Admitting Service and Morbidity and Mortality in Elderly Patients After Hip Fracture: Finding a Threshold for Medical Versus Orthopedic Admission

James M. Mok, MD, Salim K. Durrani, MS, Akira Yamamoto, MD, and Hubert T. Kim, MD, PhD

Abstract

Outcomes by admitting service of 355 consecutive patients admitted for hip fracture at an academic medical center were retrospectively studied. An adverse event occurred in 53 patients (14.9%): 10 in-hospital deaths, 37 intensive care unit transfers, and 25 deaths within 30 days. No significant difference was found between percentages of patients with adverse events admitted to a medical service versus an orthopedic service (52.8% vs 47.2%; *P* = .8). Criteria that determine admitting service based on medical acuity do not adequately allocate patients at risk for serious morbidity and early mortality to a medical service. Addition of American Society of Anesthesiologists grade 4 and men 85 or older to existing criteria would increase the percentage of patients with adverse events admitted to a medical service (72% vs 28%; *P*<.005).

Hip fracture, the most common major injury in the elderly, represents an enormous public health problem.[1] It is a leading cause of morbidity, mortality, permanent disability, and institutionalization for the elderly. In 1998, more than 320,000 hip fractures occurred in the United States (90% in individuals older than 65 years[2]), and this number is expected to exceed 500,000 by 2040.[3] In the US Medicare population, patients who sustain a hip fracture have a reported mortality of 7% within 1 month, 13% within 3 months, and 24% within 12 months.[4] Their mortality remains elevated in comparison with the mortality of age-matched controls for up to 1 year.[5] The grave consequences of hip fractures can in large part be attributed to preexisting comorbidities.

Hip fracture treatment is a complex medical, surgical, and psychosocial problem.[6] Numerous investigators have tried to define risk factors for complications and death, the goal being to identify care processes that can be changed to improve outcomes.[7] Some interventions that have been investigated are multidisciplinary teams, hospitalists, geriatricians, and standardized care pathways. Although varied in their approaches, these interventions have in common the use of dedicated medical specialists to provide close management of patients' medical problems. Superiority over usual care has not been uniformly demonstrated because of the variability in approaches, but most patients who receive these interventions have shown improved complication and mortality rates.[8] Although these interventions illustrate the importance of close medical care, most were developed at specialty hospitals or high-volume centers. Implementation of an effective intervention, though ideal, might not be realistic in many hospitals because of limitations imposed by cost, personnel, and institutional culture.[9,10] The challenge lies in efficiently

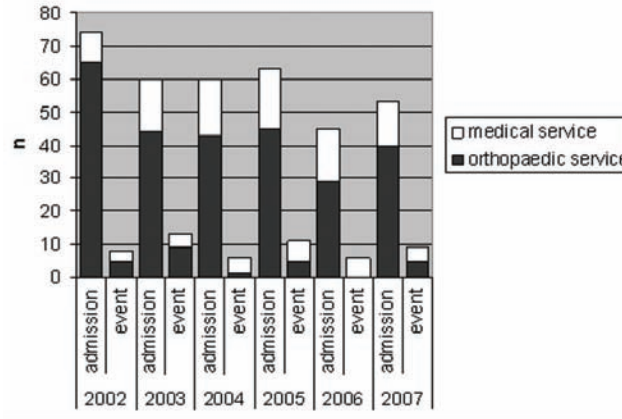

Figure. Number of patients treated for hip fracture, number of adverse events (AEs) each year, and percentage admitted to a medical or an orthopedic service. Overall, 75% of patients were initially admitted to an orthopedic service. An AE (in-hospital death, intensive care unit admission, or death within 30 days of surgery) occurred in 15% of patients. Among patients in whom an AE occurred, there was no significant difference in percentage admitted to a medical or an orthopedic service (52.8% vs 47.2%; *P* = .8).

Dr. Mok is Resident, Mr. Durrani is Visiting Medical Student, Dr. Yamamoto is Resident, and Dr. Kim is Associate Professor in Residence, Department of Orthopaedic Surgery, University of California, San Francisco, California.

