Impact of a Comanaged Geriatric Fracture Center on Short-term Hip Fracture Outcomes

Susan M. Friedman, MD, MPH; Daniel A. Mendelson, MD, MS; Karilee W. Bingham, RN, BS; Stephen L. Kates, MD

Background: Hip fractures are associated with substantial morbidity and mortality for older adults. Patients sustaining hip fractures usually have comorbid conditions that may benefit from comanagement by geriatricians and orthopedic surgeons.

Methods: The Geriatric Fracture Center (GFC) is part of a community teaching hospital. Patients are comanaged daily by a geriatrician and orthopedic surgeon, emphasizing total quality management, timely treatment, and standardized care. We reviewed medical records to compare process and outcome measures in the GFC with a local institution that did not have a fracture management service. Patients 60 years or older admitted for a proximal femur fracture from May 1, 2005, to April 30, 2006, were included; pathological, recurrent, high-energy, periprosthetic, and nonoperative fractures were excluded.

Results: Geriatric Fracture Center patients (n=193) were significantly older, were less likely to reside in the community, and had more comorbid conditions and dementia than usual care patients (n=121). Despite baseline differences, GFC patients, compared with usual care patients, had shorter times to surgery (24.1 vs 37.4 hours), fewer postoperative infections (2.3% vs 19.8%), fewer complications overall (30.6% vs 46.3%), and shorter length of stay (4.6 vs 8.3 days). Compared with GFC patients, physical restraint use was significantly higher in usual care patients (0% vs 14.1%). After we adjusted for baseline characteristics, patients treated in the GFC had shorter times to surgery, shorter length of stay, fewer cardiac complications, and fewer cases of thromboembolism, delirium, and infection. There was no difference in in-hospital mortality or 30-day readmission rate.

Conclusion: Comanagement by geriatricians and orthopedic surgeons, combined with standardized care, leads to improved processes and outcomes for patients with hip fractures.

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IP FRACTURES OCCurring in older adults are a common and serious condition, frequently leading to functional decline, morbidity, and mortality. As one consequence of the aging of America, the incidence of hip fractures is increasing.1 Fracture risk doubles every decade after age 50 years.2 In the United States, 350,000 hip fractures occur yearly,3 and this number may grow to 500,000 by 2040.4 Half of those with hip fractures fail to regain their prefracture mobility, and 20% or more die within a year of surgery5; a fourth of those who previously lived independently require long-term nursing home care.6

Because most hip fractures occur in older adults,3 the prevalence of comorbid conditions and frailty is high among patients hospitalized for hip fractures. They are at high risk of developing complications such as delirium, infection, and iatrogenic problems.7,8 These outcomes, in turn, can lead to functional decline, long-term care needs, and death. Geriatricians, who are experts in caring for medically complex individuals, may be able to identify and reduce such risks, thereby improving outcomes for patients undergoing hip fracture repair.

We recently described a Geriatric Fracture Center (GFC) that is comanaged by geriatricians and orthopedic surgeons.9 This program, in operation since 2004, is based on a model of care that has been found to lead to improved outcomes in other countries10-13 but has been rarely replicated or described in the US health care system. The program incorporates the following 5 principles: (1) most patients benefit from surgical stabilization of their fracture; (2) shorter times to surgery result in less time to develop iatrogenic illness; (3)
comanagement with frequent communication avoids iatrogenic problems; (4) standardized protocols decrease adverse outcomes; and (5) discharge planning begins at admission.

Patients treated in this program had lower than expected lengths of stay, readmission rates, and mortality, according to a national database program that adjusted for baseline patient and hospital characteristics. However, the hospital at which the program is based has a different patient population than that described in previous comanaged programs, with more than 50% of patients living in a nursing home or an assisted-living facility prior to admission. Furthermore, it is well known that there are regional differences in how care is provided across the country that are unrelated to patient characteristics. For this reason, it is unclear whether these outcomes are a result of the patient population, regional approaches to care, or the model itself.

