their role often includes leadership and co-ordination across the whole pathway from the point of fracture until recovery. In addition, they are often involved in writing policies and protocols, in training and education and in the clinical governance of the whole service. Many of these aspects that a joint model of orthogeriatrics brings are difficult to measure but undoubtedly add to quality of care.

Conclusion

The role of orthogeriatric models of care in the management of frail patients with fragility fractures is increasing as a result of national standards and guidance that are supported by an evidence base that demonstrates reduced rates of patient mortality and morbidity with improved cost-effectiveness of treatment. Much of this evidence base relates to hip fractures, and although the pathogenesis of injury and prognosis may be similar for frail elderly patients with other fragility fractures, there is a need to develop research for this group of patients to better inform current clinical practice.

Conflict of interest None.

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