Address correspondence to: James M. Mok, MD, Department of Orthopaedic Surgery, University of California, 500 Parnassus Ave, MU 320 W, Box 0728, San Francisco, CA 94143-0728 (tel, 415-476-6043; fax, 415-476-1304; e-mail, james.mok@ucsf.edu).

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Table I. Existing Criteria for Initial Admission of Hip Fracture Patients From Emergency Department to Medical Service[a]

Acute Medical Problems	
Cardiac	Acute chest pain, congestive heart failure exacerbation, new or uncontrolled arrhythmia, syncope, electrocardiogram with ischemic changes not known to be chronic
Pulmonary	Pneumonia or aspiration, chronic obstructive pulmonary disease or asthma in active exacerbation, moderate or high suspicion of or documented pulmonary embolism
Gastrointestinal	Acute gastrointestinal bleed, acute abdominal pain, decompensated cirrhosis
Renal	Renal failure not known to be chronic, severe electrolyte abnormalities that require inpatient treatment
Neurologic	Acutely altered mental status or neurologic deficit not known to be caused by baseline dementia or old stroke
Vital Signs Abnormalities	
Temperature	>38.5°C or <35°C
Heart rate[b]	>120 bpm or <50 bpm
Systolic blood pressure[b]	>180 mm Hg or <90 mm Hg
Respiratory rate[b]	>26 or <10 breaths per minute
Oxygen saturation	<90% (unless patient uses home O_2 for chronic hypoxia)
Laboratory Abnormalities	
Electrolyte abnormalities	Severe enough to require urgent correction (eg, sodium, >150 or <120 mmol/L; potassium, >6.0 or <2.8 mmol/L)
Hematocrit	<25% or a drop of >10% from baseline
Electrocardiogram	Ischemic ST- or T-wave abnormalities not known to be chronic

[a]Most patients admitted to a medical service have medical problems (acute condition, vital signs abnormalities, laboratory and radiographic findings) that would warrant medical admission even in the absence of hip fracture. Patients with chronic medical problems considered stable (eg, coronary artery disease, chronic obstructive pulmonary disease, diabetes, dementia) are admitted to an orthopedic service.
[b]Medical admission warranted when abnormality persists despite appropriate emergency department treatment (ie, pain control).

using limited resources to provide high-quality care that is based on clinical evidence.[11]

Although the literature indicates that patients with hip fracture benefit from optimized medical care,[12] in many centers it is not possible to routinely admit these patients to a medical service. Medical admission is often reserved for the sickest patients and for those at highest risk for complications and death. There is a paucity of data about the outcomes of patients admitted to a medical service versus an orthopedic service. Nevertheless, selective admission to a medical service of only the sickest patients is standard at many hospitals. We are not aware of any study that has investigated admission criteria for hip fracture patients and the effectiveness of these criteria in allocating patients at highest risk for complications or death to a medical service.

As is done at many academic medical centers, at our institution patients with hip fracture are triaged in the emergency department (ED) to a medical or an orthopedic service based on criteria that assess the presence of acute or unstable medical problems. In the study reported here, we compared patients admitted to a medical or an orthopedic service based on occurrence of 1 of 3 adverse events (AEs): death during hospitalization, intensive care unit (ICU) transfer, and death within 30 days of surgery. We evaluated the adequacy of current admission criteria in initially allocating patients with AEs to a medical service. We also defined criteria that can be used to increase the percentage of patients with AEs who are admitted to a medical service, so that these patients can receive the close medical care they require.

Patients and Methods

Included in this study were all patients (age 65 or older) admitted through the ED for surgical treatment of a hip fracture between July 2002 and May 2007. Our hospital is an urban 600-bed tertiary-care academic medical center and is not a state-designated trauma center. Patients were identified by an admitting diagnosis of proximal femur fracture (*International Classification of Diseases, Ninth Revision* code 820.xx) and surgery for hip fracture during the same hospitalization. Exclusion criteria were surgery not performed, pathologic hip fracture, previous internal fixation or arthroplasty of the ipsilateral hip, and no Social Security number. Surgery is performed on patients with hip fracture except when the risk for death from surgery is deemed too high.

