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Factors Associated With Emergency Department Length of Stay for Patients With Hip Fracture

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Abstract

Time to surgery, which includes time in the emergency department (ED), is important for all patients with hip fracture. We hypothesized that patients with hip fracture spend significantly more time in the ED than do patients with the top 5 most common conditions. In addition, we hypothesized that there are patient, physician, and hospital factors that affect the length of time spent in the ED. We retrospectively reviewed our institution's hip fracture database and identified 147 elderly patients with hip fractures who presented to our ED from December 18, 2005, through April 30, 2009. We reviewed their records for patient, practitioner, and hospital factors of interest associated with ED time and for 6 specified time intervals. Average working, boarding (waiting for an inpatient room), and total times were calculated and compared with respective averages for admitted ED patients with the top 5 most common conditions. Univariate and multivariate analyses were performed before and after adjusting for confounders (significance, $P = .05$). The mean total ED time (7 hours and 25 minutes) and working time (4 hours and 31 minutes) for patients with hip fracture were similar to the respective overall averages for admitted ED patients. However, the average boarding time for patients with hip fracture was 2 hours 44 minutes, longer than that for other patients admitted through the ED. Factors significantly associated with longer ED times were a history of hypertension, history of atrial fibrillation, the number of computed tomography scans ordered, and the occupancy rate. Admission to the hip fracture service decreased working time but not overall time. Substantial multidisciplinary work among the ED, hospital admission services, and physicians is needed to dramatically decrease the boarding time and thus the overall time to surgery.

Keywords

hip fracture, emergency department, occupancy rate, wait time, admitting service

Introduction

Hip fractures are serious injuries that affect approximately 300 000 individuals each year in the United States alone.[1] One of the potential risk factors associated with increased morbidity and mortality for patients with a hip fracture is time to surgery; for example, a 2004 study by McGuire et al[2] showed that mortality increased by 14% when surgery was delayed for more than 2 days. Previous studies have identified factors that are associated with increased time to surgery, such as unavailability of an operating room or surgical staff, stabilizing the patients' other conditions, completing the medical evaluation, and waiting for laboratory results.[3,4] Time spent in the emergency department (ED) after the decision has been made to admit a patient, and before the patient is moved to the appropriate service, also called the boarding time, is also included in the time before surgery. This delay is a time of particular risk for patients, because they are in a very disorienting environment and in pain. Moreover, there is the potential for increased testing and, in addition, an increased risk of decubitus ulcers, because they usually lie on an ED cot with poor padding.[5] Several studies have shown that longer boarding time in the ED increases the morbidity and mortality of patients with hip fracture.[6-9]

In some countries, the length of time in the ED is audited and monitored by the government. In the United Kingdom, for example, the National Health Service audits these times when

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5% of the visits result in a wait time of more than 4 hours.[10] This is not the case in the United States. Recent studies using dedicated hip fracture programs have shown that fast-tracking patients in the ED is one way to improve time to surgery.[11,12] However, to our knowledge, few studies have directly analyzed factors that may be associated with increased time in the ED alone for patients with hip fracture. In 1 such retrospective study in China, Chia et al[13] found that the time from obtaining the radiograph to making the treatment decision for patients with hip fracture was constant, suggesting that reducing the time to obtain a radiograph may help alleviate the overall wait time. In another study in Australia, Richardson and McMahon[14] found a direct relationship between the number of inpatients boarding in the ED and delay to surgery for patients with hip fracture.

To our knowledge, no systematic analysis of the factors that may be associated with increased time in the ED for patients with hip fracture has been conducted in the United States. We hypothesized that such patients spend significantly more time in the ED than do patients admitted to the ED with the top 5 most common conditions and that patient, physician, and hospital factors affect the length of time spent in the ED.

