ORIGINAL RESEARCH

Effects of a Hospitalist Care Model on Mortality of Elderly Patients with Hip Fractures

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BACKGROUND: We previously demonstrated that a hospitalist service created to medically manage patients with hip fracture reduced time to surgery and length of hospital stay, with no difference in inpatient mortality, compared with patients who received standard care. Whether this improved efficiency affects long-term mortality is unknown.

OBJECTIVE: This study examined the effects of this hospitalist service versus standard care on mortality up to 1 year and identified predictors of mortality in patients with hip fracture.

DESIGN: Retrospective cohort study.

SETTING: Tertiary care center.

PATIENTS: Four hundred and sixty-six consecutive patients admitted for surgical repair of a hip fracture in 2000-2002 with 93% 1-year follow-up.

RESULTS: There was no significant difference in survival of the patients between those on the hospitalist care service and those on the standard care service (70.5% [CI: 64.8%, 76.7%] vs. 70.6% [CI: 64.9%, 76.8%]; $P = .36$), despite the shortened time to surgery and decreased length of stay in the hospitalist group. Predictors of mortality included: admission from a nursing home (hazard ratio [HR] 2.24, [CI: 1.73, 2.90]); age at admission (HR 1.17 [CI: 0.99, 1.38]); inpatient complications, including ICU admission, myocardial infarction, or acute renal failure (HR 1.85 [CI: 1.45, 2.35]); and ASA class III or IV compared with ASA class II (HR 4.20 [CI: 2.21, 7.99]).

CONCLUSIONS: The improved efficiency in reducing length of stay and time to surgery in the hospitalist group did not adversely affect long-term mortality of this patient population. ***Journal of Hospital Medicine*** **2007;2:219–225.**

KEYWORDS: hospitalist as consultant, geriatric patient, osteoporosis, post-operative evaluation.

Because the incidence of hip fracture increases dramatically with age and the elderly are the fastest-growing portion of the United States population, the number of hip fractures is expected to triple by 2040.[1] With the associated increase in postoperative morbidity and mortality, the costs will likely exceed $16-$20 billion annually.[1–5] Already by 2002, the number of patients with hip fractures exceeded 340,000 in this country, resulting in $8.6 billion in health care expenditures from in-hospital and posthospital costs.[6–8] This makes hip fracture a serious public health concern and triggers a need to devise an efficient means of caring for these patients. We previously reported that a hospitalist service can decrease time to surgery and shorten length of stay without affecting the number of inpatient deaths or 30-day readmissions of patients undergoing hip fracture surgery.[9] However, one concern

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with reducing length of stay and time to surgery in the high-risk hip fracture patient population is the effect on long-term mortality because the death rate following hip fracture repair may be as high as 43% after 1 year.[10] To evaluate this important issue, we assessed mortality over a 1-year period in the same cohort of patients previously described.[9] We also identified predictors associated with mortality. We hypothesized that the expedited surgical treatment and decreased length of stay of a hospitalist-managed group would not have an adverse effect on 1-year mortality.

METHODS

Patient Selection

Following approval by the Mayo Clinic Institutional Review Board, we used the Mayo Clinic Surgical Index to identify patients admitted between July 1, 2000, and June 30, 2002, who matched International Classification of Diseases (9th Edition) hip fracture codes.[11] These patients were cross-referenced with those having a primary surgical indication of hip fracture. Patients transferred to our facility more than 72 hours after fracture were excluded from our study. Study patients provided authorization to use their medical records for the purposes of research.

A cohort of 466 patients was identified. For purposes of comparison, patients admitted between July 1, 2000, and June 30, 2001, were deemed to belong to the standard care service, and patients admitted between July 1, 2001, and June 30, 2002, were deemed part of the hospitalist service.

Intervention

Prior to July 2001, Mayo Clinic patients aged 65 and older having surgical repair of a hip fracture were triaged directly to a surgical orthopedic or general medical teaching service. Patients with multiple medical diagnoses were managed initially on a medical teaching service prior to transfer to the operating room. The primary team (medical or surgical) was responsible for the postoperative care of the patient and any orders or consultations required.

