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Mortality and Readmissions After Cervical Fractures From Falls In Older Adults: A Comparison To Hip Fractures Using National Medicare Data

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Abstract

Background—Cervical fractures from falls are a potentially lethal injury in older patients. Little is known about their epidemiology and outcomes.

Objectives—To examine the prevalence of cervical spine fractures after falls among older Americans and show changes in recent years. Further, to compare 12-month outcomes in patients with cervical and hip fracture after falls.

Design, Setting, and Participants—A retrospective study of Medicare data from 2007–2011 including patients ≥65 with cervical fracture and hip fracture after falls treated at acute care hospitals.

Measurements—Rates of cervical fracture, 12-month mortality and readmission rates after injury.

Results—Rates of cervical fracture increased from 4.6/10,000 in 2007 to 5.3/10,000 in 2011, whereas rates of hip fracture decreased from 77.3/10,000 in 2007 to 63.5/10,000 in 2011. Patients with cervical fracture without and with spinal cord injury (SCI) were more likely than patients with hip fracture, respectively, to receive treatment at large hospitals (54.1%, 59.4% vs. 28.1%, $p< 0.001$), teaching hospitals (40.0%, 49.3% vs. 13.4%, $p< 0.001$), and regional trauma centers (38.5%, 46.3% vs. 13.0%, $p< 0.001$). Patients with cervical fracture, particularly those with SCI, had higher risk-adjusted mortality rates at one year than those with hip fracture (24.5%, 41.7% vs. 22.7%, $p<0.001$). By one year, more than half of patients with cervical and hip fracture died or were readmitted to the hospital (59.5%, 73.4% vs. 59.3%, $p<0.001$).

Conclusion—Cervical spine fractures occur in one of every 2,000 Medicare beneficiaries annually and appear to be increasing over time. Patients with cervical fractures had higher mortality than those with hip fractures. Given the increasing prevalence and the poor outcomes of this population, hospitals need to develop processes to improve care for these vulnerable patients.

Keywords

Cervical Fracture; Mortality; Readmission

Introduction

Older Americans bear the highest burden of hospitalizations for traumatic injury,[1] with rates increasing 3–5% annually.[2] People over age 65 now comprise up to 25% of trauma admissions.[3] Most trauma in older adults is related to falls, [4] and the annual costs of acute care associated with falls in older adults is estimated to exceed $8.0 billion.[5] Severe trauma among older patients can have particularly devastating consequences, including prolonged hospitalization and rehabilitation, permanent functional impairment, and death. Better understanding the clinical consequences of trauma in older Americans and optimizing their treatment are essential to meet the needs of this rapidly growing population.

Much of what we know about the trajectory of older patients after falls is from data on those who suffer hip fractures. Hip fractures after falls are associated with high morbidity and costs, and have been a growing public health concern for decades.[6,7] However, cervical spine fracture is another consequence of falls among older patients and the types of patients who suffer this injury and their outcomes are largely unknown. Single-institution studies suggest that one-year mortality associated with these injuries may be quite high.[8] However, there are no national data on the incidence of these injuries, the characteristics of the patients experiencing cervical spine fracture, types of hospitals where these patients receive care, and how their short and long-term outcomes, compare to patients with hip fractures.

Given the lack of national data on the frequency or outcomes of cervical fractures after falls, we used Medicare data to answer the following questions: How often do these injuries occur and has the rate of injury changed over time? What are the characteristics of patients that suffer cervical spine fractures and how do they compare with those patients with hip fractures? What are the characteristics of the hospitals where these patients receive care? How do rates of mortality and readmissions during the first year after injury with cervical factures compare to those after hip fractures? And finally, what are the major causes for the first readmission to acute hospitals for patients with cervical and hip fractures?

Methods

Data Sources

We used the 100% Medicare Provider Analysis and Review (MedPAR) file to identify in-patient care for beneficiaries enrolled in the fee-for-service program. We used the American Hospital Association (AHA) survey to identify hospital characteristics and the Medicare Impact File to obtain the hospital's Disproportionate Share Hospital (DSH) index. The DSH Index determines a hospital's eligibility to receive federal compensation for serving a disproportionate share of uninsured and Medicaid patients and is a proxy for caring for poor patients.[9] We used the Medicare Beneficiary Summary File to obtain vital status post-discharge and insurance information.

