ORIGINAL RESEARCH & CONTRIBUTIONS

Fixing a Fragmented System: Impact of a Comprehensive Geriatric Hip Fracture Program on Long-Term Mortality

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ABSTRACT

Context: Geriatric hip fractures are increasingly common and confer substantial morbidity and mortality. Fragmentation in geriatric hip fracture care remains a barrier to improved outcomes.

Objective: To evaluate the impact of a comprehensive geriatric hip fracture program on long-term mortality.

Design: We conducted a retrospective cohort study of patients aged 65 years and older admitted to our academic medical center between January 1, 2012, and March 31, 2016 with an acute fragility hip fracture. Mortality data were obtained for in-state residents from the state public health department.

Main Outcome Measures: Mortality within 1 year of index admission and overall survival based on available follow-up data.

Results: We identified 243 index admissions during the study period, including 135 before and 108 after program implementation in October 2014. The postintervention cohort trended toward a lower unadjusted 1-year mortality rate compared with the preintervention cohort (15.7% vs 24.4%, p = 0.111), as well as lower adjusted mortality at 1 year (relative risk = 0.73, 95% confidence interval = 0.46-1.16, p = 0.18), although the differences were not statistically significant. The postintervention cohort had significantly higher overall survival than did the preintervention cohort (hazard ratio for death = 0.43, 95% confidence interval = 0.25-0.74, p = 0.002).

Conclusion: Fixing fragmentation in geriatric hip fracture care such as through an orthogeriatric model is essential to improving overall survival for this patient population.

INTRODUCTION

Hip fractures represent a major health burden for geriatric patients in the US, with more than 250,000 adults aged 65 years and older hospitalized with hip fractures annually.[1] Hip fractures can be highly debilitating, resulting in loss of functional independence and a 1-year mortality rate approaching 30%.[2] With the aging population, the worldwide incidence of hip fracture is expected to increase by 240% in women and 310% in men by 2050, compared with 1990.[3]

Given the scope and importance of the problem, fragmentation in geriatric hip fracture care is a growing concern. Patients may be admitted to multiple different services and units in a single hospital, involvement of geriatric or hospital medicine consultants may be variable, and standardized care pathways may be lacking. Such inconsistency in inpatient care contributes to delays in surgery, discharge, and functional recovery; more hospital-acquired complications; higher readmission rates; failure to adhere to best practices in osteoporosis management; and poor coordination with outpatient clinicians.[4-9] As a result, major professional societies, hospital regulatory agencies, insurers, and national and international health organizations have called for a population health management approach to geriatric hip fracture care.[10]

We recently implemented a comprehensive geriatric hip fracture program to address fragmentation in care at our own institution. We previously reported short-term outcomes that included a 0.9-day reduction in hospital length of stay, a stable 30-day all-cause readmission rate, and improvements in pharmacologic osteoporosis treatment and outpatient follow-up that were sustained over nearly 18 months.[10] The aim of this study was to evaluate the impact of a comprehensive geriatric hip fracture program on long-term mortality.

METHODS

Study Setting and Population

The design for our quality improvement initiative has been described in detail.[10] The project was conducted at the University of Colorado Hospital, which is a 620-bed, urban, quaternary-care academic medical center in Aurora, CO, and carries a level II trauma center designation. Our study population included patients aged 65 years and older admitted with an acute fragility hip fracture between January 1, 2012, and March 31, 2016.

Intervention

Our comprehensive geriatric hip fracture program went live on October 29, 2014. It was designed to improve the fragmentation in care at our institution, namely: 1) a lack of a cohesive interprofessional team taking ownership of this patient population along the continuum of care and 2) a lack of standardized application of evidence-based care.

