Article

Geriatric Orthopaedic Surgery & Rehabilitation
2017, Vol. 8(2) 87-93
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DOI: 10.1177/2151458517692651
journals.sagepub.com/home/gos
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Comparison of 3 Different Perioperative Care Models for Patients With Hip Fractures Within 1 Health Service

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Abstract

Introduction: Orthogeriatric care models have been introduced within many health-care facilities to improve outcomes for hip fracture patients. This study aims to evaluate differences in care between 3 models, an orthopedic model, a geriatric model, and a comanaged model. **Materials and Methods:** A retrospective analysis was conducted for hip fracture patients treated at Western Health between November 2012 and March 2014. All patients aged 65 years or older were included in the analysis. **Results:** There were 183 patients in the orthopedic model, 137 in the geriatric model, and 126 in the comanaged model. Demographics and clinical characteristics were similar across the 3 models. Length of stay, mortality, and discharge destination were also consistent across the 3 groups. However, groups involving geriatricians were more likely to receive preoperative medical assessments, have greater recognition of postoperative medical problems, and have implementation of long-term osteoporosis management. **Conclusion:** The involvement of geriatricians in perioperative care models resulted in more comprehensive medical care without impacting length of stay, mortality, or discharge destination.

Keywords

hip, fracture, orthopedic, orthogeriatric, perioperative

Received May 3, 2016; Revised December 29, 2016; Accepted January 6, 2017.

Introduction

Hip fractures are extremely common. Between the years 2006 and 2007, 16 518 osteoporotic hip fractures were reported among Australians aged 40 years or older.[1] The average age at presentation is reported to be 84 years in men and 83 years in women, with the majority occurring in women.[1,2] It has been shown in Australia[3] and worldwide[4] that hip fractures are linked to high rates of complications and mortality. Hip fracture-related mortality is about 10% at one month and one-third within 12 months, with many survivors never regaining their preinjury level of function.[1,2]

Orthogeriatric care models have been introduced to ameliorate these outcomes. Clear benefits of geriatric intervention have been demonstrated when considering mortality, length of stay, and time to surgery.[5] The first dedicated hip fracture unit in Australia reported accordingly, demonstrating that a joint admission involving geriatricians resulted in more comprehensive preoperative assessment, shorter times to surgery, reduced postoperative complications, and diminished mortality rates.[6]

Western Health is an Australian tertiary metropolitan teaching hospital that over the past 2 years has implemented 3 different care models for patients with hip fractures. The orthopedic model involved the treating orthopedic surgical team assuming all responsibility for the medical and surgical care of the patients, with the acute medical team as a referral service.

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In 2012, the geriatric model was introduced whereby patients with neck of femur fractures were admitted in the geriatric unit, which then assumed responsibility for all perioperative medical care needs of the patient, including overnight and weekend cover.

In 2013, the comanaged model was introduced whereby the geriatrician-led medical team attended to the medical care of hip fracture patients during routine hours from Monday to Friday. Outside the routine hours and on weekends, all management issues were attended to by the orthopedic team.

The aim of this study is to identify differences in perioperative care between the 3 described models and the association with length of stay and additional patient outcomes for the hip fracture patients.

Patients and Methods

A retrospective analysis was conducted in hip fracture patients treated at Western Health for the period November 2012 to March 2014. All patients aged 65 years or older were included. Preoperative data were collected on age, gender, comorbidities, Charlson comorbidity index,[7] American Society of Anesthesiologists grade,[8] fracture type, mobility, place of residence, date and time of admission, and preoperative medical assessments. Postoperative data were collected on procedure performed, date and time of surgery, reason for surgical delay of more than 36 hours, date of discharge, complications, mobility, discharge destination, attendance to a rehabilitation service, measurement of osteoporosis biochemical markers (vitamin D, calcium, phosphate, liver function test, and thyroid-stimulating hormone), osteoporosis discharge plan, and inpatient mortality. The data were collected through an electronic patient record database that includes all of the medical notes and investigation results relating to each admission episode. Length of stay was measured according to the midnight census method outlined by Liem et al[9] and represents the period of time the patient was admitted during their acute stay. The number of patients who underwent surgery within a 36-hour time interval was measured, and in instances where this was not achieved, the reason was recorded. Reasons for surgical delay were recorded as follows:

- Medical: Patient unfit for surgery at the time of diagnosis.
- Operating suite: Lack of surgical time or cancellation and subsequent delay.
- Orthopedic: Orthopedic review did not occur within 36 hours.
- Diagnosis: Uncertainty in hip fracture diagnosis, requiring further investigation.