We hypothesized that a standardized, comanaged program focused on the care of elderly patients with hip fracture will lead to fewer complications overall (primary outcome) and improved processes and other clinical outcomes (secondary outcomes) compared with usual care (UC). The 2 hospitals share house staff, medical students, and some faculty and have a similar catchment area. After adjusting for baseline differences in patient characteristics, this study assessed the independent contribution of the model of care to patient outcomes.

METHODS

DESCRIPTION OF GFC AND UC MODELS

The GFC model of care is a standardized program in which each patient is comanaged by faculty geriatricians. Standardized order sets are used at each stage of care. Early surgical intervention is emphasized as a goal of care. A dedicated fracture operating room was not available when this study was conducted. The GFC is staffed by a mixture of faculty orthopedic surgeons, private practice orthopedic surgeons, orthopedic house staff, and faculty geriatricians. Subspecialty consultations are minimized in the GFC model. The program is located in a 261-bed, community-based teaching hospital. It is loosely affiliated with many assisted-living facilities and nursing homes as a preferred site for geriatric admissions.

The UC model does not have a standardized approach to care. Hospitalists are consulted for the management of medical conditions and complications as they occur. The UC program has a designated fracture operating room available each weekday, permitting early fracture surgery. The UC model is staffed by faculty orthopedic surgeons, orthopedic house staff, and faculty hospitalists. Both models share anesthesiologists drawn from the same department. Although faculty orthopedic surgeons in both models are members of the same department, the surgeons did not work in both hospitals during the period of this study. This program is based at a tertiary care hospital with an overlapping catchment area.

STUDY DESIGN

This is a retrospective cohort study that incorporates medical record review with an outcomes management database. Information for this database was collected on all patients with hip fractures in the GFC starting 6 months after the program began. Using methods identical to the medical record review for UC, the reviewer validated chronic diseases and complications through retrospective medical record review as part of the ongoing outcomes management program. The university’s research subject review board approved the presentation of these data and the collection of comparison data from another hospital. Data for patients treated in UC were obtained through medical record review covering the same period. All medical records were reviewed by the same research nurse (K.W.B.) employed by the university.

SUBJECTS

All patients 60 years and older with diagnosis related group codes 209 (major joint and limb reattachment procedures of the lower extremity), 210 (hip and femur procedures except major joint, ages 17 years and older, with comorbidities and/or complications), 211 (hip and femur procedures except major joint, ages 17 years and older, without comorbidities or complications), and 544 (major joint replacement or reattachment of lower extremity), who met inclusion and exclusion criteria, underwent review for baseline predictors, process variables, and outcomes. Patients who were admitted during the period of May 1, 2003, through April 30, 2006, who underwent surgical repair of proximal femur fracture, were analyzed. Pathological, high energy, recurrent, periprosthetic, and nonoperatively treated fractures were excluded.

BASELINE VARIABLES

Demographics (age, race, sex, and residence prior to admission) were obtained for all patients. The presence and severity of 17 diseases were determined and weighted according to the Charlson protocol, and an index score was created for each patient. A subset of 10% of the medical records at each site was reviewed by the research team to validate Charlson scores (r = 0.996).

OUTCOME VARIABLES

Time to surgery was defined as the time from admission to the time the patient arrived in the operating room. Restraint use was defined as any mention of physical restraints identified in either notes or orders. Length of stay was defined as the number of days in which the patient was in the hospital at midnight. In-hospital mortality was recorded. The hospital system’s computerized records, which included readmissions to both facilities, were searched for evidence of rehospitalization within 30 days of discharge.