Patients were triaged in the ED for admission to a medical or an orthopedic service based on existing criteria that assess medical acuity (Table I). In general, patients are admitted to an orthopedic service except when they have medical problems that warrant medical admission even in the absence of a hip fracture. Patients with chronic medical problems that are considered stable (eg, coronary artery disease, chronic obstructive pulmonary disease, diabetes, dementia) are admitted to an orthopedic service. Exceptions are made on a case-by-case basis depending on the consensus of the attending physicians of the ED, orthopedic, and medical services. The admitting service assumed primary responsibility for the patient, including daily rounds, notes, orders, nursing communications, subspecialty consultations, diagnostic evaluations, and treatments. For patients admitted to an orthopedic service, an internal medicine consultation was routinely obtained for

Table II. Cohort (N = 355)

Characteristic	n	%
Age (y)		
Mean (SD)	83 (8.00)	
65–74	56	15.77
75–84	126	35.49
85–94	154	43.38
95+	19	5.35
Sex		
Male	91	25.63
Female	264	74.37
American Society of Anesthesiologists grade		
Mean (SD)	3 (0.58)	
2	81	23.08
3	232	66.10
4	37	10.54
5	1	0.28
Admitting service		
Orthopedic surgery	266	74.93
Internal medicine	70	19.72
Cardiology	18	5.07
Other	1	0.28
Time to surgery (days)		
Mean (SD)	1.2 (1.5)	
Within 2	329	92.68
Within 4	342	96.34
Type of surgery		
Closed reduction and percutaneous pinning	38	10.70
Open reduction and internal fixation	175	49.30
Arthroplasty	142	40.00
Length of stay, days: mean (SD)	7.2 (4.0)	
Adverse event		
Any adverse event[a]	53	14.93
In-hospital death	10	2.82
Intensive care unit transfer	37	10.42
Death within 30 days	25	7.04
Disposition		
Home	51	14.37
Rehabilitation or skilled nursing facility	286	80.56
In-hospital death	10	2.82
Other	8	2.25

[a]Number of patients in whom adverse event(s) occurred.

Table III. Percentage of Patients in Each Category in Whom an Adverse Event[a] Occurred

Category	%
Age (y)	
65–74	7.14
75–84	13.49
85–94	18.18
95+	21.00
Sex	
Male	26.40
Female	10.98
American Society of Anesthesiologists grade	
2	8.64
3	14.22
4	29.73
5	100
Admitting service	
Orthopedic	9.40
Medical	31.50

[a]Defined as in-hospital death, intensive care unit transfer, or death within 30 days of surgery.

preoperative risk stratification and recommendations. The consultant continued to follow the patient at their discretion and usually did not write orders.

Data collected included age, sex, admitting service, time to surgery, length of stay, type of surgery, American Society of Anesthesiologists (ASA) grade, disposition, date of death, and occurrence of an AE. Time to surgery was defined as number of calendar days between admission and surgery, and length of stay as number of days between admission and discharge. Type of surgery was categorized as closed reduction and percutaneous pinning; open reduction and internal fixation (sliding hip screw or intramedullary implant); or arthroplasty (hemiarthroplasty or total hip arthroplasty). Patient's ASA grade was decided by the anesthesiologist during preoperative evaluation (grade 1, normal and healthy; grade 2, mild systemic disease; grade 3, severe but not incapacitating systemic disease; grade 4, severe, incapacitating systemic condition that is a constant threat to life; grade 5, near death).[13] An AE was defined as 1 of 3 outcomes: death during hospitalization, ICU transfer during hospitalization, or death within 30 days of surgery. If more than 1 AE occurred for a given patient, it was counted only once for calculations involving total number of patients with any AE. Information regarding in-hospital deaths, ICU transfers, and dispositions were obtained from internal hospital census records. Death and date of death after discharge were obtained from the Social Security Death Index.

