

**IDENTIFYING OUTCOMES ASSOCIATED WITH CO-MANAGED, CARE  
MODELS FOR PATIENTS WHO HAVE SUSTAINED A HIP FRACTURE: AN  
INTEGRATIVE LITERATURE REVIEW**

Genni Lynch RN, Grad Cert Diabetes Education

Research Nurse

Orthopaedic Unit

Princess Alexandra Hospital

199 Ipswich Rd

Woolloongabba 4101

Queensland

Australia

Telephone: +617 31766640

Mobile: +438085284

email: [Genni.Lynch@health.qld.gov.au](mailto:Genni.Lynch@health.qld.gov.au)

Dr Marion Tower RN PhD

Senior Lecturer

School of Nursing & Midwifery

University of Queensland

Mater Clinical School

Mater Education Unit

Level 4 Corporate Services

Raymond Tee

South Brisbane

QLD 4101

Dr Lorraine Venturato RN PhD

Associate Professor

Faculty of Nursing, University of Calgary

2500 University Drive NW, Calgary, T2N 1N4, Alberta, Canada

Adjunct Associate Professor

Centre for Health Practice Innovation, Griffith Health Institute

Griffith University, Nathan QLD 4111, Australia

## ABSTRACT

### Aims and objectives:

The aim of the integrative literature review is to: identify themes associated with improved patient outcomes related to orthogeriatric co-managed inpatient unit models of care for patients who had sustained a hip fracture.

### Approach:

An integrative literature review was undertaken from 2002 - July 2013 using electronic databases with specific search terms.

### Methods:

The theoretical framework of Whittemore and Knafl (2005) was used to guide the review. This framework was chosen as it allows for the inclusion of varied methodologies and has the capability to increase informed evidence-based nursing practice (Whittemore & Knafl, 2005).

### Results:

Five distinct themes related to outcomes emerged from the analysis, which were: time from admission to surgery; complications; length of stay; mortality; and initiation of osteoporosis treatment.

### Conclusion:

The analysis of this integrative literature review clearly indicates the need for national and international set of agreed upon outcome measures to be adopted to facilitate the comparison of models of care. This would significantly improve the way in which outcomes and costs are

reported further enhancing international partnerships as the health care team strive to achieve overall improvements in the management of older people presenting to hospital with hip fracture.

**Key words**

Fractured neck of femur,

Hip fracture,

Fragility fracture,

Co-managed,

Co-managed care,

Multidisciplinary care,

Ortho geriatric care.

Accepted Manuscript

## INTRODUCTION

Hip fracture is a serious and common health problem, and the incidence dramatically increases with age. Indeed, the majority of hip fractures occur in persons aged 65 years and older (Brauer, Coca-Perraillon, Cutler, & Rosen, 2009). Hip fracture is a common cause of morbidity and mortality and presents complex challenges that require a specialised approach with regard to patient care (Davoli, Pellicciotti, Pignedoli, & Ferrar, 2011).

The notion of orthopaedic surgeons and geriatricians sharing management of hip fracture patients originated in the United Kingdom (UK). Surgeon Lionel Cosin recognised during the 1940's, the need for early and appropriate intervention and commenced multi-disciplinary patient assessment and early rehabilitation, with the support of physiotherapists and engaging in multi-disciplinary patient assessment (Barton & Mulley, 2003). This was later reported in 1957 by Michael Devas, an orthopaedic consultant, in Hastings, England who was an advocate for early surgery and early rehabilitation. He collaborated with geriatrician colleague, Bobby Irvine, to create an orthogeriatric model of care in Hastings, England (Barton & Mulley, 2003). This was the first collaborative approach to the care of the frail, older person with hip fracture. The term "orthogeriatric care" was formally introduced

in the late 1970's with published data relating to patient outcomes appearing in the literature in the mid-eighties (Heyburn, Beringer, Elliott, & Marsh, 2004). Prior to this the traditional model of care for this patient group was and still remains in many health care facilities as admission to an orthopaedic or trauma ward, where the orthopaedic surgeon is responsible for not only the surgical fixation of the fracture, but also the medical management of the patient as well. However, contemporary Australian evidence suggests that an orthogeriatric model of care reduces length of stay (LOS) and can lead to a 45% decrease in the probability of complications such as delirium, congestive cardiac failure (CCF), pneumonia, deep vein thrombosis (DVT), pulmonary embolism (PE), pressure ulcers, arrhythmias, myocardial infarction and mortality. Conversely, Tha et al (2009) argue that the best design and setting of comprehensive hip fracture management in the elderly is unknown. Regardless, the mainstay of treatment is surgical repair and a multidisciplinary, co-managed approach that may maximise patient recovery (Hung, Egol, Zuckerman, & Si, 2012).

In the last decade several models of care have been adopted worldwide in caring for this patient group and these models have generally been based on integration of the two disciplines of orthopaedic and geriatric medicine (Davoli et al., 2011). In a literature review undertaken by Kammerlander et al (2010) the observation was made that whilst it is unclear what the best model of care for hip fracture patients is, there is a trend towards models using an integrated approach to patient care. Specifically, incorporating all the suggested positive features of the various models of care such as a multidisciplinary team approach to care, prioritising the patient from admission to discharge, the incorporation of a geriatrician in the trauma unit and the development of guidelines to guide treatment. A multidisciplinary team (MDT) within the context of orthopaedic care is made up of members from different healthcare professions with specialised skills and expertise, for example, physiotherapists,

occupational therapists, orthopaedic nurses and dieticians. The members collaborate together to make recommendations that facilitate quality patient care (Department of Health, 2013).

The establishment of hip fracture registries is becoming more common internationally. Australia and New Zealand are currently working towards the establishment of the Australia and New Zealand Hip Fracture Registry (ANZHFR). Hip fracture registries aid in the establishment of guidelines, the definition of standards of care and measurable quality indicators. Ultimately registries allow for comparison of meaningful data, which in turn may be used to understand and improve practice.

### **Models of care**

A model of care is a multifaceted concept, which largely defines the way health services are delivered to provide patient care. A robust model should be underpinned by the best available evidence and informed by sound conceptual and theoretical principles (Davidson, Halcomb, Hickman, Phillips, & Graham, 2006). Over several decades, models of care for the management of the older hip fracture patient have emerged in an attempt to improve overall outcomes of this growing patient population. These models have sought to minimize in-hospital complications, streamline hospital care, facilitate early discharge and reduce costs associated with hip fractures (Giusti, Barone, Razzano, Pizzonia, & Pioli, 2011). There are various models associated with the co-management of care for the elderly patient with a hip fracture described in the literature, however, it remains unclear what is the best model in terms of favorable outcomes for this group of patients. Wakeman, Sheard, and Jenner (2004) using an adaptation of work by (Heyburn et al., 2004), describe four models of care described in Table 1, used in Britain to manage hip fracture:

Cameron and colleagues (2005) define ortho geriatric care as medical care for older patients with orthopaedic disorders that is provided collaboratively by orthopaedic services and aged care or rehabilitation services (see fig1). The patient is assessed by the geriatric team pre and postoperatively and rehabilitation may occur in this setting or in a step down rehabilitation unit.