The type of postoperative complications was categorized and recorded according to those most commonly reported in the literature, in the context of osteoporotic fractures.[9] Thirty-day and 1-year mortality data were obtained from Births, Deaths and Marriages, Victoria. One-year mortality was only collected on the orthopedic and geriatric models, as for the comanaged model, less than 1 year had elapsed since time of admission and, therefore, his data was not available.

A total of 446 patients were reviewed. Of these, 183 patients were admitted under the orthopedic model, 137 under the geriatric model, and 126 under the comanaged model. Three patients were excluded from our analysis as they were admitted under one unit but transferred to another during their acute admission.

Formal ethical approval was obtained from the Western Health office for research under QA number: QA2014.44, and the Melbourne Health Human Research Ethics Committee under MH project number: 2014.172.

Statistical Analysis

Frequency and proportions were used to describe the patients included in the study. Logistic regression was performed to estimate the univariable associations between the model of care (orthopedic, geriatric, or comanaged) and the following outcomes: cardiac complications, delirium, pulmonary complications, renal failure, and 30-day mortality. Multivariable logistic regression analyses assessed the association between the aforementioned associations after adjusting for sex and age, which we selected a priori.

Quantile regression was used to evaluate the association between the model of care and the median length of stay (a positively skewed variable). Quantile regression is used to model a specified percentile of a response variable, conditional on 1 or more predictors. It is therefore similar to linear regression, which models the conditional mean of the response variable. Quantile regression makes no assumptions regarding the distribution of the regression residuals and, therefore, offered an advantage over linear regression. As well, quantile regression was preferable to Wilcoxon rank sum test because it allows for adjustment of potential confounding variables.

Results

Patient Characteristics

Table 1 describes the demographics and characteristics of all hip fracture patients admitted to Western Health between November 2012 and March 2014. The patient characteristics were similar between the 3 groups of patients. The median age was 83 years, 322 (72.2%) of the patients were women, 283 (63.5%) of patients were living at home, and 177 (39.7%) were mobilizing unaided prior to their injury.

Fracture Pattern and Procedure Type

Table 2 describes the clinical characteristics, with no observable difference between the groups. Of the 446 patients, 211 (47.3%) patients were diagnosed with an intracapsular fracture, 195 (43.7%) with an inter(per)trochanteric fracture, and 40 (9.0%) with a subtrochanteric fracture.

Table 1. Characteristics of the 446 Patients Admitted to Western Health With a Hip Fracture: November 2012 to March 2014.

	Orthopedic Model (n = 183)	Geriatric Model (n = 137)	Comanaged Model (n = 126)	Total (n = 446)
Median age (SD), years	84 (7.0)	83 (8.3)	82 (7.6)	83 (7.6)
Sex				
Female (%)	127 (69.4)	98 (71.5)	97 (77.0)	322 (72.2)
Male (%)	56 (30.6)	39 (28.5)	29 (23.0)	124 (27.8)
Median number of comorbidities (IQR)	5 (3-6)	5 (4-7)	4 (3-5)	5 (3-6)
Ischemic heart disease (%)	36 (19.7)	26 (19)	23 (18.3)	85 (19.1)
Median Charlson comorbidity index (IQR)	6 (5-7)	5 (4-7)	6 (4-7)	6 (4-7)
Preoperative residence: home (%)	118 (64.5)	90 (65.7)	75 (59.5)	283 (63.5)
Preoperative mobility: unaided walking (%)	66 (36.1)	54 (39.4)	57 (45.2)	177 (39.7)
Median ASA grade (IQR)	3 (3-4)	3 (3-3)	3 (3-4)	3 (3-4)

Abbreviations: ASA, American Society of Anesthesiologists; IQR, interquartile range (ie, 25th and 75th percentiles); SD, standard deviation.