Institutional review board approval was obtained. The requirement of informed consent was waived because no patient contact was required for this study, and the risk for loss of privacy was minimal.

Statistical Analysis

Survival analysis with the Kaplan-Meier method was used to determine cohort mortality at specific points. AE risk factors were identified with multivariate logistic regression. Patient demographics and AE occurrence were compared between admitting services. Multivariate linear regression was used to correlate admitting pattern fluctuations with AE occurrence. Continuous data were compared with the Mann-Whitney test for nonparametric data. Age and ASA grade were treated as continuous variables. Nominal data were compared with the χ^2 test. The binomial test was used to determine whether 2 groups' proportions differed significantly from a 1:1 distribution. Statistical significance was defined as $P \leq .05$.

Results

Three hundred fifty-five patients met the inclusion criteria. Patient characteristics are listed in Table II. Mean age was 83 years (SD, 8.0 years). Seventy-four percent of patients

Table IV. Patient Characteristics and Adverse Event Rates by Admitting Service[a]

Characteristic	Admitting Service		*P*	Relative Risk[b]
	Medical	Orthopedic		
Age (y)	83.97	83.15	.4	
American Society of Anesthesiologists grade	3.18	2.78	<.001	
Sex (% male)	31.46	23.68	.1	
Time to surgery (days)	1.83	0.98	<.001	
Length of stay (days)[c]	9.18	6.52	<.001	
Adverse event (%)				
Any adverse event	31.46	9.40	<.001	3.35
In-hospital death	7.87	1.13	<.001	6.96
Intensive care unit transfer	21.35	6.77	.001	3.15
Death within 30 days	17.98	3.38	<.001	5.32

[a]Patients admitted to a medical service had significantly higher American Society of Anesthesiologists grade, longer time to surgery, longer length of stay, and, reflecting their medical acuity, significantly higher adverse event rates for all categories.
[b]Univariate analysis.
[c]Excludes patients who died in hospital.

Table V. Patients in Whom an Adverse Event Occurred: Characteristics and Admitting Service[a]

Characteristic	Admitting Service		*P*
	Medical	Orthopedic	
Adverse event (%)			
Any adverse event	52.8	47.2	.8[b]
In-hospital death	70	30	.3[b]
Intensive care unit transfer	51	49	1.0[b]
Death within 30 days	64	36	.2[b]
Age (y)	84.43	86.16	.1
American Society of Anesthesiologists grade	3.32	2.88	<.05
Sex (% male)	39	52	.4

[a]There was no significant difference in percentage admitted to a medical or an orthopedic service for all categories of adverse events from a 1:1 distribution. American Society of Anesthesiologists grade was significantly higher for patients in whom an adverse event occurred on a medical service than for patients in whom an adverse event occurred on an orthopedic service.
[b]By binomial test.

were women. Seventy-five percent of patients were admitted to an orthopedic service. The percentage of patients admitted to an orthopedic service ranged by year from 64% to 88% (Figure 1). There were no significant differences among years in percentage admitted to an orthopedic service, age, percentage of men, or ASA grade ($P>.05$). An AE occurred in 15% of patients. There were no statistically significant correlations between percentage of patients admitted to an orthopedic service and AE occurrence; a trend toward significance was found between increasing orthopedic admissions and decreasing percentage of patients who died within 30 days of surgery ($r = 0.49$, $P = .06$). Univariate analysis detected no significant differences in AEs between types of surgery ($P>.2$).

Kaplan-Meier analysis found 7% mortality at 30 days, 13.6% at 3 months, 17.2% at 6 months, 21.5% at 1 year, and 29.4% at 2 years.

Table III lists the percentages of patients in whom an AE occurred, arranged by age, sex, ASA grade, and admitting service. Multivariate logistic regression included age, sex, and ASA class as variables ($\chi^2 = 22.41$, $P = .0001$). Male sex (odds ratio [OR], 2.8; 95% confidence interval [CI], 1.50-5.26; $P = .001$) and higher ASA grade (OR, 2.12; 95% CI, 1.24-3.61; $P = .006$) were found to be independent predictors of an AE. There was a trend toward significance for older age (OR, 1.03; 95% CI, 0.99-1.08; $P = .1$), though this was not statistically significant.