After July 1, 2001, these patients were admitted by the orthopedic surgery service and medically comanaged by a hospitalist service, which consisted of a hospitalist physician and 2 allied-health practitioners. Twelve hospitalists and 12 allied health care professionals cared for patients during the study period. All preoperative and postoperative evaluations, inpatient management decisions, and coordination of outpatient care were performed by the hospitalists. This model of care is similar to one previously studied and published elsewhere.[12] A census cap of 20 patients limited the number of patients managed by the hospitalist service. Any overflow of hip fracture patients was triaged directly to a non-hospitalist-based primary medical or surgical service as before. Thus, 23 hip fracture patients (10%) admitted after July 1, 2001, were not managed by the hospitalists but are included in this group for an intent-to-treat analysis.

Data Collection

Study nurses abstracted all data including admitting diagnoses, demographic features, type and mechanism of hip fracture, admission date and time, American Society of Anesthesia (ASA) class, comorbid medical conditions, medications, all clinical data, and readmission rates. Date of last follow-up was confirmed using the Mayo Clinic medical record, whereas date and cause of death were obtained from death certificates obtained from state and national sources. Length of stay was defined as the number of days between admission and discharge. Time to surgery was defined in hours as the time from hospital admission to the start of the surgery. Finally, time from surgery to dismissal was defined as the number of days from the initiation of the surgical procedure to the time of dismissal. Thirty-day readmission was defined as readmission to our hospital within 30 days of discharge date.

Statistical Considerations

Power

The power analysis was based on the end point of survival following surgical repair of hip fracture and primary comparison of patients in the standard care group with those in the hospitalist group. With 236 patients in the standard care group, 230 in the hospitalist group, and 274 observed deaths during the follow-up period, there was 80% power to detect a hazard ratio of 1.4 or greater as being statistically significant (alpha = 0.05, beta = 0.2).

Analysis

The analysis focused on the end point of survival following surgical repair of hip fracture. In addition to the hospitalist versus standard care service, demographic, baseline clinical, and in-hospital data were evaluated as potential predictors of survival. Survival rates were estimated using the method of Kaplan and Meier, and relative differences in survival were evaluated using the Cox proportional hazards regression models.[13,14] Potential predictors were analyzed both univariately and in a multivariable model. For the multivariable model, initial variable selection was accomplished using stepwise selection, backward elimination, and recursive partitioning.[15] Each method yielded similar results. Bootstrap resampling was then used to confirm the variables selected for each model.[16,17] The threshold of statistical significance was set at $P = .05$ for all tests. All analyses were conducted in SAS version 8.2 (SAS Institute Inc., Cary, NC) and Splus version 6.2.1 (Insightful Corporation, Seattle, WA).

RESULTS

There were 236 patients with hip fractures (50.6%) admitted to the standard care service, and 230 patients (49.4%) admitted to the hospitalist service. As shown in Table 1, the baseline characteristics of the patients admitted to the 2 services did not differ significantly except that a greater proportion of patients with hypoxia were admitted to the hospitalist service (11.3% vs. 5.5%; $P = .02$). However, time to surgery, postsurgery stay, and overall length of hospitalization of the hospitalist-treated patients were all significantly shorter.

Patients were followed for a median of 4.0 years (range 5 days to 5.6 years), and 192 patients were still alive at the end of follow-up (April 2006). As illustrated in Figure 1, survival did not differ between the 2 treatment groups ($P = .36$). Overall survival at 1 year was 70.6% (95% confidence interval [CI]: 66.5%, 74.9%). Survival at 1 year in the standard care group was 70.6% (95% CI: 64.9%, 76.8%), whereas in the hospitalist group, it was 70.5% (95% CI: 64.8%, 76.7%). As delineated in Table 2, cardiovascular causes accounted for 34 deaths (25.6%), with 14 of these in the standard care group and 20 in the hospitalist group; 29 deaths (21.8%) had respiratory causes, 20 in the standard care group and 9 in the hospitalist group; and 17 (12.8%) were due to cancer, with 7 and 10 in the standard care and hospitalist groups, respectively. Unknown causes accounted for 21 cases, or 15.8% of total deaths.