Progression of Care

The median length of stay for those being treated in the orthopedic model was 7 days (interquartile range [IQR]: 5-10), and 8 days for patients in the geriatric (IQR: 5-10) and comanaged models (IQR: 6-12); quantile regression did not demonstrate an association between the model of care and the length of stay (geriatric: $\beta = 1.0$, 95% confidence interval [CI] = −0.2 to 2.2, $P = .096$; comanaged: $\beta = 1.0$, 95% CI = −0.2 to 2.2, $P = .105$; Table 3).

One hundred thirteen (61.8%) patients within the orthopedic model and 78 (61.9%) patients within the comanaged model received surgery within 36 hours. The geriatric model was slightly better, with 92 (67.2%) patients undergoing surgery within 36 hours. If surgery did not occur within 36 hours, a reason was sought, as described in Table 2.

Medical Care

A preoperative assessment was completed for 41 (22.4%) patients in the orthopedic model, 135 (98.5%) patients in the geriatric model, and 95 (75.4%) patients in the comanaged model. Not only was this medical assessment completed more frequently in the geriatric and comanaged groups, it was also more likely to be performed by a physician at the consultant level rather than a trainee, when compared to the orthopedic model.

Table 4 describes the univariable and multivariable logistic regression models for the association between model of care and the presence/absence of the following: cardiac complications, delirium, pulmonary complications, renal failure, and 30-day mortality. One hundred eight (24.2%) patients experienced a cardiac complication, with the most common types being periods of rapid atrial fibrillation and non-ST-segment elevation myocardial infarction. Cardiac complications were similar between the 3 models of care.

The most common postoperative complication was delirium, which was diagnosed in 140 (31.4%) patients. After adjusting for age and sex, patients receiving care from the geriatric model and the comanaged model were more likely to be diagnosed with delirium compared to those receiving care from the orthopedic model (geriatric: odds ratio [OR] = 2.55, 95% CI = 1.52-4.26, $P < .001$; comanaged: OR = 3.17, 95% CI = 1.88-5.33, $P < .001$).

There were 121 (27.1%) patients who suffered a pulmonary complication, with pneumonia and atelectasis being the most prevalent. After adjusting for age and sex, patients receiving care from the geriatric model and comanaged model were more likely to be diagnosed with pulmonary complications compared to those receiving care from the orthopedic model (geriatric: OR = 2.02, 95% CI = 1.19-3.45, $P = .010$; comanaged: OR = 2.75, 95% CI = 1.61-4.71, $P < .001$).

The number of cerebral complications, thromboembolic complications, surgical wound infections, urinary tract infections, renal failure, pressure ulcers, gastrointestinal complications, adverse drug reactions, and reoperation were similar between the 3 groups.

It was found that osteoporosis-related blood markers were checked in 133 (97.1%) patients in the geriatric model, 110 (87.3%) patients in the comanaged model, and only 27 (14.8%) patients in the orthopedic model. A comment recommending follow-up for osteoporosis management was present in only 9 (4.9%) of the orthopedic model discharge summaries, 83 (65.9%) of those from the comanaged model, and 122 (89.1%) of those from the geriatric model.

Outcomes of Care

Postoperatively, 273 (61.2%) patients had a rehabilitation admission after their acute care. Final destination was then determined, or if there was no rehabilitation admission, the immediate discharge destination from acute care was used. Overall, 220 (49.3%) patients were discharged home and 173 (38.8%) to a high-level care facility. Eighty-two (19.1%) patients had a final destination that was different to their premorbid residency. A similar proportion of patients were discharged from their acute admission to rehabilitation, residential care, and home across the 3 models (Table 5). One difference was the utilization of community palliative care programs within residential facilities, with 2 (1.1%) patients in the

Table 2. Fracture Characteristics and Surgical Timing of the 446 Patients Admitted to Western Health With a Hip Fracture: November 2012 to March 2014.