Results by Admitting Service

Table IV lists patient characteristics and AEs for patients admitted to a medical versus an orthopedic service. Rates of AEs were significantly higher for patients admitted to a medical service, and the same was true of all AE subcategories, reflecting these patients' medical acuity. Patients admitted to a medical service also had significantly higher ASA grade, longer time to surgery, and longer length of stay.

Results by Occurrence of Adverse Event

The binomial test showed no significant difference between the percentage of patients with AEs admitted to a medical versus an orthopedic service (Table V). Patients with AEs admitted to an orthopedic service were significantly older (86.16 vs 82.85 years; $P<.05$) and had a higher percentage of men (52% vs 20.7%; $P<.005$) than patients without AEs admitted to an orthopedic service, but ASA grade did not differ significantly (2.88 vs 2.77; $P = .4$). Patients with AEs admitted to a medical service had a higher ASA grade (3.32 vs 3.12), were older (84.43 vs 83.75 years), and had a higher percentage of men (39.3% vs 27.9%) than patients

Table VI. Allocation of Patients With Adverse Events to a Medical or an Orthopedic Service With Retrospective Application of Modified Admission Criteria, Compared With Existing Criteria[a]

Characteristic	Existing Admission Criteria			Existing Admission Criteria + Men 85 and Older + ASA Grade 4		
	Medical	Orthopedic	*P*	Medical	Orthopedic	*P*
Adverse event						
Any adverse event	52.8	47.2	.8[b]	72	28	<.005[b]
In-hospital death	70	30	.3[b]	80	20	.1[b]
Intensive care unit transfer	51	49	1.0[b]	78	22	.001[b]
Death within 30 days	64	36	.2[b]	68	32	.1[b]
Admission rate	25	75		37	63	
Adverse event rate	31.5	9.4		30	4.2	

Abbreviation: ASA, American Society of Anesthesiologists.
[a]With addition of men age 85 years or older and ASA grade 4 to medical admission, the proportion of patients admitted to a medical service was significantly different from a 1:1 distribution for any adverse event and intensive care unit transfer. The medical admission rate would increase from 25% to 37% without changing the risk level of admitted patients as measured by the adverse event rate while significantly decreasing the adverse event rate among orthopedic admissions.
[b]By binomial test.

without AEs admitted to a medical service, but none of these differences was statistically significant (*P*>.2).

In a comparison of patients with AEs admitted to an orthopedic service and patients without AEs admitted to a medical service, the orthopedic service patients had a lower ASA grade (2.88 vs 3.32; *P* = .09), were older (86.16 vs 83.75 years; *P* = .3), and had a higher percentage of men (52% vs 27.8%; *P*<.05), but only male sex was statistically significant.

Modification of Existing Criteria

To determine a threshold for medical versus orthopedic admission, we attempted to define criteria that would increase the percentage of patients with AEs admitted to a medical service without substantially changing the acuity level. For the entire cohort of patients with ASA grade 4, 48% of whom were admitted to an orthopedic service, an AE occurred in 30%. Among men older than 85, 67% of whom were admitted to an orthopedic service, an AE occurred in 39%. Addition of ASA grade 4 and men age 85 or older to existing criteria increased the percentage of patients with AEs admitted to a medical service. With the modified criteria applied retrospectively, a significantly higher percentage of patients in whom any AE occurred would have been admitted to a medical rather than an orthopedic service (Table VI). A statistically significant difference was also found for patients who required ICU transfer. The percentage of patients who died in the hospital or within 30 days of surgery admitted to a medical service would also be increased but did not reach statistical significance. The percentage of patients admitted to a medical service increased from 25% to 37%. The percentage of patients with an AE admitted to a medical service, with the modified criteria applied, remained largely unchanged (31.5% vs 30%; *P* = .9). The results indicated that the additional admissions to a medical service did not decrease the overall risk level of patients admitted to a medical service (AE rate). The percentage of patients with AEs admitted to an orthopedic service decreased significantly, from 9.4% to 4.2% (*P*<.05).