Historically, geriatric patients with hip fractures could variably be admitted to the Orthopedic Surgery Service, with subspecialty consultation or hospitalist (nongeriatrician) comanagement if requested; to 1 of 8 general medicine teams if under age 75 years or to 1 of 2 acute care for the elderly teams if over age 75

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years; to Family Medicine; or to subspecialty services. These services were staffed by rotating house staff, advanced practice practitioners, and attending physicians, which could include surgeons, hospitalists, general internists, geriatricians, family practitioners, or medical subspecialists.

In addition, geriatric patients with hip fractures could be admitted to numerous inpatient units. Each unit was staffed by different nurses, pharmacists, care managers, and social workers, and often by different physical and occupational therapists.

After discharge, geriatric patients with hip fractures could be cared for by practitioners at diverse skilled nursing facilities, inpatient rehabilitation facilities, or primary care clinics, either internal or external to our system.

This decentralized care model was accompanied by substantial variability in geriatric hip fracture care, including practitioner roles and expectations and the content, timing, and quality of the care itself. It also represented a barrier to process improvement work, in that it was more difficult to design, implement, and iterate on standardized care pathways in the absence of a stable interprofessional team.

Our comprehensive geriatric hip fracture program therefore included the following key interventions: 1) admission of all ward-status patients to the Orthopedic Surgery Service with hospitalist comanagement; 2) geographic placement of patients with hip fractures on the Orthopedics Unit; and 3) use of standardized, evidence-based admission, preoperative, and postoperative electronic order sets. The order sets bundled perioperative and geriatric best practices, including delirium precautions (eg, frequent reorientation, maintenance of normal sleep-wake cycles, encouragement of use of sensory aids), multimodal analgesia (ie, ice to affected area, scheduled acetaminophen treatment, and low-dose oral oxycodone and intravenous hydromorphone as needed; fascia iliaca compartment blocks were not introduced until after the current study period), a bowel regimen, venous thromboembolism prophylaxis, a urinary catheter removal protocol, and early mobilization with physical and occupational therapy. The order sets also included laboratory workup and pharmacologic treatment of osteoporosis and a streamlined workflow for discharge planning.

On the basis of these interventions, the percentage of patients admitted to the Orthopedic Surgery Service increased from 65% to 96%, the percentage discharged from the Orthopedics Unit increased from 67% to 85%, and the percentage both on-service and on-unit increased from 55% to 82% from before to after implementation.[10] Adherence to the use of the admission order set was 96%.[10] We purposely did not change clinician staffing or scheduling on services from before to after implementation; for example, clinical stretches for hospitalists on the Medicine Consult Service remained around 7 days in duration.

Data Source and Outcome Measures

We obtained patient characteristics such as age at index admission and sex via a report generated from our electronic health record. Additional demographic data, including fracture type, American Society of Anesthesiologists (ASA) class, Charlson Comorbidity Index (CCI), and time to surgery, were obtained via manual chart reviews. The standard definition of ASA class was used: ASA 1, a normal healthy patient; ASA 2, a patient with mild systemic disease; ASA 3, a patient with severe systemic disease; ASA 4, a patient with severe systemic disease that is a constant threat to life; and ASA 5, a moribund patient who is not expected to survive without the operation.[11] Time to surgery was defined as time from admission to surgical incision.[10]

Mortality data, including the date and cause of death, as listed by the coroner on the death certificate via International Classification of Diseases, Tenth Revision codes, were obtained for in-state residents in April 2017 from the Vital Statistics Program through the Colorado Department of Public Health and Environment. Admissions for out-of-state residents or for a second hip fracture during the study period were excluded.

The Colorado Multiple Institutional Review Board classified the mortality analysis (protocol 16-2674) as quality improvement.

The primary outcomes of interest were: 1) mortality within 1 year of index admission and 2) overall survival based on available follow-up data.

Statistical Analysis

We did not perform an a priori power analysis because we believed that it was important to conduct our mortality analysis using the same study period as for our previous work, to be able to interpret our results in the context of our original process measures and short-term outcomes. Thus, patients with index admissions between January 1, 2012, and October 28, 2014, were included in the preintervention cohort and between October 29, 2014, and March 31, 2016, were included in the postintervention cohort.