	Orthopedic Model, n (%)	Geriatric Model, n (%)	Comanaged Model, n (%)	Total, n (%)
Total	183	137	126	446
Fracture type				
Intracapsular	84 (45.9)	60 (43.8)	67 (53.2)	211 (47.3)
Inter(per)trochanteric	83 (45.4)	61 (44.5)	51 (40.5)	195 (43.7)
Subtrochanteric	16 (8.7)	16 (11.7)	8 (6.4)	40 (9.0)
Procedure type				
Internal fixation: DHS/CHS	101 (55.2)	70 (51.2)	54 (42.9)	225 (50.4)
IM nail	18 (9.8)	19 (13.9)	20 (15.9)	57 (12.8)
Hemiarthroplasty	53 (29.0)	41 (29.9)	48 (38.1)	142 (31.8)
Total hip arthroplasty	11 (6.0)	5 (3.6)	3 (2.4)	19 (4.3)
Nonoperative	0 (0)	2 (1.5)	1 (0.8)	3 (0.7)
Surgery within 36 hours				
Yes	113 (61.8)	92 (67.2)	78 (61.9)	283 (63.5)
No	70 (38.2)	45 (32.8)	48 (38.1)	163 (36.5)
Reasons for delay				
Medical	32	17	28	77
Operating suite	37	19	15	71
Orthopedic	1	3	0	4
Diagnosis	0	6	5	11

Abbreviations: CHS, cannulated hip screw; DHS, dynamic hip screw; IM, intramedullary.

Table 3. Univariable and Multivariable Quantile Regression Models of the Association Between Location of Hip Fracture Management and Length of Stay.[a]

		Unadjusted Model		Adjusted Model[b]	
Model Type	Median (IQR)	β (95% CI)	*P* Value	β (95% CI)	*P* Value
Orthopedic	7 (5-10)	Ref	-	Ref	-
Geriatric	8 (5-10)	1.0 (−0.2 to 2.2)	.095	1.0 (−0.2 to 2.2)	.096
Comanaged	8 (6-12)	1.0 (−0.2 to 2.2)	.103	1.0 (−0.2 to 2.2)	.105

Abbreviations: 95% CI, 95% confidence interval; IQR, interquartile range (ie, 25th and 75th percentiles).
[a]β represents the estimated difference in the median length of stay.
[b]Adjusted model includes sex and age.

orthopedic model, 6 (4.4%) in the geriatric model, and 6 (4.8%) in the comanaged model receiving palliative care input.

Mobility at the time of discharge was obtained from physiotherapy discharge notes. As many of these patients required rehabilitation services to improve their mobility, this was not seen as a final mobility assessment but rather a measure of comparison. Mobility results were similar across the 3 groups, with 3.4% of participants mobilizing unaided, 51.3% aided, and 45.3% being nonambulant at the time of discharge from their acute admission.

Mortality

Mortality was found to be similar across all the models with 3 inpatient deaths reported (orthopedic: n = 1, geriatric: n = 0, comanaged: n = 2) and 10 patient deaths within 30 days (orthopedic: n = 4, geriatric: n = 3, comanaged: n = 3). At 1 year, there were 16 deaths within the orthopedic and geriatric models (orthopedic: n = 10, geriatric: n = 6). Univariable and multivariable regression models did not show an association between the model of care and 30-day mortality (Table 4).

Discussion

This is the first study to compare 3 different models of care within 1 health-care service. The results highlight important areas of similarity and discrepancy. In particular, the results suggest an improvement in medical care for patients in models involving geriatric input, without an adverse effect on length of stay, mortality, and discharge destination.

Hospital length of stay has a direct correlation with cost[9] and is therefore an important outcome parameter when comparing care models. The geriatric and comanaged models at Western Health produced shorter length of stay periods when compared to other reported models also involving geriatrician input. The median length of stay for all the patients under the geriatric and comanaged models was 8 days, compared to 16.5 and 19 days for care models in New Zealand[10] and an average of 18.1 days

Table 4. Univariable and Multivariable Logistic Regression Models of the Association Between Location of Hip Fracture Management and the Presence/Absence of the Following Patient Outcomes: Cardiac Complications, Delirium, Pulmonary Complications, Renal Failure, and 30-Day Mortality.