COMPLICATIONS

Renal failure was defined as any mention in a progress note of renal failure or insufficiency, dehydration, prerenal azotemia, or elevated serum urea nitrogen or creatinine levels. Delirium was defined as any documented mental status change in physician or nursing notes. Hypoxia was defined as a PO2 lower than 60 mm Hg (to convert to kilopascals, multiply by 0.133) and/or oxygen saturation lower than 89% not present at admission. Pneumonia, congestive heart failure, and cerebrovascular events were defined by clinical diagnosis by the practitioner caring for the patient. Myocardial infarction was defined by a new elevation of troponin level postoperatively or an elevated creatine kinase with positive MB fraction. Surgical site infection required clinical evidence of infection plus a positive surgical wound culture. Urinary tract infection required a positive urine culture plus clinical diagnosis not present at admis-
sion. Patients were considered to have had a postoperative infection if they developed pneumonia, urinary tract infection, and/or a surgical site infection. Deep venous thrombosis and pulmonary embolism were defined by clinical diagnosis confirmed by radiologic study. Hemorrhagic stroke and intracranial or retroperitoneal bleeding were defined by clinical diagnosis confirmed by a computed tomographic scan. Significant gastrointestinal tract bleeding was defined by clinical diagnosis with radiographic confirmation. New arrhythmias were defined by clinical diagnosis and confirmed by an electrocardiogram. A subset of 10% of the medical records at each site was reviewed by a geriatrician coauthor (S.M.F. or D.A.M.) to validate outcome measures. Kappa values for complications that occurred ranged from 0.57 to 1.00. Of the 13 complications that occurred in this sample, 11 had a K value greater than 0.70, showing strong agreement, and 9 had a K value greater than 0.90, showing excellent agreement.

STATISTICAL ANALYSIS

Differences in baseline variables and outcomes between the 2 sites were compared via χ² analysis for categorical variables, and the Fisher exact test was used for variables with expected cell values less than 5. Continuous variables were compared via the unpaired t test. To assess the independent contribution of site, regression models were constructed, with age, race, sex, place of residence, and baseline comorbidity as covariates. Continuous outcomes (time to surgery and length of stay) were evaluated via linear regression modeling, and dichotomous outcomes (restraint use, mortality, readmissions, and complications) were evaluated via logistic regression. Separate regression models were run for each outcome of interest. Regression models were then stratified by age older than the median age of 85 years and 85 years or younger.

Because there was a substantial and significant difference between the 2 sites in baseline prevalence of dementia, dementia was included as a covariate, and the Charlson comorbidity score excluding dementia was also included as a covariate. Race was dichotomized into white and nonwhite, given the small proportion of patients in the latter category. Residence was dichotomized into community and non–community dwelling.

RESULTS

Baseline differences between the 2 populations are given in Table 1. The patients cared for in the GFC program were older, less likely to reside in the community prior to admission, and more likely to have dementia, which reflected the referral patterns of the 2 hospitals. The GFC patients also had significantly higher Charlson comorbidity scores than their UC counterparts (3.4 vs 2.6).

Differences between the 2 models of care with respect to outcomes are depicted in Table 2, which presents both unadjusted and adjusted data. Patients treated in the GFC model had significantly shorter times to surgery (24.1 vs 37.4 hours) and lower lengths of stay (4.6 vs 8.3 days). They had fewer complications (30.6% vs 46.3%), with significantly lower risks of delirium, infection, cardiac complication, hypoxia, and thromboembolism. Infections are presented in Table 2 as a summary variable, but the rates were lower in the GFC vs UC for urinary tract infection (1.0% vs 14.1%; P<.001) and pneumonia (1.6% vs 6.6%; P=.02), with a nonsignificant trend toward lower rates of wound infection (0 vs 1.7%; P=.07). Some patients developed multiple postoperative infections. Adjusted risk of restraint use and bleeding could not be determined because no GFC patients experienced these outcomes, and adjusted risk of stroke could not be determined because no UC patients experienced this outcome.

When regressions were split by age older than 85 years vs 85 or younger, differences were more pronounced for those older than 85 years for outcomes of any complications, delirium, and infection. In the group older than 85 years, outcomes were significantly improved in the GFC for readmission (odds ratio [OR], 0.28 [P=.04]), hypoxia (OR, 0.14 [P=.007]), and thromboembolism (OR, 0.03 [P=.02]), but not in those 85 years or younger (OR, 0.97 [P=.96]; OR, 0.29 [P=.05]; and OR, <0.01 [P>.99]; respectively).