Materials and Methods

We used an institutional review board-approved hip fracture database that is maintained by an anesthesiologist and is being used to measure outcomes in patients with hip fracture. Demographic data are entered into the database by a research nurse. We identified 153 patients who were admitted to the ED at our institution (an academic Level II trauma center that receives 60 000 cases in the ED every year) from December 18, 2005, through April 30, 2009. Institutional review board approval was received for our retrospective review of the medical records for these identified patients. The data of interest were obtained from the patient charts, and a standard excel sheet, set up before the data collection began, was used as the data collection tool. One abstractor collected the information, including times in the ED and to admission, number of images obtained in the ED, and the alert status of the hospital, from the patient charts.

Of the 153 patients, 6 had been initially treated at another facility's ED and were excluded, leaving 147 patients (143 caucasians, 4 African Americans) as our study group. The average age was 81.9 $\pm$ 6.5 years. The cause of injury was a fall (143 patients) or a motor vehicle accident (4 patients).

We reviewed the database and charts for patient, physician, and hospital factors of interest and for 6 specific time intervals. Patient factors were demographics; American Society of Anesthesiologists[15] score; time of day and day of the week entering the ED; initial potassium, calcium, sodium, blood urea nitrogen, creatinine, and hematocrit laboratory values obtained during the visit; the time of the ED visit (categorized as 12:00 PM to 8:00 PM, 8:00 PM to 4:00 AM, and 4:00 AM to 12:00 PM); Charlson comorbidity values (age adjusted and unadjusted); any atrial fibrillation on initial electrocardiogram readings; and any history of coronary artery disease, congestive heart failure, cerebrovascular disease, hypertension, diabetes, dementia, osteoporosis, chronic pulmonary disease, or cancer. Physician factors were the total number of ED consultations, the number and type of radiologic images during the visit, and the admitting service. Hospital factors were the ambulance diversion status of the ED on entry and the daily inpatient occupancy rate for each given patient. The average occupancy rate was 86% $\pm$ 7%, and the hospital was at 95% capacity for 26% of the time and at or over 100% capacity for 3% of the time. The 6 identified time intervals during a single visit were (1) from entry in the ED to entry into a patient room, (2) from entry in the patient room to the ED physician's assessment, (3) from entry in the ED to the first radiographic image obtained, (4) from the ED physician assessment to the initial consultation, (5) from the initial consultation to admission, and (6) boarding time (defined as the time from when the patient's admitting orders were entered into the computer to the time the patient was in a bed on the admitting service).

Two overall ED times were used, the working time (not including boarding time) and the total time (including boarding time). All of the available times and the boarding time were averaged and compared with the respective average times for all patients with the top 5 conditions who were evaluated in the ED and admitted to the hospital from 2005 through 2009. The top 5 conditions were abdominal pain, chest pain, shortness of breath, fall, and motor vehicle accident. Because of limitations in the times entered into the medical record, 8 patients did not have a boarding time. However, these patients were still included in calculating the averages of the various times for which they had an entry, which resulted in there being a difference in the actual recorded total time compared to the calculated total time, which is boarding time + working time.

Univariate analysis, using Student's t tests and 1-way analysis of variance, was carried out to test for significant differences in the working, boarding, or total time for various categories and to identify any predictor variables ($P = .05$). This was done to see whether there was any significant difference between groups before adjusting for confounding variables. Multivariate analysis using Cox proportional hazard models was used to test various predictors on the outcome of time in the ED by adjusting for confounding variables. Confounding variables included gender, day of the week, time of day, year of admission, and admitting service. Models were created with the working, boarding, or total time as the end points. Once a model was run, a hazard ratio was produced. A hazard ratio of greater than 1 is associated with decreased time, whereas a ratio of less than 1 is associated with increased time. PASW Statistics 18 (IBM, Armonk, New York) and Excel 2007 (Microsoft, Redmond, Washington) were used to carry out the analysis.