In the univariate analysis, we found 29 variables that were significant predictors of survival (Table 3). A hospitalist model of care was not significantly associated with patient survival, despite the shorter length of stay (8.4 days vs. 10.6 days; $P < .001$) or expedited time to surgery (25 vs. 38 hours; $P < .001$), when compared with the standard care group, as previously reported by Phy et al.[9] In the multivariable analysis (Table 4), however, the independent predictors of mortality were ASA class III or IV versus class II (hazard ratio [HR] 4.20; 95% CI: 2.21, 7.99), admission from a nursing home versus from home or assisted living (HR 2.24; 95% CI: 1.73, 2.90), and inpatient complications, which included patients requiring admission to the intensive care unit (ICU) and those who had a myocardial infarction or acute renal failure as an inpatient (HR 1.85; 95% CI: 1.45, 2.35). Even after adjusting for these factors, survival following hip fracture did not differ significantly between the hospitalist care patients and the standard care patients (HR 1.16; 95% CI: 0.91, 1.48).

DISCUSSION

In our previous study, length of stay and time to surgery were significantly lower in a hospitalist care model.[9] The present study shows that neither the reduced length of stay nor the shortened time to surgery of patients managed by the hospitalist group was associated with a difference in mortality compared with a standard care group, despite significantly improved efficiency and processes of care. Thus, our results refute initial concerns of increased mortality in a hospitalist model of care.

Delivery of perioperative medical care to hip fracture patients by hospitalists is associated with significant decreases in time to surgery and length of stay compared with standard care, with no differences in short-term mortality.[9,18] Although there have been conflicting reports on the impact of length of stay and time to surgery on long-term outcomes, our findings support previous results that decreased time to surgery was not associated with an observable effect on mortality.[19-23.] A recent study by Orosz et al. that evaluated 1178 patients showed that earlier hip fracture surgery (performed less than 24 hours after admission) was not associated with reduced mortality, although it was associated with shorter length of stay.[19] Our study also corroborates the results of an examination of 8383 hip fracture patients by Grimes et al., who found that time to surgery between 24 and 48 hours after admission had no effect on either 30-day or long-term mortality compared with that of those who underwent surgery between 48 and 72 hours, between 72 and 96 hours, or more than 96 hours after admission.[20] However, both these results and our own are contrary to those of Gdalevich, whose study of 651 patients found that 1-year mortality

TABLE 1
Characteristics of 466 Hip Fracture Patients at Time of Admission

Patient characteristic	Standard care n = 236		Hospitalist care n = 230		*P* value
Age (years)	82		83		.34
Female sex	171	72.5%	163	70.9%	.70
Comorbidity					
Coronary artery disease	69	29.2%	77	33.5%	.32
Congestive heart failure	41	17.4%	49	21.3%	.28
Chronic obstructive pulmonary disease	36	15.3%	38	16.5%	.71
Cerebral vascular accident or transient ischemic attack	36	15.3%	50	21.7%	.07
Dementia	54	22.9%	62	27.0%	.31
Diabetes	45	19.1%	46	20.0%	.80
Renal insufficiency	17	7.2%	17	7.4%	.94
Residence at time of admission					.07
Home	149	63.1%	138	60.0%	
Assisted living	32	13.6%	42	18.3%	
Nursing home	55	23.3%	50	21.7%	
Ambulatory status at time of admission					.14
Independent	114	48.3%	89	38.7%	
Assistive device	99	41.9%	115	50.0%	
Personal help	9	3.8%	16	7.0%	
Transfer to bed or chair	9	3.8%	7	3.0%	
Nonambulatory	5	2.1%	3	1.3%	
Signs at time of admission					
Hypotension	4	1.7%	3	1.3%	> .99
Hypoxia	13	5.5%	26	11.3%	.02
Pulmonary edema	37	15.7%	29	12.6%	.34
Tachycardia	19	8.1%	25	10.9%	.3
Fracture type					.78
Femoral neck	118	50.0%	118	51.3%	
Intertrochanteric	118	50.0%	112	48.7%	
Mechanism of fracture					.82
Fall	219	92.8%	212	92.2%	
Trauma	1	0.4%	3	1.3%	
Pathologic	7	3.0%	6	2.6%	
Unknown	9	3.8%	7	3.0%	
ASA* class					.38
I or II	33	14.0%	23	10.0%	
III	166	70.3%	166	72.2%	
IV	37	15.7%	41	17.8%	
Location discharged to†					.07
Home or assisted living	24	10.5%	13	5.9%	
Nursing home	196	86.0%	192	87.3%	
Another hospital or hospice	8	3.5%	15	6.8%	
Time to surgery (hours)	38		25		.001
Time from surgery to discharge (days)	9		7		.04
Length of stay	10.6		8.4		< .00
Readmission rate	25	10.6%	20	8.7%	.49