	Unadjusted Model		Adjusted Model[a]	
	OR (95% CI)	P Value	OR (95% CI)	P Value
Cardiac complications				
Orthopedic	Ref	-	Ref	-
Geriatric	0.63 (0.35-1.12)	.115	0.63 (0.35-1.14)	.130
Comanaged	1.28 (0.76-2.16)	.357	1.34 (0.78-2.29)	.288
Delirium				
Orthopedic	Ref	-	Ref	-
Geriatric	2.34 (1.42-3.86)	.001	2.55 (1.52-4.26)	<.001
Comanaged	2.86 (1.73-4.75)	<.001	3.17 (1.88-5.33)	<.001
Pulmonary complications				
Orthopedic	Ref	-	Ref	-
Geriatric	1.87 (1.11-3.15)	.019	2.02 (1.19-3.45)	.010
Comanaged	2.43 (1.45-4.10)	.001	2.75 (1.61-4.71)	<.001
Renal failure				
Orthopedic	Ref	-	Ref	-
Geriatric	0.78 (0.41-1.50)	.462	0.81 (0.42-1.55)	.522
Comanaged	1.88 (1.07-3.33)	.029	2.03 (1.14-3.62)	.017
30-Day mortality				
Orthopedic	Ref	-	Ref	-
Geriatric	1.00 (0.22-4.53)	.996	0.98 (0.22-4.48)	.983
Comanaged	1.10 (0.24-5.02)	.899	1.06 (0.23-4.87)	.937

Abbreviations: 95% CI, 95% confidence interval; OR, odds ratio.
[a]Adjusted model includes sex and age.

Table 5. Discharge Destinations by Location of Hip Fracture Management.

	Orthopedic, n (%)	Geriatric, n (%)	Comanaged, n (%)	Total, n (%)
Rehabilitation	110 (60.1)	90 (65.7)	73 (57.9)	273 (61.2)
Residential Facility	59 (32.2)	37 (27.0)	40 (31.7)	136 (30.5)
Home	13 (7.1)	10 (7.3)	11 (8.7)	34 (7.6)
Deceased	1 (0.5)	0	2 (1.9)	3 (0.7)
Total	183	137	126	446

in an Australian dedicated hip service.[6] This difference can be explained by the inclusion of rehabilitative or other subacute services in the total length of stay of these orthogeriatric units. When only the acute episode length of stay was measured within the similar New Zealand study, median length of stay for their 2 orthogeriatric models was recorded as 11 and 7.5 days.[10]

Patients cared for under the orthopedic model had a median length of stay of 7 days. This was found to be comparable to other Victorian tertiary hospitals providing orthopedic-only admissions, with reported average length of stay ranging from 6.6[11] and 7.7 days.[3] Our results suggest that the incorporation of geriatricians into the care of these patients may increase the length of stay when compared to the orthopedic model; however, this association was not statistically significant.

Time to surgery is well studied in the literature, with some authors demonstrating a direct correlation between surgical delay and increased mortality.[12] The United Kingdom's Best Practice Tariff for orthogeriatric care guides medical practitioners to aim for surgery within 36 hours.[13] Our results show that the geriatric model, while having little impact on total length of stay, was associated with a higher percentage of patients undergoing surgery within 36 hours, although this did not reach statistical significance. The authors attribute this to the continuous high level of medical cover available for this group of patients, with ongoing access to a consultant geriatrician at all times. This facilitated preoperative medical optimization for patients in the geriatric model even if their admission occurred outside routine hours or during weekends.

The effects of comorbidities on hip fracture outcomes have been thoroughly studied.[2,3] Roche et al were able to show that patients with comorbidities on admission were more likely to develop a complication and subsequently had a higher mortality rate.[4] This evidence supports the preoperative medical assessment that is recommended by the Australian and New Zealand Society for Geriatric Medicine[14] to identify patients who require early medical optimization or are at increased risk of complications. Such preoperative assessments were the mainstay of the geriatric model (98.5% of patients received an assessment) and were commonly completed by a geriatric consultant. There was a significant reduction in preoperative medical assessments for the patients within the comanaged model (75.4%) and the orthopedic model (22.4%). For the patients in the orthopedic model, not only were these assessments less frequent but they were also more likely to be completed by a trainee rather than a consultant.

In addition to a comprehensive preoperative workup, geriatric involvement also resulted in a more thorough postoperative assessment and follow-up. In our study, patients in both groups involving geriatricians were more likely to receive a postoperative diagnosis of delirium when compared to the orthopedic group. Although this did not translate into a significant improvement in mortality for our series, other studies have demonstrated that early recognition helps to reduce duration of postoperative delirium[6] and thereby decrease 6-month mortality.[15] With highly consistent patient characteristics across all 3 groups, the significant difference in the incidence of postoperative delirium can be considered a function of the care model. Postoperative delirium was noted in 20% of the patients in the orthopedic model, whereas this incidence increased to 37% and 41% for the geriatric and comanaged models, respectively. Prospective data from similar Australian populations reported rates between 42% and 55%,[6,11] suggesting a lack of recognition and documentation within the orthopedic model. Similar results were found for postoperative pulmonary complications, where the orthopedic model only noted rates of