Most patients (92.9%) from each hospital were discharged to either a skilled nursing facility or an acute rehabilitation center. Hospital length of stay was evaluated by program according to residence prior to admission. Lengths of stay for GFC patients admitted from their homes or assisted-living and nursing homes was 5.1 days, 4.4 days, and 4.1 days respectively (P=.34). Similarly, length of stay for UC patients admitted from their homes, assisted-living facilities, and nursing homes was 8.1 days, 11.4 days, and 6.6 days, respectively (P=.14), ie, hospital length of stay was not significantly related to preoperative living situation for either model of care.

COMMENT

This study shows that patients treated in a comanaged GFC model of care experience better outcomes than their counterparts in the UC model, after adjusting for baseline differences. Specifically, patients in the GFC model underwent surgery approximately a half day earlier than those in the UC model. Complication rates were substantially lower, with GFC patients experiencing a 31% complication rate overall vs 46% for UC patients. The complications that were significantly lower in the GFC model were delirium, infection, cardiac complications, hypoxia, and thromboembolism. The shorter time to surgery and lower complication rate, in turn, lead to shorter length of stay.

If replicable in other centers, these results have substantial implications for improving the care of geriatric fracture patients. Hip fractures and hip fracture repair are
Table 2. Outcomes in the Geriatric Fracture Center (GFC) and Usual Care

<table>
<thead>
<tr>
<th>Outcome</th>
<th>GFC (n=193)</th>
<th>Usual Care (n=121)</th>
<th>P Value</th>
<th>Coefficient</th>
<th>95% Confidence Interval</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to surgery, mean (SD), h</td>
<td>24.1 (17.0)</td>
<td>37.4 (63.8)</td>
<td>.007</td>
<td>-12.93</td>
<td>(-2.19 to -23.68)</td>
<td>.02</td>
</tr>
<tr>
<td>Restraint use, %</td>
<td>0</td>
<td>14.1</td>
<td>&lt;.001</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Length of stay, mean (SD), d</td>
<td>4.6 (3.3)</td>
<td>8.3 (6.3)</td>
<td>&lt;.001</td>
<td>-3.74</td>
<td>(-2.56 to -4.91)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>In-hospital mortality, %</td>
<td>1.6</td>
<td>2.5</td>
<td>.68</td>
<td>0.17</td>
<td>(0.02 to 1.14)</td>
<td>.07</td>
</tr>
<tr>
<td>30-d Readmission rate, %</td>
<td>9.8</td>
<td>13.2</td>
<td>.35</td>
<td>0.52</td>
<td>(0.23 to 1.18)</td>
<td>.12</td>
</tr>
<tr>
<td>Complications overall, %</td>
<td>30.6</td>
<td>46.3</td>
<td>.005</td>
<td>0.26</td>
<td>(0.14 to 0.47)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Delirium, %</td>
<td>24.4</td>
<td>32.2</td>
<td>.13</td>
<td>0.27</td>
<td>(0.13 to 0.53)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Postoperative infection, %</td>
<td>2.3</td>
<td>19.8</td>
<td>&lt;.01</td>
<td>0.04</td>
<td>(0.01 to 0.13)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Renal insufficiency, %</td>
<td>6.2</td>
<td>7.4</td>
<td>.67</td>
<td>0.70</td>
<td>(0.25 to 1.97)</td>
<td>.50</td>
</tr>
<tr>
<td>Bleeding, %</td>
<td>0</td>
<td>3.3</td>
<td>.02</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Cardiac, %</td>
<td>1.0</td>
<td>7.4</td>
<td>.004</td>
<td>0.15</td>
<td>(0.03 to 0.83)</td>
<td>.03</td>
</tr>
<tr>
<td>Hypoxia, %</td>
<td>6.7</td>
<td>14.1</td>
<td>.03</td>
<td>0.22</td>
<td>(0.09 to 0.55)</td>
<td>.001</td>
</tr>
<tr>
<td>Thromboembolism, %</td>
<td>0.5</td>
<td>5.0</td>
<td>.01</td>
<td>0.07</td>
<td>(0.01 to 0.77)</td>
<td>.03</td>
</tr>
<tr>
<td>Stroke, %</td>
<td>0.5</td>
<td>0</td>
<td>&gt;.99</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

*Outcomes are adjusted for age, race, sex, dementia, Charlson comorbidity score excluding dementia, and residence prior to admission (community vs not). Coefficients assess the GFC risk, with usual care as the reference. Continuous outcomes (time to surgery and length of stay) are evaluated via linear regression modeling. Dichotomous outcomes are evaluated via logistic regressions. Coefficient denotes regression coefficients for linear regressions (outcomes of time to surgery and length of stay) and odds ratios for logistic regressions (all other outcomes).