Patient characteristics in the preintervention and postintervention cohorts were compared with a Student *t*-test for continuous variables (age, ASA score, total CCI score, and time to surgery) and the Fisher exact test for categorical variables (sex and fracture type).

Next, we investigated whether there were any time trends in mortality during either the preintervention or postintervention periods by fitting a segmented regression model. An analogous investigation on survival time was conducted by fitting a Cox proportional hazards model allowing the hazard to change over time for each of the preintervention and postintervention periods. In both these analyses, the time trends were insignificant ($p > 0.19$; data not presented), suggesting that a simpler pre-post analysis would be sufficient to evaluate intervention effects.

To assess whether mortality rates differed before and after intervention, a log-link binominal regression model was used. A Cox proportional hazards model was used to compare overall survival rates between the preintervention and postintervention cohorts, with data censored at the time of death or at the time of data extraction from the state health department. All models were adjusted for the following independent predictors of mortality: Age, sex, fracture type, ASA class, total CCI score, and time to surgery.[12-20] Although other preoperative factors (eg, residence in an institution, prefracture mobility, cognitive impairment, abnormal electrocardiogram, anesthesia type, blood transfusion requirements) have also

Table 1. Patient characteristics

Characteristic	Preintervention cohort[a] (n = 135)	Postintervention cohort[b] (n = 108)	p value
Mean age, y (SD)	81.1 (9.1)	79.5 (7.9)	0.138
Female sex, no. (%)	95 (70.4)	67 (62.0)	0.175
Fracture type, no. (%)			0.218
Femoral neck	62 (45.9)	61 (56.5)	
Intertrochanteric	66 (48.9)	42 (38.9)	
Subtrochanteric/other	7 (5.2)	5 (4.6)	
Mean ASA class (SD)	3.0 (0.6)	2.9 (0.6)	0.250
Mean CCI score (SD)	6.4 (2.5)	6.1 (2.3)	0.451
Comorbidities, no. (%)			
Diabetes	32 (23.7)	29 (26.9)	
Liver disease	6 (4.4)	4 (3.7)	
Solid tumor	32 (23.7)	18 (16.7)	
AIDS	1 (0.7)	0 (0)	
Renal disease, moderate to severe	3 (2.2)	8 (7.4)	
Congestive heart failure	29 (21.5)	9 (8.3)	
Myocardial infarction	31 (23.0)	29 (26.9)	
Chronic pulmonary disease	26 (19.3)	30 (27.8)	
Peripheral vascular disease	21 (15.6)	14 (13.0)	
Cerebrovascular accident or TIA	27 (20.0)	22 (20.4)	
Dementia	66 (48.9)	41 (38.0)	
Hemiplegia	1 (0.7)	3 (2.8)	
Connective tissue disease	5 (3.7)	8 (7.4)	
Leukemia	2 (1.5)	3 (2.8)	
Malignant lymphoma	3 (2.2)	1 (0.9)	
Peptic ulcer disease	14 (10.4)	5 (4.6)	
Mean time to surgery, h (SD)	29.6 (26.2)	27.1 (17.9)	0.389

[a] January 1, 2012, to October 28, 2014.
[b] October 29, 2014, to March 31, 2016.
ASA = American Society of Anesthesiologists; CCI = Charlson Comorbidity Index; SD = standard deviation; TIA = transient ischemic attack.