Local preferences and resources determine the model adopted. Notably, models of care based on orthogeriatric co-managed care have demonstrated better outcomes than the more traditional models (G Pioli, Giust, & Barone, 2007). Orthogeriatric care provides collaborative care by specialised medical, nursing and allied health staff from admission in the emergency department through to discharge, highlighting the importance of early comprehensive and collaborative care involving the patient and their family. Several studies including Adunsky et al (2005), Chong et al (2008), Collinge et al (2013), Dy et al (2012), Fergus et al (2011), Fisher et al (2006), Folbert et al (2012), Friedman et al (2009), Gregersen et al (2012), Kammerlander et al (2010), Kates et al (2010), Leung et al (2012), Sivakumar et al (2012), Teo et al (2012), Tha et al (2009) and Vidan et al (2005) all reported a trend towards better outcomes with variations within orthogeriatric care. The evidence from using these models all suggest, reduced length of stay (LOS), reduced medical complications in hospital and lower mortality (Aged Health Network Orthogeriatric Group ACI, 2010). Studies related to co-managed models of care from around the world echo these findings, reinforcing that co-managed care in hip fracture is the gold standard model of care (Friedman, Mendelson, Bingham, & Kates, 2009; Kammerlander et al., 2010; Giulio Pioli et al., 2012). There are, however, some differences in the implementation of orthogeriatric care used internationally. The difference, generally relates to which health care professional has overall responsibility for the management of the patient.

The purpose of this integrative literature review was to explore emerging themes in order to identify improved patient outcomes related to orthogeriatric, co-managed, inpatient unit models of care for patients who have sustained a hip fracture.

## **THE REVIEW**

### **Aims**

The aim of the integrative literature review was to: identify themes associated with improved patient outcomes related to orthogeriatric co-managed inpatient unit models of care for patients who had sustained a hip fracture.

### **Design**

The theoretical framework of Whitemore and Knafl (2005) was used to guide this integrative review and provide rigor and transparency. This framework was used as it has the capability to synthesis evidence and increase evidence-based nursing practice (Whitemore & Knafl, 2005). The five stages of an integrative review as outlined by Whitemore and Knafl were used and are described below in Table 2.

## **METHODS**

### **Search methods**

Sampling the literature is essential in enhancing rigour (Whitemore & Knafl, 2005). To ensure an up-to-date approach to the issue, a computerised review of published literature from 2002 to July 2013 was undertaken. PubMed, Medline and CINAHL databases were searched with the headings 'fractured neck of femur', 'hip fracture', 'fragility fracture', 'co-managed OR co-managed care' 'multidisciplinary care OR ortho geriatric care'. The utilisation of key words, inclusion and exclusion criteria facilitated a focussed literature

search on the objectives of the review as depicted in Table 3. The search was limited to peer review articles, published in English. Studies identified in the literature search were firstly reviewed, based on their abstract and if they did not evaluate a co-managed model of care they were excluded. Qualitative and quantitative studies and opinion pieces were reviewed. Reference lists from selected key journal articles were also reviewed for further identification of potential studies.

### **Search outcome and Quality Appraisal**

The primary search generated 102 titles that were imported into EndNote bibliographic management system software. Duplicates were excluded and titles and abstracts were reviewed and read. Articles for inclusion were based on the inclusion and exclusion criteria. Full articles were read when an abstract contained inadequate detail. A total of 18 articles, one literature review and one systematic review and meta-analysis met the inclusion criteria and formed the basis of the review.

### **Data abstraction and synthesis/ analysis**

Whittemore & Knafl (2005) suggest that methods of data analysis remain poorly formulated, and that explicit methods for data analysis are required to guard against bias (Whittemore & Knafl, 2005). In this integrative review each article was read and re-read then summarised according to the model of care. Outcome data was organised in a separate spreadsheet to enable systematic comparison of data. Once themes emerged these were then summarized and uploaded into the main review document. The goal of the analysis and synthesis of the data as suggested by Whittemore & Knafl (2005) is to present a thorough and unbiased interpretation of the primary sources. Sandelowski (2000) suggests that qualitative descriptive study is the preferred method when descriptions of phenomena are desired.

Additionally, a descriptive summary of each article was added to the main document (see Table 4). Studies were grouped, examined and critiqued according to the model of care implemented on admission for the hip fracture patient. In-hospital mortality, length of stay, time to surgery and complication rate are the most frequently used outcome parameters, however, not all these outcomes are discussed or measured in each paper. To ensure rigour, papers were also reviewed by two reviewers (LV & MT).

## RESULTS

The evolution of care for the older person with a fractured neck of femur has developed worldwide into a model of care that recognises the importance of early comprehensive assessment, streamlined timely care, early mobilisation and a collaborative multidisciplinary team approach to patient centred care, Friedman et al (2009) Pioli et al (2011) and Kates et al (2010).

Analysis of the papers in the integrative review identified five distinct themes associated with improved patient outcomes related to international, co-managed, multi-disciplinary inpatient unit models of care for patients who had sustained a hip fracture. Themes were common across all types of literature reviewed. These themes were:

- time from admission to surgery,
- complications,
- length of stay
- mortality
- initiation of osteoporosis treatment

These themes were all based around Model D: orthogeriatric care. The analysis of the

literature was framed using the models of care as described by (Wakeman, Sheard, & Jenner, 2004).