Study Sample

We included beneficiaries who were discharged from acute-care hospitals from January 1, 2007 through December 31, 2011 in our cohort. We used data from 2012 to ensure one year follow-up. Patients under 65 and enrolled in a Medicare Advantage health plan for part of the year were excluded since they would not have full claims data. The first admission for cervical or hip fracture was considered the index case. Cervical fracture and cervical fracture with spinal cord injury (SCI) were identified using International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes: 805.0x, 805.1x, 806.0x, 806.1x cervical fracture. We also calculated the number of patients who sustained high cervical fracture (atlanto-occipital, first or second cervical vertebrae (ICD-9 codes 805.00, 805.01, 805.11, 805.02, 805.12). Hip fracture was identified using code, 820.x, and falls were identified using codes: 880.1, 884.2, 884.3, 884.4, 884.6, 885.9, 888.0, 888.1, low-impact fall. These codes exclude patients who fell from heights, including ladders (presuming that they would generally be more robust than patients who suffered low-impact falls). Patients

with both cervical and hip fracture, who were discharged from Federal hospitals, outside of the 50 United States or District of Columbia, or who were admitted to or discharged from non-acute care hospitals, were also excluded. Lastly, we excluded 1, 522 (0.14%) patients who had both cervical spine and hip fracture. In cases where patients were transferred from one acute hospital to another, only data from the receiving hospitals were used to determine readmission rates. Lastly, we determined the reason for the first readmission to an acute care hospital.

Outcomes

The primary outcome of interest was mortality 30, 90, and 360 days after admission. The secondary outcome was a composite measure of mortality and hospital readmissions 30, 90, and 360 days after discharge from the index hospitalization.

Other Variables

We examined variables to describe baseline characteristics of the patients and the hospitals that treated them. All patient characteristics were obtained from Medicare files and included: demographics, comorbidities, and an injury severity measure. Demographics included: age (65–69, 70–79, ≥ 80), gender, and race (white, African-American and others). Medical comorbidities, which were identified using ICD-9 codes in Medicare Claims, included: dementia, congestive heart failure, coronary artery disease, end-stage renal disease, and diabetes. In order to adjust for patient comorbidities, we used the Hierarchical Condition Category (HCC) model, which is used by the Centers for Medicare and Medicaid to adjust payment for patients with chronic conditions.[10] The HCC includes 70 disease categories, which correlate to ICD-9 codes captured during all outpatient and inpatient encounters up to and including index admission, and is superior to Charlson or Elixhauser measures for predicting mortality in Medicare beneficiaries.[11] We controlled for dementia separately because it is not included in the HCC. Head injury is a condition in the HCC and, was therefore, included in the adjusted model. Injury severity was quantified using ICDPIC [12] conversion software to map each diagnosis code to an Abbreviated Injury Score (AIS) and to calculate an Injury Seventy Score (ISS)[13] (0-9=low;10-24=moderate; ≥25=severe). Discharge location was also obtained from Medicare Claims for patients with cervical fracture and hip fracture.

Hospital characteristics which were obtained from the American Hospital Association database included: size (small 1–99 beds; medium 100-399 beds; large ≥ 400 beds), membership in the Council of Teaching Hospitals, trauma center status (regional, community, rural, or non-trauma), region, profit status, and the Disproportionate Share (DSH) index (a proxy for caring for poor patients).

Analysis

We described patient and hospital characteristics using frequencies, percentages, means, and standard deviations where appropriate. Annual rates of cervical fracture and hip fracture were calculated per 10,000 Medicare beneficiaries for each of the study years (from 2007–2011), and displayed graphically. Characteristics of older Medicare beneficiaries and

discharge location were compared between patients with cervical fracture and hip fractures. Rao-Scott Chi-Square tests were used which account for clustering at the hospital level.