Discussion

As the effects of hip fracture on mortality and function are profound, care should expand from treatment of the fracture to treatment of the entire patient.[6] The major causes of mortality are medical problems that are independent of the type of orthopedic treatment. An autopsy study of 581 patients who died after hip fracture showed that pneumonia, cardiac failure or myocardial infarction, and pulmonary embolism were the principle causes of death in 83% of cases.[14] The importance of infection was emphasized by Myers and colleagues,[15] who surveyed 27,370 hip patients and found high ORs for in-hospital death with a diagnosis of septicemia, pneumonia, or digestive system disorder; ORs were double in the presence of cardiac, neoplastic, or cerebrovascular disease. Delirium has also been reported to be predictive of mortality.[16] Sexson and Lehner[17] found 1-year mortality to be 3 times higher in patients with postoperative complications. A prospective observational study of 2,903 patients admitted for hip fracture identified pneumonia, cardiac failure, and urinary tract infection as the most common postoperative complications.[18] Postoperative complications are an important contributor to mortality; efforts to reduce mortality should be directed at preventing these complications.[19]

Management of these patients primarily by a medical or an orthopedic service depends on the existing process of care. As processes of care might have a direct effect on outcomes, they have been the subject of investigation. Delay of surgery has been examined in several studies.[18,20] Hannan and colleagues[21] found significant differences in 6-month patient outcomes after hip fracture among hospitals and attributed these to variability in inpatient and postacute services. Clague and colleagues[1] found that shorter times between presentation and admission after implementation of a fast-track protocol led to increased in-hospital mortality. The investigators concluded that this increased mortality resulted from premature labeling of patients as stable (ie, medical evaluations had been incomplete).

Attempts to improve outcomes after hip fracture have involved different processes of care, including management

Close Medical Management With Multidisciplinary Teams, Hospitalists, Geriatric Medicine Physicians, and Standardized Care Pathways: The Evidence

In a Cochrane review encompassing 9 trials and 1,887 patients up until December 2002, Cameron and colleagues[8] concluded that studies were disparate but that trends favored multidisciplinary care of hip fractures, most notably for the outcome measure of death or deterioration.

More recently, Phy and colleagues[22] reported results of a system in which hip fracture patients were admitted and managed by a hospitalist. Time to surgery was faster, patients were discharged sooner, and there were no significant differences in readmission rates, inpatient deaths, or complications.

In a randomized trial of 319 hip fracture patients assigned to a daily multidisciplinary geriatric team or usual care, Vidan and colleagues[23] found statistically significant improvements for in-hospital deaths and major complications, which were attributed in part to better clinical management.

Gholve and colleagues[11] conducted a prospective study of 151 hip fracture patients who entered a multidisciplinary integrated care pathway that standardized management up to time of surgery. Significant reductions occurred in 30-day mortality (8% vs 13%).

In a survey of nurses and orthopedic surgeons after implementation of a hospitalist system for arthroplasty patients, Huddleston and colleagues[24] found that prompt and coordinated postoperative medical management produced strong satisfaction and a sense of enhanced ease in providing care.

Improvements in outcomes resulting from these interventions demonstrate the potential benefits of close medical management, further highlighted by Fisher and colleagues,[25] who compared outcomes of 951 hip fracture patients before and after initiation of daily geriatric medicine management of all patients, previously performed by an orthopedic service. Statistically significant reductions occurred in in-hospital mortality (7.7% decreased to 4.7%) and in postoperative medical complications (sepsis, pneumonia, urinary tract infection, delirium, venous thromboembolism, pressure sores, acute coronary events, cerebrovascular syndromes). A higher percentage of patients were placed on appropriate thromboembolism prophylaxis, and readmission rates were lower.

by interdisciplinary teams, hospitalists, geriatric medicine physicians, and standardized care pathways—the results of these efforts are discussed in the Box above.