*American Society of Anesthesia.
†18 Inpatient deaths were excluded.
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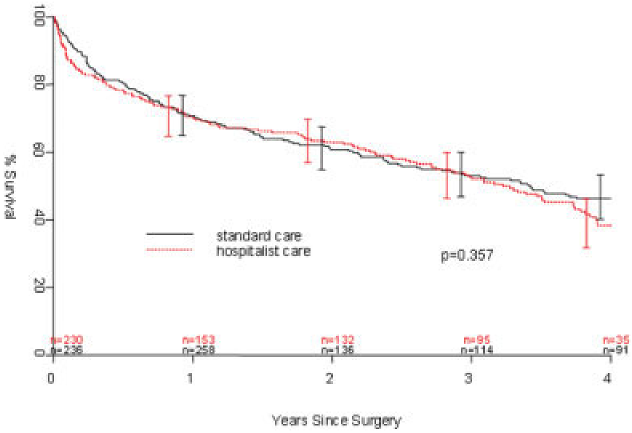

FIGURE 1. Survival following original hip fracture repair of 230 patients receiving hospitalist care and 236 patients receiving standard care. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

TABLE 2
Certified Underlying Cause of Death as Recorded on Death Certificates after 1 Year of Following Patients with Hip Fractures

	Standard care	Hospitalist care	Total No. of deaths	%
Cancer	7	10	17	12.8%
Cardiovascular	14	20	34	25.6%
Infectious	5	4	9	6.8%
Neurological	5	10	15	11.3%
Other	0	2	2	1.5%
Renal	4	2	6	4.5%
Respiratory	20	9	29	21.8%
Unknown	11	10	21	15.8%
Total	66	67	133	100.0%

was 1.6-fold higher for those whose hip fracture repair was postponed more than 48 hours.[21] However, time to surgery in both the standard care and hospitalist model in our study was well below the 48-hour cutoff, suggesting that operating anywhere within the normally accepted 48-hour time frame may not influence long-term mortality.

Because of the small number of events in both groups, we were unable to specifically compare whether a hospitalist model of care has any specific impact on long-term cause of death. Although causes of death of patients with hip fracture were consistent with those of previous studies,[10,24] our death rate at 1 year, 29.4%, was higher than that seen among similar population groups at tertiary referral centers.[19,20,24–29] This is most likely a result of the cohort having a high proportion of nursing home patients (22%)[19,24,26] transferred for evaluation to St. Mary's Hospital, which serves most of Olmsted County, Minnesota. This hospital also has some characteristics of a community-based hospital, as it is where greater than 95% of all county patients receive care for surgical repair of hip fracture. Mortality rates are often higher at these types of hospitals.[30] Previous studies using patients from Olmsted County indicate results can also be extrapolated to a large part of the U.S. population.[31] In Pitto et al.'s study, the risk of death was 31% lower in those admitted from home than for those admit-

TABLE 3
Univariate Predictors of Mortality 1 year after Surgical Repair of Hip Fracture