19%, compared to 30% and 36% for the comanaged and geriatric models, respectively. We attribute the discrepancy in rates of postoperative diagnoses to the medically focused ward rounds offered by the geriatricians compared to the orthopedic surgeons, accompanied by the specific skill set that geriatricians possess for diagnosis and treatment of conditions such as delirium. Our study showed similar recorded complications as other Australian studies, with 24.4% of patients suffering a cardiac complication compared to 23.7%[6], and 27.1% of patients suffering a pulmonary complication compared to 21.4%.[6]

In addition, postoperative osteoporosis management was implemented with greater efficiency within the groups involving geriatricians. Bellantonio et al observed female patients presenting with hip fractures and noted that 87% was not receiving adequate treatment for osteoporosis, and of those, 40% was not receiving treatment at all.[16] In order to assess this within our series, we chose to measure the frequency of osteoporosis-specific biochemical assessment and discharge planning. We believe these factors represent a more accurate association with long-term osteoporosis prevention than recording patients' osteoporosis medication, which has been used in previous studies.[9] Furthermore, medication assessment was found to be unreliable due to the fact that osteoporosis preventative medications were often commenced by the patient's local doctor and continued throughout the admission without investigation of effectiveness or appropriateness. The geriatric model performed significantly better at both the biochemical workup of osteoporosis as well as the implementation of its post-discharge follow-up, when compared to the comanaged and orthopedic models. The assessment and management of osteoporosis is an extremely important component of hip fracture management, as the majority of these fractures occur in the elderly and result from minimal trauma.[17]

These discussion points suggest improved medical care for patients in models involving geriatric input without an effect on length of stay, mortality, and discharge destination. After reviewing the evidence, the authors feel that these similarities observed in the aforementioned outcome measures are the result of a lack in long-term data. A large 2016 study conducted by Hawley et al[18] was able to capture a significant reduction in mortality for hip fracture patients treated by care models involving geriatricians. However, this study included 11 acute hospitals and a total of 33 152 patients who were studied over a 10-year period. With the assessment of a large number of patients and long-term follow up, it is reasonable to expect reductions in mortality rates in orthogeriatric care models. At the time of our study, units involving geriatricians for the care of hip fracture patients had only been implemented for less than 2 years. Hawley et al[18] suggests that one of the reasons for reduced mortality was likely an environment of better coordination of multidisciplinary care and better communication between staff. In its relative infancy, our geriatric and comanaged models may not have been logistically optimized in terms of the provision of multidisciplinary care. If we were to revisit our study at the 10-year mark, we may also capture reduced mortality rates with a logistically optimized comanaged model.

Additionally, it could be postulated that at least a portion of the observed differences between care models may be a product of improved medical documentation rather than true clinical differences. Nevertheless, a secondary argument can be made for the benefits of improved documentation, such as increased accuracy of medical coding, leading to better cost weightings for models involving geriatrician input.

The authors acknowledge several limitations. Due to the retrospective study design, the majority of our outcome parameters relied on adequate documentation at the time of patient admission, thus introducing potential for inaccuracy. Efforts were made to limit the impact of this by thoroughly examining each page of the medical record and adopting the same technique of information retrieval for every patient. Secondly, the comanaged model was implemented in November 2013 and therefore represents a much newer model than the other 2, posing a limitation to the 1-year mortality follow-up for the patients in this group.

Conclusion

Our results show that care models involving geriatrician input provide patients with more comprehensive medical management while having little impact on total length of stay, when compared to an orthopedic model. Patients managed by comanaged or geriatric models of care were more likely to undergo a preoperative medical assessment, have investigation and management planning of osteoporosis, and have identification of postoperative complications such as delirium. In addition, these patients were more likely to gain access to palliative care facilities.

Geriatricians have been incorporated into the care of hip fracture patients to improve outcomes. This study demonstrates that involvement of geriatricians in the care of this patient group provides more comprehensive medical care without impacting length of stay, mortality, or discharge destination.

Acknowledgments

The authors would like to thank geriatrician Dr Claire McKie for her support and involvement in the preparation of this study.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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