### **Time from admission to surgery**

Of the eighteen studies included in the review nine reported a reduction in time from admission to surgery in Model D. Five of the studies did not report on time from admission to surgery and three reported no significant improvement on this outcome. The theme identified the need for prompt surgery and the demand for hospitals to provide efficient, streamlined care. The theme focused on the measurement of time from admission to surgery as a mean number of hours. Chong et al (2008), Collinge et al (2013) Leung et al (2011), Teo et al (2012) identified the major cause of a delay to surgery to some extent, being patients medically unfit and the rest of the delay due to a lack of theatre availability. Sivakumar et al (2012) discussed having dedicated hip fracture lists and an emphasis on rapid fixation. Kammerlander et al (2010) discussed prioritising all patients for surgical management from the emergency department. Kates et al (2010) stated that early surgery is fundamental to the concept of Model D. Leung et al (2011) reported a shorter time from admission to surgery in Model D when comparing it to Model A ( $p = 0.02$ ). They hypothesized this was due to pre-operative geriatric input facilitating early diagnosis and management of concurrent medical conditions and quicker optimisation of existing co-morbidities. Vidan et al (2005) also reported a reduction in time from admission to surgery though it should be noted that this finding was not statistically significant. Pioli et al (2011) suggested that surgical delay may significantly affect long-term outcomes and may in some part explain the differences in results from various hospitals. Friedman et al (2009) reported that a delay to surgery has an impact on length of stay and went on to state that, in their program, both the orthopaedic surgeon and geriatrician agreed that there was a connection between surgical delays and risk

of adverse outcomes. Friedman et al (2009) in the comparison of Model A and D, and after adjusting for age, sex, race and dementia reported patients accessing surgery approximately half a day earlier in Model D ( $p=0.02$ ).

The literature reflects a commonality that medically fit hip fracture patients should be operated on the day of, or the day after admission, preferably within 48 hours from admission and during daylight working hours. Liem et al (2012) reported a shorter time to surgery has been associated with a decrease in complication rate and LOS. Kates et al (2010) discussed the frequently occurring condition of poly pharmacy where more than six to nine medications have been prescribed in the elderly hip fracture patient. Jyrkka et al (2009) reported that over half of elderly persons using five or more different types of drugs daily were taking either, drugs that were not necessary, drugs that represent therapeutic duplication or drugs that did not have a clear indication of use. To adequately determine the required medications in an elderly patient presenting acutely to hospital has the potential to delay surgery for a considerable length of time. The early involvement of a geriatrician particularly pre-operatively to adequately determine the required medications for an elderly patient presenting acutely to hospital seems most appropriate to enable timely surgery and reduce the potential for surgical delays related to these medication issues. Leung et al (2011) discussed limitations within their study and cited the Hawthorne Effect, an effect that sees bias when people are being studied (Cherry, 2013). Vidan et al (2005) stated that their trial may be limited by the open nature of the study, which may have led to unintentional bias. Folbert et al (2012) found no difference in time from admission to surgery when comparing Model A and Model D, stating the small sample size was a limitation of the study and concluded future large scale randomised studies were needed to confirm their results.

### **Complications**

The reporting of complications was varied amongst the studies. Fifteen of the nineteen studies reported on complications. It was not apparent that there was any consensus regarding the definition of a complication post hip fracture. Kates et al (2010) reported on delirium, re-admission and re-operation rates, whereas Dy et al (2012) reported on nine individual complications and then grouped them together and described 'any complication', which resulted in statistically significant result, ( $p=0.05$ ). Interestingly in Dy's (2012) study, which compared Model A and Model D, no difference was reported in LOS or time from admission to surgery, however, a reduction in complications was reported. This is interesting as one would expect a reduced LOS if there is a reduction in complications. Dy (2012) stated this was likely the result of early discharge planning being a continued focus of the unit. Chong et al (2008) reported in their study the prevalence of cardiac complications post operatively at 58%. Sivakumar et al (2012) reported 55.9% of patients required blood transfusion post-operatively, however this was not recorded as a complication. Sivakumar et al (2012) also reported 54%, of their patient's experienced post-operative delirium. Delirium was the most commonly reported complication across all the studies, though varied classification makes it a very difficult outcome to compare. Fergus et al (2011) state in their study that the sample size of 115 patients, was a limitation of the study as it was difficult to comment on the effect of complications and mortality. Nevertheless they did state that dementia was a common comorbidity that might impact on a longer length of hospital stay and a higher level of dependency upon discharge that was reported in their study.

### **Length of stay (LOS)**

All nineteen of the articles reported on LOS. This may be due to the fact that it is an easily accessed statistic and is important because it impacts on hospital costs. It is important to note that the method LOS was reported on across institutions and times of LOS varied

across studies. LOS, as defined by the Agency for Healthcare Research and Quality, (US Department of Health and Human Services, 2013) as the number of nights a patient remained in hospital for his or her stay. Both Fisher et al (2006) and Dy et al (2012) found no differences in LOS when comparing Model A and Model D. Sivakumar et al (2012) reported a mean LOS of 18.1 days; however, this incorporated acute care and early rehabilitation in the same ward while. Conversely, Kates et al (2010) reported discharge usually occurs on the third hospital day (mean LOS of 4.3 days) thereby only reflecting the acute phase of the admission. Patients are either discharged to a skilled nursing facility or to a rehabilitation unit. A cornerstone of the Geriatric Fracture Center (GFC) described by Friedman et al (2009) is the commencement of discharge planning on admission. The GFC reported a LOS in Model D of 4.6 days with a ( $p = 0.001$ ). Leung et al (2011) also report a statistically significant reduced LOS in Model D ( $p = 0.001$ ) as did Adunsky et al (2005) ( $p = 0.01$ ).

### **Mortality**

Mortality was a prominent theme, reported in seventeen out of the eighteen articles, suggesting it is a commonly used outcome parameter. In most cases, mortality was reported as in-hospital mortality and where indicated compared between models of care, Friedman et al (2009), Dy et al (2012), Fisher et al (2006), Leung et al (2011), Vidan et al (2005), Deschodt et al (2011), Gregersen et al (2012), Folbert et al (2012) and Khan et al (2002). Mortality was described in all articles reporting on outcomes in Model D, unfortunately, it was difficult to compare mortality as this varied depending on LOS between models of care Sivakumar et al (2012). In studies that incorporated rehabilitation into LOS, such as, Sivakumar et al (2012), inpatient mortality was reported at 4.9% and post-operative mortality at 3.4%. Gregersen et al (2012), reported no reduction in either in-patient mortality or three-month mortality between models and surmised that it may have been due to a longer time to

surgery in Model D. Information bias may have occurred with various differences in the reporting of mortality rates and should be considered in conjunction with length of stay and transfer rates (Agency for Healthcare Research and Quality, 2013). In this review and as discussed by Liem et al (2012) varying length of inpatient hospital stays across international hip fracture units influenced in-hospital mortality. Khan et al (2002) discussed mortality as an outcome measure and found no statistically significant difference in mortality when pre and post introduction of an orthogeriatric model of care was compared. Collinge et al (2013) also reported no statistical differences in 30 day and one year mortality between pre and post introduction of an orthogeriatric model of care. Tha et al (2009) reported an overall mortality of 3.9%. Kates et al (2010) reported an inpatient mortality of 2.8% and Fisher et al (2006) reported a steady decline in mortality in their unit from 7.7% to 4.7%. Interestingly Dy et al (2012) analysed mortality against ASA grades and found no difference after controlling for covariates.