Variable	Hazard ratio (95% CI†)	*P* value
Age on admission per 10 years	1.41 (1.20, 1.65)	< .001
ASA* II	1.0 (referent)	
ASA* III	5.27 (2.79, 9.96)	< .001
ASA* IV	11.7 (5.97, 22.9)	< .001
History of chronic obstructive pulmonary disease	1.82 (1.35, 2.43)	< .001
History of renal insufficiency	2.40 (1.62,3.55)	< .001
History of stroke/transient ischemic attack	1.46 (1.10, 1.95)	.01
History of diabetes	1.70 (1.29,2.25)	< .001
History of congestive heart failure	2.26 (1.73, 2.96)	< .001
History of coronary artery disease	1.53 (1.20, 1.97)	< .001
History of dementia	2.02 (1.57, 2.59)	< .001
Admission from home	1.0 (referent)	
Admission from assisted living	1.47 (1.06, 2.04)	.02
Admission from nursing home	3.04 (2.33, 3.98)	< .001
Independent	1.0 (referent)	
Use of assistive device	1.81 (1.39, 2.36)	< .001
Personal help	3.49 (2.16, 5.64)	< .001
Nonambulatory	3.96 (2.47, 6.35)	< .001
Crackles on admission	2.03 (1.50, 2.74)	< .001
Hypoxia on admission	1.56 (1.04, 2.32)	.03
Hypotension on admission	6.21 (2.72, 14.2)	< .001
Tachycardia on admission	1.66 (1.15, 2.41)	.007
Coumadin on admission	1.57 (1.13, 2.18)	.007
Confusion/unconsciousness on admission	2.23 (1.74, 2.87)	< .001
Fever on admission	1.98 (1.16, 3.40)	.01
Tachypnea on admission	1.95 (1.39, 2.72)	< .001
Inpatient myocardial Infarction	3.59 (2.35, 5.48)	< .001
Inpatient atrial fibrillation	2.00 (1.37, 2.92)	< .001
Inpatient congestive heart failure	2.62 (1.79, 3.84)	< .0001
Inpatient delirium	1.46 (1.13, 1.90)	< .005
Inpatient lung infection	2.52 (1.85, 3.42)	< .001
Inpatient respiratory failure	2.76 (1.64, 4.66)	< .001
Inpatient mechanical ventilation	2.56 (1.43, 4.57)	.002
Inpatient renal failure	3.60 (1.97, 6.61)	< .001
Days from admission to surgery	1.06 (1.005, 1.12)	.03
Intensive care unit stay	1.93 (1.51, 2.47)	< .001

*American Society of Anesthesia; †confidence interval.

TABLE 4
Multivariable Predictors of Survival Following Surgical Repair of Hip Fracture

Variable	Hazard ratio (95% CI†)	*P* value
Age on admission per 10 years	1.17 (0.99, 1.38)	.07
ASA* class III or IV	4.20 (2.21, 7.99)	< .001
ASA* class II	1.0 (referent)	
Admission from nursing home	2.24 (1.73, 2.90)	< .001
Admission from home or assisted living	1.0 (referent)	
Inpatient myocardial infarction, inpatient acute renal failure, or intensive care unit stay	1.85 (1.45, 2.35)	< .001
No inpatient myocardial infarction, no inpatient acute renal failure, and no intensive care unit stay	1.0 (referent)	

*American Society of Anesthesia; †Confidence interval.

ted from a nursing home.[32] The latter patients normally have a higher number of comorbid conditions and tend to be less ambulatory than those in a community home-dwelling setting. Our study also demonstrated that admission from a nursing home was a strong predictor of mortality for up to 1 year in the geriatric population. This may reflect the inherent decreased survival in this patient group, which is in agreement with the findings of other studies that showed inactivity and decreased ambulation prior to fracture were associated with increased mortality.[33–35]

Multiple comorbidities, commonly seen in a geriatric population, translate into a higher ASA class and an increased risk of significant in-hospital complications. Our study confirmed the findings of previous studies that a higher ASA class is a strong predictor of mortality,[21,26,30,35–37] independent of decreased time to surgery.[38] We also noted that significant in-hospital complications, including renal failure, respiratory failure, and myocardial infarction, are documented predictors of mortality after hip fracture.[27] Although mortality may vary depending on fracture type (femoral neck vs. intertrochanteric),[39–41] these differences were not observed in our study, in line with the results of previous published studies.[37,42] Controlling for age and comorbidities may be why an association was not found between fracture type and mortality. Finally, in a model containing comorbidity, ASA class, and nursing home residence prior to fracture, age was not a significant predictor of mortality.

Our study had a number of limitations. First, this was a retrospective cohort study based on chart review, so some data may have been subject to recording bias, and this might have differed between the serial models. Because of the retrospective nature of the study and referral of some of the patients from outside the community, our 1-year follow-up was not complete, but approached a respectable 93%. Other studies have described the benefits derived by a hospitalist practice only following the first year of its implementation, likely because of the hospitalist learning curve.[43,44] This may be why there was no difference in mortality between the standard care and hospitalist groups, as the latter was only in its first year of existence. Additional longitudinal study is required to find out if mortality differences emerge between the treatment groups. Furthermore, although in-hospital care may influence short-term outcomes, its effect on long-term mortality has been unclear. Our data demonstrate that even though a hospitalist service can shorten length of stay and time to surgery, there were no appreciable intermediate differences in mortality at 1 year. Further prospective studies are needed to determine whether this medical-surgical partnership in caring for these patients provides more favorable outcomes of reducing mortality and intercurrent complications.

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