Results

The average total, working, and boarding times for our patients with hip fracture were (in hours:minutes) 7:25, 4:31, and 2:44, respectively (Figure 1). In comparison, the average total, working, and boarding times for ED-admitted patients with the top 5 most common conditions were (in hours:minutes) 7:39,

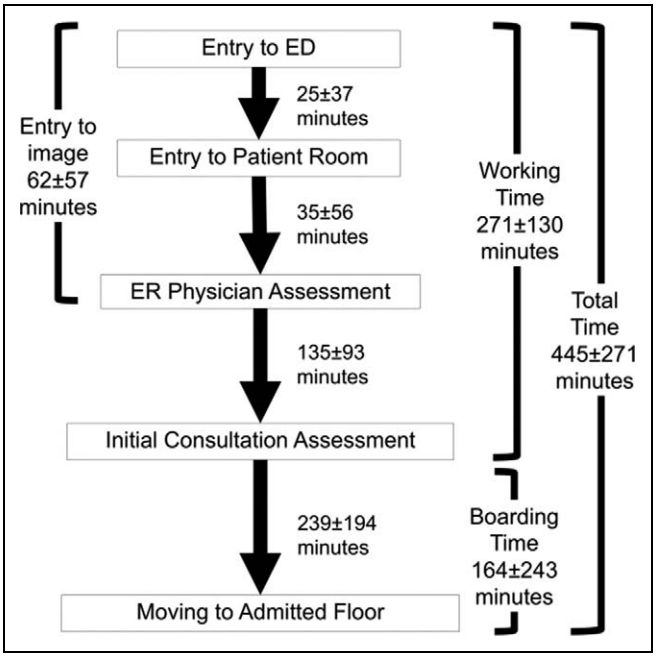

Figure 1. A timeline showing the events that occur in patients with hip fracture, with the average ± SD for all time points: time from entry in the ED to entering the patient room, time from entering the patient room to the ED physician's assessment, time from the ED physician's assessment to the initial consultation, and time from the initial consultation to admission. ED indicates emergency department; SD, standard deviation.

5:46, and 1:53, respectively. By univariate analysis, gender was the only category that was a significant ($P < .05$) factor when comparing the total time and the service to which the patient was admitted, and fracture type was significant when comparing the working time (Table 1).

Table 2 lists the full Cox proportional hazard model analysis performed to examine confounding variables. After taking into account confounding variables (for example, having a history of osteoporosis), gender was no longer significant ($P = .068$) when compared to the end points. For the patient factors, hypertension had an adjusted ratio (95% confidence interval) of 0.4 (0.237-0.677) when using boarding time as the end point. For the hospital factors, the percentage of occupied beds had an adjusted hazard ratio of 0.968 (0.927-0.995) and 0.938 (0.906-0.973) when using the total time and boarding time as end points, respectively. For the physician factors, being admitted to the hip fracture service was significant, with an adjusted ratio of 2.057 (1.348-3.139) using the working time as the end point.

Discussion

Hip fractures are serious injuries that require prompt medical and surgical care to reduce mortality and morbidity. Studies have shown that treatment delays in the ED can be reduced with the use of "fast-track" programs.[16,17] However, to our knowledge, no one has performed a systematic analysis of the factors associated with wait times in the ED in the United

Table 1. Patient, Physician, and Hospital Factors Analyzed.

Factors	Value
Patient factors	
Gender[a]	
Male, n	40
Female, n	107
Fracture type[b]	
Femoral neck, n	73
Intertrochanteric, n	64
Other, n	10
Age-adjusted Charlson comorbidity index, mean ± SD	6.2 ± 2.1
Age unadjusted Charlson comorbidity index, mean ± SD	2.5 ± 2
ED entry day of the week	
Monday	23
Tuesday	21
Wednesday	19
Thursday	19
Friday	28
Saturday	22
Sunday	15
ED entry time of day	
12:00 PM-8:00 PM	66
8:00 PM-4:00 AM	33
4:00 AM-12:00 PM	48
Comorbidities	
Atrial fibrillation	25
Coronary artery disease	60
Congestive heart failure	26
Cerebrovascular disease	25
Hypertension	116
Diabetes	29
Dementia	38
Osteoporosis	40
Chronic pulmonary disease	46
Cancer	38
Laboratory studies, mean ± SD	
Potassium, meq/L; normal, 3.5-5.0	4.2 ± 0.6
Hematocrit, %; normal, 36-46	37.4 ± 5.2
Blood urea nitrogen, mg/dL; normal, 7-22	24 ± 12.6
Creatinine, mg/dL; normal, 0.5-1.2	1.1 ± 0.6
Sodium, meq/L; normal, 135-148	139 ± 3.4
Calcium, mg/dL; normal, 8.4-10.5	9.5 ± 0.5
Physician factors	
Number of images	
Radiographs	
<4 sets	56
4 sets	45
>4 sets	46
CT	
1 scan	38
>1 scan	23
Admitting service[c]	
Hip fracture service	111
Medicine, surgery, cardiology, neurology	36
Hospital factors	
Alert status on day of ED entry[d]	
Yellow alert	114
Red alert	35
Daily occupancy rate, %	85.5 ± 7