### **Osteoporosis (OP)**

Osteoporosis is not considered an outcome parameter in itself, nevertheless this theme was relevant to the management of OP with hip fracture patients associated with these models of care. Hip fractures are among the most common consequences of osteoporosis and when an elderly patient is admitted to hospital with a hip fracture, a unique opportunity for treatment presents itself (Gardner, Flik, Mooar, & Lane, 2002). Liem et al (2012) argue every patient presenting with a hip fracture should be assessed on admission and discharge for the use of appropriate osteoporosis medication. Osteoporosis remains an under treated disease Gardner et al (2002) however it is expected that treatment rates will increase with ongoing and sustained educational efforts. OP was less commonly used as an outcome parameter in this integrative review. Notably, Kates et al (2010) suggests, that all patients sustaining a low

energy hip fracture are said to have OP. Eight of the studies mentioned OP or reported on it in some way. Fisher et al (2006) discussed OP treatment in Model A and Model D and reflected that fracture prevention was often ignored prior to Model D. Gregersen et al (2012) reported an increase in treatment of osteoporosis in Model D when compared to Model A. Indeed in the study by Kates et al (2010) patients managed in Model D had vitamin D levels measured and were started on vitamin D therapy immediately with antiresorptive therapy recommended on discharge. This is important as Tha et al (2009) noted that most patients who have sustained a fragility fracture are not assessed for OP and subsequently do not receive antiresorptive therapy.

There appears to be no apparent consensus on the reporting of osteoporosis treatment either on admission or on discharge. This is despite the fact that once a person has had one fragility fracture they are at increased risk of further fractures, known as the ‘fracture cascade’ (Australian Institute of Health and Welfare AIHW, 2010). Osteoporosis treatment and secondary fracture prevention are widely discussed practices within hip fracture units so this finding is a little surprising. Data from the Australian Dubbo OP study Jones et al (1994) indicates that the increase in risk following a fracture persists for up to 10 years and moreover 40% of women and 60% of men will experience a second fracture within this period (Australian Institute of Health and Welfare AIHW, 2010). ‘Within Australia someone is admitted to hospital with an OP fracture every five to six minutes’ (International Osteoporosis Foundation, 2007), unfortunately it remains under reported, under diagnosed and consequently under treated.

## **DISCUSSION**

This literature review highlights a trend towards Model D, co-managed hip fracture

care. In this review models of care based on Model D have demonstrated better outcomes than other models. Internationally it is emerging as the preferred model. The model provides collaborative care by specialised clinicians from admission to discharge. It highlights the importance of early comprehensive and collaborative care involving the patient and their family. Effective collaborative, multidisciplinary teamwork can take different forms; however, it relies on positive attitudes, good communication and information sharing with a collective responsibility for care and outcomes (British Orthopaedic Association, 2007). Importantly it is underpinned by persistence and determination. This includes collecting and analysing data to support the effectiveness of practice (Kates et al., 2010).

Variance in the delivery of the model of care exists around issues within the model, particularly in regard to the health care professional group responsible for the management of the patient Kates et al (2010) significantly, the principal of shared care remains embedded in the model. The Aged Health Network Group (2010) echoes Kates opinion advising the orthogeriatric model of care should be adopted as best practice in the management of the older person presenting to hospital with a hip fracture. Additionally international guidelines such as the NICE guidelines (National Institute for Health and Clinical Excellence, 2011) from the United Kingdom (UK) have been developed, endorsing orthogeriatric collaborative care. The UK National Hip Fracture Database (NHFD), a joint undertaking between the British Geriatrics Society and the British Orthopaedic Association, has been developed to facilitate improvements in the quality and cost effectiveness of hip fracture care and is based on the orthogeriatric model of care.

To date, there has been no agreed upon set of outcome measures recognised internationally to aid comparison of performance between hospitals. As seen throughout this review, the diverse LOS figures highlight the importance of consensus in defining and

measuring LOS across acute, non-acute and rehabilitation in order to facilitate valid comparisons between programs. Definitions around LOS are an important outcome measure particularly when estimating cost of hip fracture care. Notably, since 2007 the UK NHFD has been gradually implemented throughout the UK, enabling patient outcomes to be assessed by all contributing hospitals. The measures assessed include four of the five themes revealed through the review. They are: time from admission to surgery, assessment of OP treatment on admission and discharge, LOS and mortality at 30 days. Complications in general are not recorded, with the exception of pressure ulcers. An international consensus is needed on the most significant surgical and non-surgical complications for reporting purposes. A similar database, the Australia and New Zealand Hip Fracture Registry (ANZHFR) is also being developed. The ultimate goal of the registry is to ‘use data to improve performance and maximize outcomes for older patients sustaining a hip fracture’. An ANZHFR will enable timely comparison of a pre-determined data set to aid comparison between patient outcomes at contributing hospitals and go some way in reducing variation of care that exists within the management of hip fracture patients. The ANZHFR will enable more aligned international reporting and comparisons of care delivered. The aims shared by hip fracture units internationally encompass reducing mortality, improving functional outcomes and enabling a return to previous residence thereby reducing rates of admission to aged care facilities.

### **Limitations**

A limitation of the study was the small number of articles found that matched the search criteria. Due to the variance in reporting of outcome measures only five most commonly reported patient outcomes were identified. A further limitation is that other variables, difficult to isolate in this review that may influence the outcomes measured have

not been considered. Whilst it is difficult to exclude some publication bias, all methods of rigour have been applied to exclude bias.

## **CONCLUSION**

The analysis of the integrative literature review clearly indicates the need for an international set of agreed upon outcome parameters to be adopted to facilitate the comparison of models of care internationally. This would significantly improve the way in which outcomes and costs are reported both nationally and internationally enabling an international partnership as we strive to achieve overall, sustained improvements in the management of people presenting to hospital with hip fracture. In this review time from admission to surgery, complications, length of stay, mortality and osteoporosis identification and treatment emerged as the most frequently assessed outcome parameters. As discussed in this review, a variety of models have been described in the literature with a documented tendency towards better patient outcomes with the implementation of an orthogeriatric model of care. The upcoming establishment of the ANZHFR will enable comparisons of various models of care and quality outcomes between participating hospitals across Australia and New Zealand and enhance national and international benchmarking as we strive to offer exemplary management and care of our patients.