Unstable due to one site not experiencing outcome

Postoperative infection included urinary tract infection, pneumonia, and surgical site infection. Bleeding included gastrointestinal, retroperitoneal, intracranial bleeding, hemorrhagic stroke, or wound hematoma. Cardiac included any new arrhythmia, acute myocardial infarction, or congestive heart failure.

associated with a high incidence of morbidity and mortality. As the country continues to age and as the increase in the population older than 85 years, who are at the highest risk for hip fractures, continues to grow faster than other segments of the population, the need to optimize treatment is urgent. Adopting a comanaged model, with protocol-driven care and a total quality management approach, may help to reduce the morbidity and functional decline that often occur in patients with hip fractures. Efforts are under way to replicate this approach to hip fracture care in other hospitals to determine whether similar results are realized.

Comanaged care for patients with hip fractures has been used for many decades in other countries and has led to fewer complications, lower readmission rates, and reduction in mortality. This approach—using a geriatrician to co-manage patients—has rarely been described in the United States. A variation on this model of care—using internists or hospitalists to comanage care—has also been described in the United States. Both approaches have been shown to improve outcomes for patients admitted for hip fracture.

Several elements of the GFC model may help to reduce time to surgery. First and perhaps foremost is the expectation that hip fractures are treated as “urgent but not emergent” conditions. Both the orthopedic and geriatric leadership of this program have stressed from the inception of the program that there is a connection between surgical delays and risk of adverse outcomes. Patients are evaluated by orthopedics in the emergency department and by the geriatrician on the same day if they are consulted by 3 PM and by 11 AM the following morning if they are called after 3 PM. Both orthopedic surgeons and geriatricians are available 7 days a week. A geriatrician is available by telephone 24 hours a day as part of the geriatrics on-call coverage. Because of the standardized assessment form, concerns that may arise during the evaluation by the anesthesiologist are limited.

The GFC model incorporates several standardized elements that may reduce delirium. Standardized order sets specifically state the need to avoid medications that may affect mental status, such as antihistamines, hypnotics, anticholinergics, and benzodiazepines. Pain is assessed regularly with a standard pain regimen aimed at optimizing treatment while minimizing cognitive adverse effects. Physical restraints are not used, and patients are cared for by nursing staff experienced in looking after frail older adults at risk for developing delirium.

Similarly, several standard elements of the GFC model may, in turn, lead to lower risk of postoperative infection. The most common type of postoperative infection seen in the study population was urinary tract infections. Shorter times to surgery and routine early discontinuation of Foley catheters lead to shorter durations of catheter use, which, in turn, is likely to reduce urinary tract infection rates. It should be noted that a urinalysis is routinely done at all admissions to the GFC, which is not the case for UC. Positive urine cultures obtained several days into the admission in the UC cohort may therefore overestimate the incidence of urinary tract infections, labeling them as new infections, when they were present but asymptomatic at admission. Given the required “pay for performance” initiatives of the Center for Medicare and Medicaid Services and nonpayment for hospital-acquired conditions that include catheter-associated urinary tract infection, it will be important to document routinely the absence of urinary tract infection at admission in order to demonstrate whether this type of infection results from the hospitalization.
lute numbers for pneumonia and wound infection are smaller but also show lower rates in the GFC model.

Both hospitals operate in a competitive environment for rehabilitation beds. Most patients were discharged to a skilled nursing facility or subacute rehabilitation unit following hospitalization. An analysis of length of stay by program according to baseline residence showed no difference based on residence prior to hospitalization. The shorter length of stay in the GFC model is not an artifact of nursing home residents having a skilled bed to return to after surgery.