Abbreviations: ANOVA, analysis of variance; CT, computed tomography; ED, emergency department; SD, standard deviation.

[a] Gender is significant ($P < .05$) when comparing the total time in univariate analysis. Women had a significantly longer time than men.

[b] Category is significant ($P < .05$) when comparing the working time in univariate analysis using ANOVA.

[c] Category is significant ($P < .05$) when comparing the working time in univariate analysis. For admitting service, being admitted to medicine, surgery, cardiology, or neurology had a significantly longer time compared to hip fracture service.

[d] The total is 149, because the hospital was on red or yellow alert twice.

Table 2. Multivariate Cox Proportion Hazard Models.

Factors	Working time			Boarding time			Total time		
	P value	Hazard ratio	95% CI	*P* value	Hazard ratio	95% CI	*P* value	Hazard ratio	95% CI
Patient factors									
Gender	.063	1.557	.977-2.483	.745	1.074	.697-1.655	.074	1.491	.961-2.314
Fracture type (IT vs all other fractures)	.172	1.301	.892-1.897	.242	1.248	.861-1.809	.707	1.074	.739-1.562
Charlson comorbidity index	.921	1.005	.910-1.110	.867	0.992	.905-1.088	.754	1.015	.924-1.115
ASA status	.078	1.493	.957-2.330	.845	0.957	.617-1.486	.487	1.175	.746-1.849
ED entry year									
2005	.978	.990	.461-2.122	.332	.672	.301-1.500	.215	.623	.295-1.316
2006	.523	.801	.406-1.582	**.010**[a]	**.408**	**.206-.806**	**.007**	**.414**	**.217-.789**
2007	.243	.677	.351-1.303	.054	.501	.248-1.011	.102	.565	.286-1.119
2008-2009	.547			.039			.052		
ED entry day									
Monday	.688	.850	.385-1.878	.192	.619	.301-1.273	.499	.776	.373-1.617
Tuesday	.138	.530	.228-1.227	.344	.674	.297-1.528	**.008**	**.322**	**.139-.746**
Wednesday	.144	1.849	.810-4.219	.327	.658	.285-1.521	.413	.711	.315-1.609
Thursday	.859	.917	.354-2.380	.397	1.451	.614-3.429	.488	.740	.316-1.734
Friday	.499	.777	.374-1.614	.795	.911	.450-1.842	.182	.623	.311-1.248
Saturday	.265	.655	.311-1.378	.263	.641	.294-1.398	.237	.637	.302-1.344
Sunday	.063			.243			.173		
ED entry time									
12 PM-8 PM	.381	1.211	.789-1.860	**.002**	**1.954**	**1.272-3.003**	**.031**	**1.623**	**1.045-2.523**