### **Conflict of interest**

No conflicts of interest

**GLOSSARY**

ED	emergency department
LOS	length of stay
OP	osteoporosis
OR	operating room
UTI	urinary tract infection
CCF	congestive cardiac failure
DVT	deep vein thrombosis
PE	pulmonary embolism
UK	United Kingdom
ANFHFR	Australia and New Zealand Hip Fracture Registry
ASA	American Society of Anaesthesiologists
GFC	Geriatric Fracture Centre

Accepted Manuscript

- Aged Health Network Orthogeriatric Group ACI. (2010). The Orthogeriatric Model of Care: Clinical Practice Guide 2010. *Clinical Practice Guide*.
- Agency for Healthcare Research and Quality. (2013). AHRQ Quality Indicators—Guide to Inpatient Quality Indicators: Quality of Care in Hospitals—Volume, Mortality, and Utilization. from <http://qualityindicators.ahrq.gov/>
- Australian Institute of Health and Welfare AIHW. (2010). *The problem of osteoporotic hip fracture in Australia*. Canberra.
- Barton, A, & Mulley, G. (2003). History of the development of geriatric medicine in the UK. *Postgrad med J*, 79, 229-234.
- Brauer, Ca, Coca-Perrailon, M, Cutler, D. M, & Rosen, A. B. (2009). Incidence and mortality of hip fractures in the united states. *JAMA*, 302(14), 1573-1579. doi: 10.1001/jama.2009.1462
- Cherry, K. (2013). About.com psychology. doi: [http://psychology.about.com/od/hindex/g/def\\_hawthorn.htm](http://psychology.about.com/od/hindex/g/def_hawthorn.htm)
- Close, J, Harris, I, Seymour, H, Chehade, M, Ahmad, L, Hau, R, & Mitchell, P. Australian & New Zealand Hip Fracture Registry. doi: <http://anzhfr.org/>
- Davidson, P, Halcomb, E, Hickman, L, Phillips, J, & Graham, B. (2006). Beyond the rhetoric: what do we mean by a 'model of care'? *University of Wollongong Research Online*.

- Davoli, M. L, Pellicciotti, F, Pignedoli, P, & Ferrar, I A. (2011). Comprehensive care. *Eur J Phys Rehabil Med*, 47(2), 265-279.
- Department of Health, Western Australia. (2013). *Multidisciplinary Teams*. Retrieved from [http://www.health.nt.gov.au/Cancer\\_Services/CanNET\\_NT/Multidisciplinary\\_Teams/index.aspx](http://www.health.nt.gov.au/Cancer_Services/CanNET_NT/Multidisciplinary_Teams/index.aspx)
- Dy, C, Dossous, P-M, Ton, Q, Hollenberg, J, Lorch, D, & Lane, J. (2012). The Medical Orthopaedic Trauma Service: An Innovative Multidisciplinary Team Model That Decreases In-Hospital Complications in Patients With Hip Fractures. *Journal of Orthopaedic Trauma*, 26(6), 379-383.
- Fisher, A. A, Davis, M. W, Rubenach, S. E, Sivakumaran, S, Smith, P. N, & Budge, M. M. (2006). Outcomes for Older Patients With Hip Fractures: The Impact of Orthopedic and Geriatric Medicine Cocare. *Journal of Orthopaedic Trauma*. 2013 Mar 19. [Epub ahead of print], Volume 20(3), March 2006, pp 172-180, pp 172-180
- Friedman, S. M, Mendelson, D. A, Bingham, K. W, & Kates, S. L. (2009). Impact of a comanaged geriatric fracture center on short-term hip fracture outcomes. *Archives of Internal Medicine*, 169(18), 1712-1717. doi: 10.1001/archinternmed.2009.321
- Gardner, MI J, Flik, K, R, Moorar, P, & Lane, J. M. (2002). Improvement in the Undertreatment of Osteoporosis Following Hip Fracture. *The Journal of Bone & Joint Surgery*, 84(8), 1342-1348.
- Giusti, A, Barone, A, Razzano, M, Pizzonia, M, & Pioli, G. (2011). Optimal setting and care organization in the management of older adults with hip fracture. *European Journal of Physical Rehabilitation*, 47 (2), 281-296.
- Gregersen, M, Morch, M, & Damsgaard, M. (2012). Geriatric intervention in elderly patients with hip fracture in an orthopedic ward. *Journal of Injury and Violence Research*, 4(4), 45-51.
- Heyburn, Gary, Beringer, Timothy , Elliott, James , & Marsh, David (2004). Orthogeriatric Care in Patients with Fractures of the Proximal Femur. *Clinical Orthopaedics and Related Research*, 425(August 2004), 35-43.
- Hung, William, Egol, Kenneth, Zuckerman, Joseph D, & Si, Albert. (2012). Hip Fracture Management, Tailoring care for the Older Patient. *Journal American Medical Association*, 307(20), 2185-2192.
- International Osteoporosis Foundation. (2007). Osteoporosis Incidence. doi: <http://www.iofbonehealth.org/>
- Jones, G., Nguyen, T., Sambrook, P. N., Kelly, P. J., Gilbert, C., & Eisman, J. A. (1994). Symptomatic fracture incidence in elderly men and women: The Dubbo osteoporosis epidemiology study (DOES). *Osteoporosis International*, 4(5), 277-282. doi: 10.1007/bf01623352
- Kammerlander, C, Roth, T, Friedman, S. M, Suhm, N, Luger, T. J, Kammerlander-Knauer, U, . . . Blauth, M. (2010). Ortho-geriatric service—a literature review comparing different models. *Osteoporosis International*, 21(4), 637-646. doi: 10.1007/s00198-010-1396-x
- Kates, S. L, Mendelson, D. A, & Friedman, S.M. (2010). Co-managed care for fragility hip fractures. *Osteoporosis International*, 21(Suppl 4), 621-625.
- Liem, I.S.L, kammerlander, N, Suhm, N, kates, S.L, & Blauth, M. (2012). Literature review of outcome parameters used in studies of geriatric fracture centres. *Orthopaedic trauma Surgery*, DOI 10.1007/s00402-012-1594-4, 1594-1594.
- National Institute for Health and Clinical Excellence. (2011). The management of hip fracture in adults. In N. c. g. 124 (Ed.).