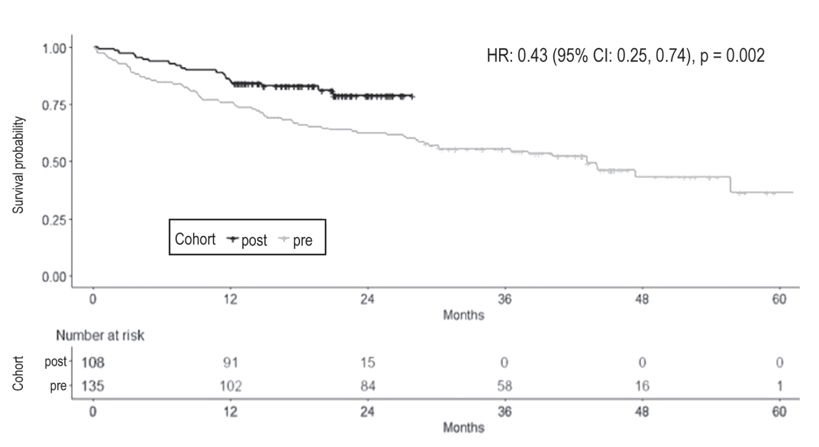

Figure 1. Overall survival for geriatric patients with hip fractures before and after intervention.
CI = confidence interval; HR = hazard radio (adjusted for age, sex, fracture type, American Society of Anesthesiologists class, Charlson Comorbidity Index, and time to surgery); post = postintervention; pre = preintervention.

been found to predict mortality at various postoperative time points, we chose these 6 variables given their relative importance and availability and to avoid having too few events per variable.[12-21]

Descriptive statistics were used to compare the cause of death at 1 year between the preintervention and postintervention cohorts.

A 2-sided p value less than 0.05 was considered statistically significant. All data analyses were performed using R version 3.4.4 (R Project for Statistical Computing, Vienna, Austria).

RESULTS

We identified 243 index admissions among Colorado residents during the study period, including 135 before and 108 after program implementation. There was no difference in baseline patient characteristics between the 2 cohorts (Table 1).

The postintervention cohort had a lower unadjusted 1-year mortality rate compared with the preintervention cohort, although the difference did not reach statistical significance (15.7% vs 24.4%, p = 0.111). The postintervention cohort also showed a nonsignificant but clinically important trend toward lower adjusted mortality at 1 year compared with the preintervention cohort (relative risk [RR] = 0.73, 95% confidence interval [CI] = 0.46-1.16, p = 0.18). Predictors of mortality at 1 year included age (RR = 1.05 per 1-year increase in age, 95% CI = 1.02-1.08, p = 0.001), male sex (RR = 1.80, 95% CI 1.28-2.51, p = 0.001), ASA class (RR = 1.70 per 1-point increase, 95% CI = 1.39-2.08, p < 0.0001), and CCI (RR = 1.13 per 1-point increase, 95% CI = 1.06-1.21, p < 0.0001).

The postintervention cohort had significantly higher overall survival than the preintervention cohort (hazard ratio for death = 0.43, 95% CI = 0.25-0.74, p = 0.002; Figure 1). Sensitivity analyses showed that statistical results were robust to different follow-up lengths.

The most common cause of death at 1 year in the study population was dementia (18.2% of the preintervention cohort and 17.6% of the postintervention cohort, respectively), followed by heart disease (12.1% and 17.6%), fall (15.2% and 5.9%), cancer (12.1% and 11.8%), and chronic kidney disease (9.1% and 5.9%). All patients with dementia listed as the cause of death also carried a prefracture diagnosis of dementia.

DISCUSSION

A comprehensive geriatric hip fracture program led to significant improvements in overall survival for geriatric patients with hip fractures. A population-based system redesign demonstrates the potential to drive improvements in patient-centric outcomes, in addition to providing inpatient operational efficiencies that decrease health care costs.