We considered two outcomes in these analyses: 1. survival and, 2. composite measure of survival and hospital readmission. We calculated survival from the date of index hospitalization and date of death, and calculated readmission based on the date of discharge from the index hospitalization. We used Kaplan-Meier survival curves to examine unadjusted survival and the composite rates of survival and readmissions for patients with cervical and hip fractures. We used Rao-Scott Chi-Square tests to compare unadjusted proportions of those who died by 30, 90, and 360 days after injury.[14] We performed a second analysis to compare composite rates of death or readmission by 30, 90, or 360 days as a secondary outcome for patients with cervical (with and without spinal cord injury) and hip fracture; since this outcome includes censored observations, these proportions were obtained from the unadjusted Kaplan-Meier survival curves, and compared across three groups using an Wald test that takes clustering by hospital into account. [15]

To calculate adjusted proportions of death and composite death/readmission at the three time points (30, 90, and 360 days) in the cervical and hip fracture groups, we used a weighted propensity score approach to calculate adjusted Kaplan-Meier curves.[16,17] P-values comparing the cervical and hip fracture groups were calculated accounting for clustering at the hospital level.[15,17] The propensity for being in the cervical and hip fracture groups was calculated using logistic regression models with age, gender, race, Injury Severity Score, Hierarchical Conditional Categories, dementia, and hospital characteristics as independent variables as predictors of each group. By estimating the propensity for being in each of the three groups (cervical fracture, cervical fracture with SCI, or hip fracture) propensity score methods provide better control for observed confounding factors than regression models alone; propensity methods improve the ability to compare groups in observational studies. When we calculated the propensity-weighted Kaplan-Meier curves, each patient was weighted by the inverse propensity of being in their observed group, with the goal of balancing characteristics across the groups.

All analyses were conducted using SAS statistical software, version 9.3 (Cary, NC). A p value of <0.05 was considered statistically significant. The study was approved by the Partners Human Research Committee and by the institutional review board of the Harvard School of Public Health

Results

Rates of cervical fracture and hip fracture over the study period (Figure 1)

Among Medicare beneficiaries over 65 years old in 2007–2011, there were 67,162 admissions for cervical fracture without spinal cord injury, 5,593 for cervical fracture with spinal cord injury (SCI) and 1,009,738 admissions for hip fracture after low-impact falls. There were 1522 (0.14%) patients with both cervical spine and hip fracture who were excluded from this analysis. Among cervical fractures, 44.9% had high cervical injury (atlanto-occipital, first and second cervical vertebrate). The number of cervical spine fractures increased 15% from 4.6 per 10,000 Medicare beneficiaries in 2007 to 5.3 per

10,000 Medicare beneficiaries in 2011 whereas the number of hip fractures decreased 18% from 77.3 per 10,000 Medicare beneficiaries in 2007 to 63.5 per 10,000 Medicare beneficiaries in 2011.

Patient characteristics

Patients with cervical fracture were younger than patients with hip fracture (60.8% cervical, 46.4% SCI, vs. 70.0% hip, ≥ 80 years, and more likely to be male (42.8% cervical, 61.7% SCI, vs. 27.1% hip). The majority of patients in the cervical fracture without SCI and hip fracture groups had low severity injuries (78.2% SCI vs. 93.0% hip, ISS < 9). Patients with cervical fracture were more likely to have moderate (19.6% cervical, 52.3% SCI, vs. 6.5% hip, ISS 10–24) or severe injury (2.2% cervical, 17.0% SCI, vs. 0.4% hip, ISS > 25) than patients with hip fracture. All differences in patient characteristics were statistically significant (p <0.001). (see Table 1)

Patients with cervical fracture with or without SCI were more likely to die in hospital than patients with hip fracture (8.5 % cervical, 26.1% SCI, and 3.2% hip). Of those patients who were discharged from the hospital, patients with cervical facture were more likely to be discharged home (30.1% cervical, 12.0% SCI, and 8.7% hip). Across groups the majority of patients were discharged to a skilled nursing facility or long-term care (54.9% cervical, 52.7% SCI, 83.6% hip). All differences in discharge location were statistically significant (p <0.001). (Not shown).