- Pioli, G, Giust, A, & Barone, A. (2007). Orthogeriatric care for the elderly with hip fractures:where are we? *Aging clinical and experimental Research*, 20(2), 113-121.
- Pioli, Giulio, Frondini, Carlo, Lauretani, Fulvio, Davoli, Maria Luisa, Pellicciotti, Francesca, Martini, Emilio, . . . Lunardelli, Maria Lia. (2012). Time to surgery and rehabilitation resources affect outcomes in orthogeriatric units. *Archives of Gerontology and Geriatrics*, 55(2), 316-322. doi: <http://dx.doi.org/10.1016/j.archger.2011.11.010>
- Tha, H.S., Armstrong, D, Broad, J, Paul, S, & Wood, P. (2009). Hip fracture in Auckland: contrasting models of care in two major hospitals. *Internal Medicine Journal*, 39(2), 89-94. doi: 10.1111/j.1445-5994.2008.01721.x
- US Department of Health and Human Services. (2013). Agency for Healthcare Research and Quality. from <http://www.ahrq.gov/>
- Wakeman, R, Sheard, P. D, & Jenner, G. H. (2004). Ortho-geriatric liaison – the missing link? *Journal of Bone & Joint Surgery, British Volume*, 86-B(5), 636-638. doi: 10.1302/0301-620x.86b5.15502
- Whittemore, R, & Knaf, K. (2005). The integrative review:updated methodology. *Journal of Advanced Nursing*, 52(5), 546-553.

Figure 1 - Orthogeriatric care model

Table 1 - Models of care

Model of care	Pre-operative management	Ward	Post-operative management	Features
A	Orthopaedic surgeon	Orthopaedic/trauma ward	Orthopaedic surgeon	Specialised medical consultation provided in Orthopaedic unit as required
B	Orthopaedic surgeon	Orthopaedic/trauma ward	Orthopaedic surgeon	Multidisciplinary ward rounds in Orthopaedic unit as required
C	Orthopaedic surgeon	Orthopaedic/trauma ward with early transfer to rehabilitation unit	Immediate post-operative period orthopaedic surgeon with early transfer to Geriatric unit	Early transfer to Geriatric Orthopaedic rehabilitation unit, managed by Geriatrician

D	Orthopaedic surgeon & Geriatrician	Orthogeriatric unit	Orthopaedic surgeon & Geriatrician	Orthogeriatric co-managed care
---	------------------------------------	---------------------	------------------------------------	--------------------------------

\*Multidisciplinary team (MDT) - team members from different healthcare professions with specialised skills and expertise (eg. physiotherapists, occupational therapists, orthopaedic nurses and dieticians). The members collaborate together to make recommendations that facilitate quality patient care (Department of Health, 2013)

**Table 2 - Stages of integrative review**

Stage	Application
Problem identification	Many methods of care of the elderly following hip fracture care have been described. Co-managed, multi-disciplinary inpatient units

Literature search	A computerised review of the literature was conducted using PubMed, Medline and CINAHL databases with the headings fractured neck of femur, hip fracture, fragility fracture, co-managed OR co-managed care OR multidisciplinary care OR ortho geriatric care was used. Studies that focused on certain aspects of the hip fracture population for example just males or just hip fracture patients with dementia were also excluded. The review was undertaken from 2000 to published articles in July 2013. Relevant articles cited in the literature review were also read. Review articles with language other than English, studies that were published only in abstract form and letters were excluded.
Data evaluation	By supervisors.
Data analysis	Content analysis of the literature. Studies grouped examined and critiqued A according to key themes.
Presentation	By publication

**Table 3 – Inclusion & exclusion criteria**

Inclusion	Exclusion
<ul style="list-style-type: none"> <li>• Papers published between 2002 and July 2013</li> <li>• Only articles with fractured neck of femur, hip fracture,</li> </ul>	<ul style="list-style-type: none"> <li>• Papers published prior to 2002 were excluded (in an attempt to reflect current trends) or after July 2013,</li> </ul>

<p>fragility fracture, co-managed or comanaged care or multidisciplinary care or ortho geriatric care were included.</p> <ul style="list-style-type: none"> <li>To be included papers had to report on primary research relating to co-managed, multi-disciplinary inpatient units for the care of elderly people sustaining hip fracture published in peer-reviewed journals.</li> <li>Only papers published in English were included</li> </ul>	<p>opinion papers, guidelines and reports were excluded.</p> <ul style="list-style-type: none"> <li>Relevant articles cited in the literature review were read.</li> <li>Review articles with language other than English were excluded.</li> <li>Papers reporting on pathological or high-energy hip fractures were excluded.</li> </ul>
---	---

**Table 4 - 18 papers included in review 1 literature review and 1 systematic review & meta-analysis**

Reference	Country	Sample	Method	Model of Care	Discussion / Results	Strength & Limitations	Time Admission to OR	Complications	Mortality	LOS	OP
-----------	---------	--------	--------	---------------	----------------------	------------------------	----------------------	---------------	-----------	-----	----

Reference	Country	Sample	Method	Model of Care	Discussion / Results	Strength & Limitations	Time Admission to OR	Complications	Mortality	LOS	OP
Friedman	USA Rochester	193	Retrospective cohort study	Compared Model A & Model D	<p>A. Traditional orthopaedic model D. Geriatric Fracture Centre. Outcome measures included; Model D had:</p> <ul style="list-style-type: none"> <li>• lower times from admission to OR p&lt;.007</li> <li>• reduced LOS p&lt;.001</li> <li>• fewer complications with significantly lower risk of delirium, infection, cardiac complications, hypoxia and thromboembolism</li> <li>• no difference in hospital mortality between the two groups</li> <li>• geriatricians and surgeons available seven days a week.</li> </ul>	Strengths-strict definition of variables 10% of records were validated by other team members.	Y	Y	Y	Y	N
Dy et al	USA New York	306	Retrospective cohort	Compared Model A & Model D	<p>A. Traditional orthopaedic model. D. Medical orthopaedic trauma service co-management provided by orthopaedic surgeons, physicians and a dedicated physician extender e.g. a nurse practitioner. Outcome measures included</p> <ul style="list-style-type: none"> <li>• no significant difference between the groups with time from admission to OR</li> <li>• LOS – no difference between the two groups.</li> <li>• Significantly lower incidence of any complication in Model D p&lt;0.05.</li> <li>• New onset arrhythmia p&lt;0.03 and UTI p&lt;0.01 significantly lower in Group 2.</li> <li>• No difference in mortality between the two groups</li> </ul>	Limitation -no follow up of patients.	Y	Y	Y	Y	N