This study has several limitations, which might be eliminated by a randomized controlled trial. Unfortunately, this was not possible owing to the incremental implementation of the program and the “culture change” that it created among professional staff caring for patients within the GFC. It was therefore necessary to compare patients treated in the GFC with similar patients from another institution.

First, a retrospective cohort study depends on data available from medical record review for identification of comorbidity and complications. Because the data depend on clinical assessments done by health care providers, who often differ by site, it is possible that ascertainment rates in the 2 systems were different, which could bias results. However, issues of ascertainment were in operation both preoperatively, in the Charlson calculation, and postoperatively, in the complication assessment. It is unlikely that the direction of bias would be different in these 2 situations. Furthermore, outcomes that do not require clinical interpretation, such as time to surgery, length of stay, readmission rates, and mortality, show the same direction of outcome as the complication rates.

Because data collection was retrospective, it depended on operational definitions that could be obtained routinely from the medical records. For example, the definition of delirium was broad and may have identified patients with conditions other than delirium, such as depression, thereby overestimating the incidence of this outcome. Prospective data collection using formal, daily testing, such as the Confusion Assessment Method, would help to validate results.

Multiple baseline patient characteristics were adjusted for to determine the independent contribution of model of care to the outcomes of interest. However, it is still possible that differences may be attributable to something other than the model of care, such as unmeasured patient characteristics, surgical approach, or nursing care, which were not measured in this study. We attempted to minimize unanticipated confounding variables by comparing the GFC model within a common health care system. In addition, intermediate variables, such as timing of physical therapy, nutrition, amount and type of pain medication, and timing of Foley catheter discontinuation, were not able to be measured in this retrospective review. Future studies evaluating this model prospectively should measure intermediate variables and their relationship to outcomes.

This was an unblinded medical record review, which could have led to bias in determining baseline characteristics as well as complications. However, this issue was addressed prior to the start of the study in 2 ways: first, by developing strict definitions of each variable, and second, by having other members of the team validate a subset of 10% of the medical records at each site for both comorbidities and complications.

Finally, this study focuses on in-hospital and short-term outcomes of care. While these outcomes are important in improving quality of life, reducing length of stay, and reducing the time to being able to bear weight and thus, potentially, return to function, it will be important to evaluate more long-term outcomes, such as functional status and location of residence at 12 months. Collection of data on long-term outcomes is currently under way.

It will be important to determine whether this model can be replicated in other settings and to learn whether there are cultural barriers that impede implementation of this approach to care. Efforts are under way to replicate this program in other settings.

The availability of geriatricians in this country is limited, with approximately 9000 geriatricians currently practicing in the United States. A variation on the GFC model that uses hospitalists to co-manage patients with hip fracture has previously been described. It will be important in the future to determine whether there is a “value added” in having geriatricians vs hospitalists provide co-management. Development of a curriculum to address geriatric issues and principles for patients with hip fracture may help to enable hospitalists to optimize care for older adults.

In conclusion, hip fracture care that incorporates co-management by a geriatrician and orthopedic surgeon, standardized protocols, and a total quality management approach leads to improved processes and clinical outcomes. Replication of this program may improve outcomes for older adults with a common and serious condition associated with substantial morbidity. Future prospective studies are needed to confirm these results and to evaluate the components that are most critical to the program’s success.

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Correspondence: Susan M. Friedman, MD, MPH, Department of Medicine, University of Rochester School of Medicine and Dentistry, 1000 South Ave, Box 58, Rochester, NY 14620 (Susan_Friedman@urmc.rochester.edu).

Author Contributions: Dr Friedman had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Friedman, Mendelson, Bingham, and Kates. Acquisition of data: Friedman, Mendelson, Bingham, and Kates. Analysis and interpretation of data: Friedman, Mendelson, and Kates. Drafting of the manuscript: Friedman. Critical revision of the manuscript for important intellectual content: Friedman, Mendelson, Bingham, and Kates. Statistical analysis: Friedman. Obtained funding: Kates. Administrative, technical, and material support: Mendelson, Bingham, and Kates. Study supervision: Friedman, Mendelson, and Kates.

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REFERENCES