8 PM-4 AM	**.012**	**1.992**	**1.162-3.416**	**.020**	**1.953**	**1.112-3.429**	**.032**	**1.875**	**1.056-3.328**
4 AM-12 PM	.038			.006			.046		
Comorbidities									
Atrial fibrillation	.809	.937	.551-1.592	.081	.607	.346-1.063	**.023**	**.513**	**.289-.910**
Coronary artery disease	.895	.971	.629-1.500	.091	1.493	.938-2.375	.081	1.454	.955-2.216
Congestive heart failure	.793	1.084	.592-1.982	.456	.792	.430-1.462	.442	1.284	.678-2.430
Cerebrovascular disease	.767	.918	.522-1.616	.174	1.475	.842-2.582	.668	.885	.507-1.546
Hypertension	.284	.752	.447-1.266	**.000**	**.374**	**.218-.643**	**.044**	**.567**	**.327-.984**
Diabetes	.330	1.288	.774-2.144	.887	1.039	.617-1.749	.719	.910	.545-1.521
Dementia	.834	.950	.589-1.533	.542	1.166	.712-1.907	.748	1.084	.664-1.768
Osteoporosis	.717	1.088	.689-1.721	.139	.706	.444-1.120	.497	.854	.541-1.348
Cancer	.772	1.075	.659-1.753	.442	.830	.517-1.334	.668	.898	.551-1.466
Chronic pulmonary disease	.432	.830	.521-1.322	.378	1.241	.767-2.008	.732	.919	.569-1.486
Potassium (3.5-5.0)[b]	.867	.955	.560-1.631	.720	.910	.543-1.524	.774	1.079	.643-1.808
Hematocrit (36-46)	.461	1.175	.766-1.803	.078	1.454	.958-2.208	.431	1.169	.793-1.723
BUN (7-22)	.559	.869	.542-1.392	.499	.856	.547-1.342	.618	.889	.559-1.413
Creatinine (.5-1.2)	.552	1.165	.704-1.928	.869	1.047	.608-1.802	.937	.978	.563-1.698
Sodium (135-148)	.967	.985	.484-2.003	.825	.917	.428-1.965	.829	1.082	.530-2.208
Calcium (8.4-10.5)	.575	.771	.310-1.917	.050	2.481	.999-6.162	.298	1.639	.647-4.152
Physician factors									
Number of radiographs	.767	1.016	.914-1.130	.157	.917	.814-1.034	.860	.991	.893-1.099
Number of computed tomography scans	.942	1.008	.815-1.246	.052	.806	.648-1.002	**.043**	**.794**	**.634-.993**
Admission to the hip fracture service vs other services	**0.001**	**2.128**	**1.359-3.332**	.570	.882	.248-1.011	.233	1.302	.844-2.008
Hospital factors									
Discharge status									
Yellow alert	.179	1.460	.840-2.538	.240	.728	.429-1.236	.060	1.678	.978-2.878
Red alert	.880	.962	.579-1.597	.804	1.075	.607-1.905	.366	.778	.452-1.339
Hospital occupancy rate	.870	.997	.962-1.033	**.002**	**.938**	**.901-.977**	**.014**	**.952**	**.915-.990**