Our comprehensive geriatric hip fracture program may have contributed to improved overall survival through several mechanisms. The fragmentation in the inpatient care team decreased after implementation, with a higher percentage of patients on the Orthopedic Surgery Service and on the Orthopedics Unit.[10] Our admission order set included items designed to minimize inpatient complications, such as delirium and urinary tract infections. The reduction in length of stay and improvements in outpatient follow-up may also have played a role.[10] Our program also significantly improved the rate of calcium, vitamin D, and bisphosphonate prescribing at the time of discharge.[10] Although we were unable to determine long-term medication adherence, osteoporosis therapy may be associated with a mortality benefit; the Health Outcomes and Reduced Incidence with Zoledronic Acid Once Yearly (HORIZON) Trial demonstrated a mortality benefit with intravenous zoledronic acid therapy compared with placebo at a median follow-up of only 1.9 years.[22] It is less likely that the survival difference in our study was attributable to baseline differences in the preintervention and postintervention cohorts, given the adjustment for age, sex, fracture type, comorbidities, and time to surgery. In addition, there were no changes in surgical or anesthesia management during the study period.

Our study adds to a growing body of literature that orthogeriatric models of care improve outcomes, including long-term mortality. A meta-analysis by Grigoryan and colleagues[23] showed that routine orthogeriatric collaboration improved 6- to 12-month mortality compared with standard care (ie, geriatric or hospitalist consultation on an as-needed basis), with an odds ratio of 0.83 (95% CI = 0.74-0.94). Another meta-analysis, by Moyet et al,[24] found similar results. Our estimated reduction in 1-year mortality is consistent with findings from these studies, although our finding was not statistically significant, likely because of the modest size of our clinical population. Given the range of clinically important mortality reduction that remains plausible on the basis of this study's findings, a study of our intervention in a larger patient population may be of value to obtain more precise estimates of the reduction that is possible with this approach to care. Results of our quality improvement initiative also demonstrate that the impact on survival for geriatric patients with hip fractures can extend even beyond 12 months. Although the optimal orthogeriatric model (routine geriatric consultation on an orthopedic ward, routine orthopedic consultation on a geriatric ward, or shared comanagement on an orthogeriatric ward) remains unclear in the literature, our study lends further support to the comanagement care delivery system.[23,24] Unfortunately, the prevalence of any orthogeriatric model of care in the US remains unknown.

Strategies that reduce fragmentation in geriatric hip fracture care are increasingly important. The osteoporosis care gap continues to widen, with declining rates of bone mineral density testing and use of bisphosphonates in patients with osteoporosis.[25] Although the age-adjusted hip fracture rate for women aged 65 years and older steadily declined between 2002 and 2012, it has recently plateaued, resulting in 11,000 more hip fractures than previously projected between 2013 and 2015.[25] The 1-year mortality rate for geriatric patients with hip fractures has also remained near 30% nationally.[2,25] In 2016, the Centers for Medicare and Medicaid Services proposed the Surgical Hip and Femur Fracture Treatment episode payment model to encourage health systems to redesign care processes and improve quality and care coordination while reducing costs.[26] This Medicare initiative had been slated to go into effect on January 1, 2018, but is now on hold, placing the onus back on clinicians to drive change in their local environments.

This study has some limitations. First, we were not able to include out-of-state residents in our mortality analysis because of the inability to access this data via the state health department or to reliably contact patients and families after discharge. However, this should not have affected the validity of our analysis of in-state residents. Second, we did not perform an a priori power analysis given the fixed size of our original study population; a follow-up study with a larger sample size would be of value. Third, we believe that we adjusted our analyses for the most important independent predictors of mortality but cannot rule out the possibility of confounding from other unmeasured variables. Fourth, because of the relatively small number of deaths, we were not able to draw meaningful conclusions about any differences in cause of death between the 2 cohorts. Fifth, because of multiple concurrent interventions, it was not possible to assess the impact of individual interventions on overall survival. Sixth, we also were not able to determine whether rates of inpatient complications such as delirium or urinary tract infections actually decreased from before to after intervention, because of confounding introduced by variability in evaluation or documentation practices between services and units. Finally, this was a single-center initiative, which limits generalization to other institutions.

CONCLUSION

Our comprehensive geriatric hip fracture program improved overall survival by targeting the fragmented system of care at our institution. Our experience may inform future efforts to improve the quality, safety, and efficiency of care for this vulnerable patient population. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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