Challenging Practical Considerations. Although patients treated for hip fracture at teaching hospitals in the United States have been shown to have improved survival,[26] the appropriate allocation of admissions to a medical or an orthopedic service is often the source of debate. Implementation of comprehensive evidence-based interventions might not be realistic because of the effort and expense required, particularly at centers that do not receive a high volume of hip fracture patients. Ideally, comanagement by orthopedic and medical services would provide the same quality of care to all patients; in practice, the admitting service takes primary responsibility of overall management, including evaluation and treatment of medical issues. Routine admission of all hip fracture patients to a medical service would provide close medical management but might not be practical. At the other extreme, admitting all patients to an orthopedic service would likely adversely affect outcomes, as comorbidities and postoperative complications might not be managed as closely. Optimizing existing processes of care might represent a simple, inexpensive, and practical method of improving outcomes. Although previous studies have identified risk factors for morbidity and mortality, translating these data into admission criteria that allocate the highest risk patients to a medical service is challenging.

The Current Study. We identified patients who may have benefited from close medical care as those with early mortality or serious medical complications requiring ICU transfer. These criteria were validated by a multivariate logistic regression analysis that identified male sex and higher ASA grade as independent predictors of AEs (these factors were shown to predict mortality in previous studies). Age was not statistically significant, which is consistent with other studies that did not find age to be an independent predictor of mortality.[27] No statistically significant relationship was found between type of surgery and AE, also consistent with the literature.[15,19,28] Mortality in our cohort and mortality in other published series were similar.[18,29-32]

Existing criteria at our institution resulted in admission of 25% of elderly hip fracture patients to a medical service. These criteria indeed allocated the sickest patients to a medical service, resulting in an AE rate of 31.5% compared with 9.4% of patients on an orthopedic service. Patients admitted to a medical service included a significantly higher percentage of those who died in hospital, required ICU transfer, or died within 30 days of surgery. Similar results were reported by Moran and colleagues,[18] who found that patients deemed medically unfit for surgery and admitted for medical workup and treatment had increased mortality at 30 days (relative risk, 2.3) and 90 days (relative risk, 2.1). Patients admitted to a medical service at our center had a significantly higher ASA grade. Time to surgery was significantly longer because patients required medical stabilization and risk stratification. Zuckerman and colleagues[20] found that, though surgical delay of more than 2 days nearly doubled 30-day mortality on univariate analysis, it was not statistically significant when ASA grade and age were controlled.

The results also indicate that the criteria based on medical acuity did not identify a substantial number of the

highest risk patients (as measured by subsequent AEs) for admission to a medical service. Among patients with AEs, no statistically significant difference was found between the percentage admitted to a medical service versus an orthopedic service (52.8% vs 47.2%; $P = .8$). In other words, a substantial percentage of patients with serious morbidity and early mortality were not identified as high risk in the ED and therefore were admitted to an orthopedic service.

As these patients would benefit most from close medical management, we investigated modifying the criteria to increase the percentage admitted to a medical service without causing an excessive increase in number of admissions. Current admission criteria use medical acuity to allocate patients to a medical service. As a result, many patients with severe (but chronic and stable) comorbidities are admitted to an orthopedic service. Adding patients who are ASA grade 4 or men age 85 or older would result in a significantly higher percentage of patients with AEs being admitted to a medical service (72% vs 28%; $P<.005$). There was a trend toward a larger percentage of patients who died in hospital or within 30 days admitted to a medical service, but this trend lacked the power to reach statistical significance. The most striking difference was observed for patients who required ICU transfer, which decreased from 49% admitted to an orthopedic service to 22%. The modified criteria would increase the admission rate to a medical service from 25% to 37%, but the percentage of patients with AEs would remain unchanged, at approximately 30%. This suggests that the modified criteria would not change the risk level of patients admitted to a medical service but would decrease the AE rate of patients admitted to an orthopedic service, from 9.4% to 4.2%.