Reference	Country	Sample	Method	Model of Care	Discussion / Results	Strength & Limitations	Time Admission to OR	Complications	Mortality	LOS	OP
Fisher et al 2005	Australia Canberra	951	Prospective observational control retrospective control	Compared Model A & Model D	<p>A. Geriatric consultation only service. D. Ortho-geriatric co-care model.</p> <p>Outcome measures in Model D</p> <ul style="list-style-type: none"> <li>reduction in in-hospital mortality <math>p &lt; 0.01</math></li> <li>reported reduction in post-operative medical complications including sepsis, pneumonia, UTI, delirium, DVT, PE, pressure sores, acute coronary and cerebrovascular syndromes,</li> <li>re-admission rates reduced <math>p &lt; 0.001</math>.</li> <li>No differences in LOS between the two models.</li> <li>12% pre co-managed care to 69% post co-managed in osteoporosis treatment.</li> </ul>	<p>Limitation - Historic rather than concurrent control group. Single institution. Improvement from 12% pre co-managed care to 69% post co-managed in osteoporosis treatment.</p>	N	Y	Y	Y	Y
Leung et al	Hong Kong	548	Retrospective cohort	Compared Model A & Model D	<p>Outcome measures in Model D included</p> <ul style="list-style-type: none"> <li>admission to OR shorter by 17% <math>p &lt; 0.02</math></li> <li>Mortality at 12 months less <math>&lt; 0.02</math>.</li> <li>Higher % patients remain independent in <math>p &lt; 0.02</math></li> <li>Mortality at 12 months <math>p &lt; 0.02</math></li> <li>no difference in complications between models</li> </ul>	<p>Limitation - not blinded may be bias. Single centre no comparison of units.</p>	Y	Y	Y	Y	N
Vidan et al	Spain Madrid	319	Randomised Controlled intervention	Compared Model A & Model D	<p>Outcome measures in Model D included</p> <ul style="list-style-type: none"> <li>Median LOS in hospital was lower <math>p &lt; .06</math>.</li> </ul>	<p>Limitation - Large trial but small to detect difference in clinical or</p>	Y	Y	Y	Y	N

Reference	Country	Sample	Method	Model of Care	Discussion / Results	Strength & Limitations	Time Admission to OR	Complications	Mortality	LOS	OP
					<ul style="list-style-type: none"> <li>• complication rate was lower <math>p &lt; .003</math>. Most frequent complication was delirium and pressure ulcer.</li> <li>• reduced in hospital mortality <math>p &lt; .03</math></li> <li>• report the presence of an orthogeriatrician increased confidence of junior orthopaedic doctors and anaesthetists</li> <li>• No difference in time from admission to OR</li> </ul>	functional outcomes.					
Deschodt	Belgium	171	Controlled trial	Compared Model A & Model D	<p>Outcome measures included</p> <ul style="list-style-type: none"> <li>• LOS, mortality and readmission rates. No differences were shown between the two groups.</li> <li>• A lack of adherence to recommendations by the geriatric team may have contributed to negative findings</li> <li>• No functional benefits were found with Model D. No statistically difference in mortality between the two groups</li> </ul>	Limitation - Study included no prior evidence that care in either group was effective.	N	Y	Y	Y	Y
Gregersen	Denmark	495	Retrospective with two historical groups	Compared Model A & Model D	<p>Model D was care in orthopaedic ward with Geriatric multidisciplinary care only offered during working hours and not offered on weekends.</p> <p>Outcome measured in Model D included</p> <ul style="list-style-type: none"> <li>• LOS was reduced by two days</li> <li>• more people were treated for</li> </ul>	Limitation - was that the two cohorts were from two different times rather than concurrent time periods.	N	N	Y	Y	Y

Reference	Country	Sample	Method	Model of Care	Discussion / Results	Strength & Limitations	Time Admission to OR	Complications	Mortality	LOS	OP
					<p>OP in Model D.</p> <ul style="list-style-type: none"> <li>In hospital mortality was 8% in the intervention group vs. 6% in control group.</li> </ul>						
Folbert	The Netherlands	230	Prospective cohort study with historical group	Compared Model A & Model D	<p>Traditional orthopaedic model Co-management from admission to outpatients with the use of clinical pathways. Outcome measures in Model D included</p> <ul style="list-style-type: none"> <li>readmission within 30 days decreased significantly in <math>p &lt; .001</math></li> <li>decreasing trend in mortality</li> <li>no real difference in LOS, LOS in ED or time from admission to OR.</li> <li>Common complications included delirium which was diagnosed more frequently in Model D.</li> <li>Other complications ie UTI, urinary retention, heart failure, deep wound infection and mortality decreased in Model D <math>p &lt; .017</math></li> </ul>	<p>Limitations - small patient population. No evaluation of long term outcomes or costs. Strengths - based on a successful model of care The Rochester Model.</p>	Y	Y	Y	Y	Y
Khan et al	United Kingdom Surrey	745	Prospective study	Compared Model A & Model D	<p>Outcome measures included:</p> <ul style="list-style-type: none"> <li>No significant difference in LOS</li> <li>No significant difference in number of patients returning to pre-admission residence</li> <li>No significant difference in mortality.</li> </ul>	<p>Limitation - no demonstrable measurable improved benefit however may be due to confounding factors. Otherwise other indicators may have been more appropriate to use.</p>	N	N	Y	Y	N

Reference	Country	Sample	Method	Model of Care	Discussion / Results	Strength & Limitations	Time Admission to OR	Complications	Mortality	LOS	OP
Adunsky et al	Israel Tel Aviv	336	Partially concurrent prospective	Compared Model C & Model D Known as the 'Sheba Model'	Outcome measures included: <ul style="list-style-type: none"> <li>functional outcomes better in Model D.</li> <li>Model D two fold chance for successful rehabilitation <math>p &lt; .03</math> compared with Model C.</li> <li>Patients in Model C had a shorter stay in rehab <math>p &lt; .01</math> but a longer overall LOS <math>p &lt; .01</math>.</li> </ul>	Limitation - No randomisation ,no discussion of co-morbidities and no time from admission to OR data. No evaluation of costs	N	N	N	Y	N
Kammerlander et al	Austria Innsbruck	529	Retrospective audit	Model D Tyrolean Fracture Centre	All fragility fractures over 70 years with more than two relevant comorbidities admitted to unit. Outcome measures included <ul style="list-style-type: none"> <li>median time to OR 18 hrs</li> <li>70.5% - OR within 24hrs from admission.</li> <li>mean LOS 11.3 days.</li> <li>following OR 50.5% transferred to acute geriatric unit of these 66.4% transferred back home and 86.7% at three months returned home</li> <li>3.1% hip fracture mortality</li> </ul>	Limitation - No randomisation. No methodology Strength - follow up data available at three, six, 12 months.	Y	Y	Y	Y	N
Collinge et al 2013	USA Texas	657	Retrospective cohort	Model D	Compared over three time points: <ul style="list-style-type: none"> <li>Pre-intervention</li> <li>During intervention</li> <li>Post intervention of a comprehensive geriatric intervention with established evidenced based clinical practice guidelines.</li> </ul>	Strength - significant cost reduction	Y	N	Y	Y	N