Hospital Characteristics

As compared to patients with hip fracture, patients with cervical fracture were more likely to receive care in large hospitals (54.1% cervical, 59.4% SCI vs. 28.1% hip), teaching hospitals (40.0% cervical, 49.3% SCI, vs. 13.4% hip), and regional trauma centers (38.5% cervical, 46.3% SCI, vs. 13.3% hip). Hospital characteristics and the distribution of these three groups of patients are presented in Table 2.

Survival

We compared unadjusted mortality over one year between patients with cervical fracture without SCI, cervical fracture with SCI and hip fracture (Figure 2). In adjusted analyses accounting for patient factors and hospital characteristics, patients with cervical fractures, and cervical fractures with SCI had substantially higher 30-day mortality rates than those with hip fractures (13.0% cervical, 28.4% SCI, vs. 8.1% hip respectively, p <0.001). This gap persisted at 90 days (cervical 18.5%, 35.6 SCI%, vs. hip, 14.7%, p<0.001) and one year after the initial hospitalization (cervical 24.5% SCI 41.7%,vs. 22.7% hip, p<0.001). (See Table 3)

Survival and Readmission

Adjusted rates of composite mortality and readmissions were high in both groups: by 30 days approximately one-third of patients died or were readmitted a (31.6 % cervical, SCI, 50.1% vs. 29.7% hip, p<0.001), at 360 days more than half were readmitted (59.5% cervical, 73.4% SCI, vs. 59.3% hip, p <0.001 across 3 groups, p=(0.50 cervical vs. hip). (See Table 4) The top 5 reasons for the first readmission, within a year of the incident admission, to an

acute care hospital across all three groups were rehabilitation, pneumonia, septicemia, urinary tract infection, and hip fracture. (See Appendix A)

Discussion

Among older Medicare patients in the U.S., we found that annual rates of cervical spine fractures occur in approximately 5 per 10,000 beneficiaries during 2007 through 2011, and the rates are increasing over time. Important clinical differences between patients who suffered cervical fracture versus hip fracture included age, gender, and injury severity score. We, and others, have found that men are more likely to sustain cervical spine trauma and women are more likely to sustain hip fracture.[18] One possible explanation is that because hip fracture is so much more common than cervical fracture after low-impact falls, fall prevention and treatment for osteoporosis may shift the age-specific incidence of hip fracture towards the oldest old, who are more likely to be women.[19] Not surprisingly, head injury is closely associated with cervical spine injury,[20] leading to higher ISS among patients with cervical fracture both with and without SCI. After accounting for these differences between groups using propensity score modeling, we found that despite being younger, having fewer comorbid illnesses, and being more likely to receive care at teaching hospitals and higher-level trauma hospitals, Medicare patients who sustained a cervical fracture after a low-impact fall were nearly twice as likely to die within 30 days of their injury as those who suffered a hip fracture. Further, within a year of injury, almost one-quarter of patients who had a cervical fracture without SCI had died, and over half had died or been readmitted. Among those with cervical fracture and SCI, at one year, over 40% died and almost three-quarters had died or been readmitted. Given the high mortality and suffering caused by this condition, it is surprising that relatively little attention has been paid to describing its epidemiology or identifying the consequences of this injury.

Our study corroborates single-center studies demonstrating high mortality among older patients with cervical fracture, and extends this work by using a national sample to characterize cervical fracture as an injury occurring with increasing frequency, and with health outcomes that are worse than for hip fracture.[7] The Centers for Disease Control and Prevention guidelines suggest that older injured patients should receive treatment at trauma centers, because even when less severely injured, older patients are less likely to display physiologic signs that would activate transfer in younger patients.[21] However, patients with cervical fractures were much more likely to receive care at large, teaching hospitals and regional or community trauma centers and, therefore, we suspect that getting care at these institutions may be necessary but insufficient to improve outcomes.