An obvious confounding factor is the possibility that AEs in patients admitted to an orthopedic service might not have occurred had these patients been initially admitted to a medical service. This possibility might be particularly relevant for ICU transfer, as it is plausible that early and aggressive medical treatment might have prevented the need for ICU-level care. Patients with AEs admitted to an orthopedic service had a significantly lower ASA grade than patients with AEs admitted to a medical service. Interestingly, patients with AEs admitted to an orthopedic service had a lower ASA grade than patients without AEs admitted to a medical service (2.88 vs 3.12; $P = .09$), though this was not statistically significant, and the percentage of men was significantly higher. In the identification of patients who required ICU transfer or died early after surgery admitted to an orthopedic service under existing criteria, the modified criteria would allocate these patients to a medical service, where, ideally, AEs could be prevented. That care on a medical service would improve final outcome was not shown and is one weakness of this retrospective study. Definitive assessment of the value of treatment on a medical service would require a prospective trial in which patients are randomized to a medical or an orthopedic service. This is an area for possible future study.

Outcome Findings Specific to Academic Medical Centers? An important consideration is that the outcomes described in this study occurred at an academic medical center and therefore might not be generalizable to nonacademic centers. Academic medical centers have unique features that enhance the medical care of patients on an orthopedic service, including management by residents, who as recent medical school graduates might be more knowledgeable about medical treatments, in-house on-call service, and immediate availability of other subspecialty consultations. Therefore, admission to a primary orthopedic service at a nonacademic center might not result in the same level of medical care as at an academic center. For elderly patients with medical comorbidities, it is plausible that these differences would result in more adverse outcomes than observed on an orthopedic service in this study.[26]

Potential Study Limitations. This study had several potential weaknesses. First, the cohort included a heterogeneous patient population with variable health, functional status, and living situations. As the current admission criteria are applied to all hip fracture patients presenting to the ED, we believe we had to include all the patients to fully evaluate the criteria. Second, cohort details, such as specific comorbidities and reasons for admission to a medical service, were not included, and information about comorbidities was limited to ASA grade. Retrospective chart review would introduce bias caused by differences in documentation patterns among physicians and services as well as differences in interpretation. This was illustrated in a study that unexpectedly found that risk for in-hospital death decreased in patients with certain medical comorbidities; the investigators blamed underreporting error in patients with multiple medical problems.[15] ASA grade, which describes severity of medical illness and operative risk, has been found to predict 1-year mortality, whereas number of comorbidities has not.[19] Use of a single parameter, ASA grade, rather than individual comorbidities would also enhance the simplicity of modifications to the existing criteria. Third, interservice transfers sometimes occur after admission, so a patient might have been on a different service when an AE occurred. However, because the admitting service performs preoperative and perioperative management of patients, it is arguably the most important service. Patients also usually remain on the admitting service. Fourth, details about AEs might allow evaluation of their preventability with appropriate medical management, but judging this would be exceedingly difficult with a retrospective chart review. Finally, postdischarge death data are limited by the accuracy of the Social Security Death Index, and mortality rates might be underestimated, though this would affect patients admitted to medical and orthopedic services equally.

Conclusions

Patients who sustain hip fractures are at considerable risk for medical complications that increase mortality. Often, these patients are frail and debilitated and lack adequate support. As would be expected, previous studies have demonstrated that close medical management can decrease postoperative complications and improve survival. Admission to a medical service would provide these potential benefits of close medical management. However, at many academic medical

centers, medical admission is reserved for patients thought to be at high risk for complications. We found that admission criteria based on medical acuity did not effectively identify these patients in that a substantial percentage who subsequently demonstrated serious morbidity and early mortality were initially admitted to an orthopedic service. We presented simple modifications of existing criteria to provide the highest-risk patients with the close medical management they require. Although our results reflect the experience of a single center, they illustrate the important fact that admission criteria are a combination of resource allocation and local policy that is ultimately arbitrary and therefore changeable. The efficacy of changes must be determined through prospective study.

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