Reference	Country	Sample	Method	Model of Care	Discussion / Results	Strength & Limitations	Time Admission to OR	Complications	Mortality	LOS	OP
					<p>Outcome measures included</p> <ul style="list-style-type: none"> <li>mortality- significant difference in in-hospital mortality in the middle group treated during the implementation of Model D <math>p &lt; 0.04</math>.</li> <li>no significant differences were shown between the groups in 30 day and one year mortality.</li> <li>time from medical clearance to OR was improved in Model D <math>p &lt; 0.001</math></li> <li>time from admission to surgery not significantly different in either group <math>p &lt; 0.007</math>.</li> <li>hospital LOS was significantly reduced with LOS <math>p &lt; 0.04</math>.</li> </ul>						
Teo & Mador	New Zealand Dunedin	144	Retrospective audit	Model D	<p>Outcome measures included,</p> <ul style="list-style-type: none"> <li>Median time from ED to ward 5hr 4 min.</li> <li>Median time to OR 40hr 28min.</li> <li>38.9% had a documented history of cognitive impairment,</li> <li>36.1% had an episode of delirium.</li> <li>Median time post OR for geriatric review one day.</li> <li>Inpatient mortality 9%</li> </ul>	<p>Strengths - listed recommendations of ways to further improve service. Assessment of bone sparing medication. Identifies key standards of orthogeriatric care and audited to assess how well standards are implemented.</p>	Y	Y	Y	Y	Y
Sivakumar et al	Australia Brisbane	346	Prospective Uncontrolled	Model D Hip fracture	Joint admission of patients between surgeons and physicians in a dedicated hip	Limitation - no control group thereby	Y	Y	Y	Y	N

Reference	Country	Sample	Method	Model of Care	Discussion / Results	Strength & Limitations	Time Admission to OR	Complications	Mortality	LOS	OP
				unit	<p>fracture unit. All hip fractures from sister hospitals admitted to hip fracture unit.</p> <p>Outcome measures included</p> <ul style="list-style-type: none"> <li>• mean time to surgery – 1.8 days down to 1.4 when medically unstable patients were excluded</li> <li>• 68% of patients operated on within 48 hours of admission.</li> <li>• more than half of the cohort experienced post-operative delirium.</li> <li>• other complications included aspiration, hospital acquired pneumonia, arrhythmias, perioperative infarcts and acute pulmonary oedema.</li> <li>• mean LOS was 18.1 days providing acute and early rehabilitation.</li> <li>• mortality – 3.4%</li> </ul>	weakening interpretation of cause and effect. No post discharge follow up.					
Chong et al	Australia Victoria	426	Prospective audit	Model D	<p>All geriatric fractures 50 years and over co-managed by ortho and geriatric teams.</p> <p>Outcome measures include</p> <ul style="list-style-type: none"> <li>• time to OR which was 1.7 days,</li> <li>• LOS 11.9 days.</li> <li>• average time from admission to discharge 5.5 days</li> <li>• 65% patients admitted from home returned home</li> <li>• 3.5% mortality</li> </ul>		Y	Y	Y	Y	N
Kates et al	USA Rochester	758	Retrospective review	Model D “known as the	<p>Evolved over 15 years, gradual improvements added, minimum number of</p>	Strengths - well described model of care,	Y	Y	Y	Y	Y

Reference	Country	Sample	Method	Model of Care	Discussion / Results	Strength & Limitations	Time Admission to OR	Complications	Mortality	LOS	OP
2010				Rochester Model"	<p>cases 100, passion, support of hospital leadership and from committed surgeon and geriatrician, collection, analysis of quality data, continuous quality improvement. Protocol driven, discuss the complexity of need of the older hip fracture patient where the prevalence of comorbidities and frailty is high among patients admitted to by orthopaedic surgeons and geriatricians.</p> <p>Outcome measures included patient characteristics,</p> <ul style="list-style-type: none"> <li>• length of stay – 4.3 days,</li> <li>• 30-day readmission was 10.4%,</li> <li>• re-operation rate at 17 months was 1.9%</li> <li>• cost of care to the system was \$15,188.</li> <li>• One year mortality, 21.2%.</li> <li>• early OR is a fundamental concept of the model</li> </ul>	patient centred, protocol driven standardised care. Large patient cohort.					
Fergus et al	New Zealand Auckland	115	Prospective audit	Model D + fast track	<p>Outcome measures included</p> <ul style="list-style-type: none"> <li>• 59% accessed OR within 48 hours,</li> <li>• LOS 22.8 days.</li> <li>• most common post op complication was anaemia 24%, delirium 23%, pneumonia 17%, UTI 16%.</li> <li>• Of those living at home 70% returned home.</li> <li>• OP discussion</li> <li>• In-patient mortality 5%</li> </ul>	Limitation - audit limited by size and duration.	Y	Y	Y	Y	Y

Reference	Country	Sample	Method	Model of Care	Discussion / Results	Strength & Limitations	Time Admission to OR	Complications	Mortality	LOS	OP
Tha et al	New Zealand	203	Retrospective audit	Compared 2 types of Model D	<p>Da Co-managed geriatrician led care.            Db Co-managed care in orthopaedic ward.            Outcomes measures included</p> <ul style="list-style-type: none"> <li>• median time from admission to OR, Model Db was more than twice that of Model Da p&lt;0.0001.</li> <li>• Median LOS was shorter in Model Da p&lt;0.014.</li> <li>• Model Db had significantly more UTI's p&lt;0.011.</li> <li>• Overall in-patient mortality 3.9%.</li> <li>• Discussion around OP medication</li> </ul>	Limitation - small numbers at each hospital	Y	Y	Y	Y	Y
Liem & Kates Et al	Switzerland USA	2012	Literature review		Aim- evaluate the use of outcome parameters in published literature on Model D. 16 parameters assessed with in-hospital mortality, LOS, time to OR, residence and complication rate most used	Limitation-few reports in the literature	Y	Y	Y	Y	Y
Grigoryan Et al	Boston USA	2013	Systematic review & meta-analysis		Aim-determine if model D improves patient outcomes with benefit in LOS, mortality & cost	Limitation-few reports in the literature	Y	Y	Y	Y	Y

**Table 5 - Themes**

Theme	Sub themes
Time from admission to surgery	Passion
Complications	Leadership
Length of stay	Support of hospital leadership
Mortality	Standardized care
Osteoporosis management	Data collection

Accepted Manuscript

Accepted Manuscript