Abbreviations: ASA, American Society of Anesthesiologists; BUN, blood urea nitrogen; CI, confidence interval; ED, emergency department; IT, intertrochanteric.
[a] Boldfaced values represent significant differences.
[b] Values in parentheses represent normal value ranges. The laboratory values were tested in the models as being normal or abnormal.

States for patients with hip fracture. We performed a retrospective study evaluating patient, physician, and hospital factors that may affect time in the ED.

The total times for patients with hip fractures admitted from the ED and for patients admitted from the ED with the top 5 conditions were almost identical, suggesting that patients are

being moved out of the ED in a consistent timely manner. A study performed in an Ontario-based hospital found similar results for the working time (median, 5 hours).[18] Those investigators found the time from entry to ED physician to be approximately 1 hour or less,[18] very similar to our finding. Moreover, in 2010, the United States average working time was 4 hours and 7 minutes,[19] suggesting that the ED visit has already been streamlined to reduce potential delays in the ED workup process. However, the boarding time was significantly longer for patients with hip fracture, which suggests an area for improvement.

Univariate analysis for patient factors showed that gender and fracture type were significant. Yet these statistical significances were eliminated when using the multivariate model. For instance, when taking osteoporosis into account, the gender difference was lost, suggesting that the ED was able to equally treat everyone based on his or her condition. Multivariate analysis revealed that having a history of hypertension significantly increased the boarding and total times, both by approximately 20 minutes on average, and that a history of atrial fibrillation increased the total time by 55 minutes. One possibility may be that patients with hypertension are more complicated to manage, and thus finding a bed on the appropriate service may take longer. Other patient factors were also found to be statistically significant: the year 2006, Tuesday, the 12 PM to 8 PM time block, and the 8 PM to 4 AM time block. Both the time blocks reduced the working and total times by approximately 35 minutes. The most likely explanation for this reduction is that the ED likely has fewer patients during those times. In the year 2006, boarding time and total time increased by 50 minutes, and on Tuesdays, total time increased by 50 minutes. It is unclear as to why these time frames were associated with increased time in the ED.

For physician factors, the univariate analysis revealed that the admitting service had a significant difference in working time. Multivariate analysis found that being admitted to the hip fracture service significantly reduced the working time and that ordering computed tomography (CT) scans increased the total time, but only by 10 minutes; the obvious explanation is that obtaining CT scans in a busy ED can take time. The decision as to which service the patient is admitted is made in the ED according to the patient's presentation. Patients with acutely unstable medical conditions such as unstable hypertension or angina in general are admitted to the medical service. Any patient requiring monitoring or intensive care unit level of care is admitted to the medical service. This decision is made by the orthopedic resident in discussion with the ED staff and the on-call geriatrician. This finding correlates with the previous work by Kates et al,[12] which highlighted one of the goals of a hip fracture service, that is, to reduce the time in the ED, which ultimately reduces the time to surgery. However, the total time was reduced by only 10 minutes, suggesting that other factors, such as hospital occupancy, have a stronger influence on patient boarding time.

When examining the univariate analysis for hospital factors, none was significant. The multivariate analysis for hospital factors found the occupancy rate in the hospital to significantly increase the boarding time and total time. In 2008, the Centers for Disease Control and Prevention reported lower values than we found: 77% was the national average for hospitals with 500 beds or more and 75% was the Maryland state average.[20,21] Increasing the percentage of full beds logically leads to having an increased time, as there is simply no space. Other studies have reported similar results, showing that patient safety and efficiency are not impacted while running at 80% to 85% occupancy, but that ED wait times dramatically increase and patient safety and quality of care drop as the hospital occupancy rate increases above 90%.[11,22,23] The finding that 26% of the patients in our study were present while the hospital was above 95% capacity suggests that patient safety and quality of care may have been compromised in the ED. Solutions to long ED boarding times include streamlining paperwork and using protocols such as the Rochester model proposed by Kates et al,[12] extended-care ED units, and offsite urgent care facilities for low-severity patients.[11] Another solution would be to examine what is happening in the hospital floor to potentially reduce the wait times. Powell et al[24] suggested that by streamlining the total time spent on the floor, more beds would open up, allowing for potentially shorter wait times in the ED.

The overall time in the ED in our study is very long when considering the mandated 4-hour time in England. The factors that we found significant do not account for enough time to meet this time limit. Possible changes to meet these times would include keeping open beds available for the admission of patients with hip fracture, prioritization of patients with hip fracture over other patients, and a radical change in the admission process to allow for more work to be done on the floor rather than in the ED.

This study is not without its limitations. First, it was retrospective in nature, and the exact time of injury was unknown, because patients presented at differing times after the fracture, which could affect outcome. Second, it is limited to 1 urban teaching hospital, which could allow for possible confounders related to that 1 institution and results that might not be transferrable to others. Third, given our large number of variables, there could be inherent collinearity between variables that may affect our results. Finally, to our knowledge, there were no significant changes in hospital and ED resources and management practices, which could have impacted the length of stay.

In summary, the overall time in the ED for patients with hip fractures was the same as that for patients with the 5 most commonly seen conditions in the ED. A history of hypertension or atrial fibrillation, being admitted in the year 2006 or on a Tuesday, admission to a service other than the hip fracture service, and a high hospital occupancy rate was associated with significantly increased time spent in the ED. Admission to the hip fracture service decreased the working time but not the overall time in the ED. Despite finding factors associated with prolonged time in the ED, obtaining an ED time of less than 4 hours per the UK guidelines would take a dramatic shift in hospital and patient care protocols.

Declaration of Conflicting Interests

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