Older patients with cervical fracture could have such poor outcomes from underlying conditions or because of adverse consequences from the injury or how it is managed. For example, patients with cervical fracture who are treated with halo fixation have high rates of dysphagia and aspiration.[22] Highly coordinated, multi-disciplinary care for older injured patients, including medical management by a hospitalist, is associated with lower rates of complications, shorter hospital length of stay, and fewer discharges to long-term care facilities.[23,24] Trauma centers that treat higher volumes of geriatric patients have lower rates of in-hospital mortality, complications and failure-to-rescue than centers with lower volumes

of older patients.[25] Developing new and better treatment strategies for this population would also be immensely helpful. For example, improving outcomes among older patients who sustain fractures after falls warrants greater focus on medical processes of care and may require specialized pathways, such as Acute Care of the Elderly (ACE) Units.[26] Furthermore, clinicians and policy makers must continue to focus on reducing fractures in elderly patients, by increasing knowledge of risk factors for falls and developing individualized fall-prevention programs. [27] This is particularly important because in this study, hip fracture was the fifth leading cause of readmission among patients with both cervical fractures and hip fractures.

We found that composite rates of mortality and readmission for patients with cervical fracture rivaled or, in the case of SCI, exceeded patients with hip fractures. Readmissions are important for two reasons. First, transitions of care and hospital readmissions reduce quality of life and are associated with increased functional dependence and mortality, especially after surgery.[28] In patients with limited life expectancy due to advanced dementia or other underlying illness, or where acceptable functional recovery is unlikely, clear discussions about goals of care should precede hospital discharge. In these cases, offering palliative care, supporting caregivers, and easing transitions to comfort-directed care may be most appropriate. Given their high rates of readmission, older trauma patients with cervical fractures are an appropriate target for interventions to improve transitions of care and reduce hospital readmission.

Our study has several limitations. First, MedPAR is a large administrative database lacking the detailed clinical data needed for optimal risk adjustment. MedPAR does not include physiologic pre-hospital data, obscuring other factors that could contribute to high mortality after injury. Furthermore, ICD-9 codes do not specify the anatomic characteristics of a fracture that may render it unstable and therefore more severe. Although we sought to control for injury characteristics by using propensity score modeling and adjusting for injury severity, we could not determine whether patients were triaged correctly and that patients received care at the appropriate site of care. Second, patients with cervical fracture may have higher mortality than other injured patients because they are sicker in ways that we could not measure. For example, frailty or diminished functional reserve is strongly associated with falls [29] but is not captured in billing codes. This was why we compared their outcomes with hip fracture, which also occur among older individuals who are often frail. Third, there is a lack of standardized approaches to cervical fractures in elderly patients, and controversy exists as to which patients benefit most from surgery or spinal immobilization alone. We were unable to determine the appropriateness of surgery or its impact on outcomes after cervical fracture, because we lacked detailed information about the injury itself.

Elderly patients who sustain cervical fractures after low impact falls have very high rates of mortality and hospital readmission for up to a year. Much of that risk of death is upfront – in the early weeks after trauma – but the risk of poor outcomes remain elevated, even when compared to hip fractures. Hospitals and healthcare systems need to determine optimal strategies for these patients given the high risk of death and healthcare utilization during the year after injury. Identifying older patients who are most susceptible to cervical fracture, employing preventive measures prior to falls and more effective clinical and rehabilitative

management strategies during and after hospitalization will be critical to ensure that this vulnerable population of older Americans receives the most appropriate treatment to achieve the best possible outcomes.

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Appendix

Appendix A

Top five reasons among Medicare beneficiaries for first readmission, after the incident admission, to an acute care hospital after cervical fracture and hip fracture 2007–2011

Primary Diagnosis (ICD-9 code)	Cervical fracture without spinal cord injury (N=28,786) %	Cervical fracture with spinal cord injury (N=2202) %	Hip fracture (N=482,102) %
Rehabilitation V5789	11.7	21.8	17.4
Pneumonia 486.xx	5.1	3.3	4.1
Septicemia 038.9	3.7	5.9	4.0
Urinary Tract Infection 599.0	3.6	3.0	3.8
Hip fracture 820.21	1.3	0.5	2.1

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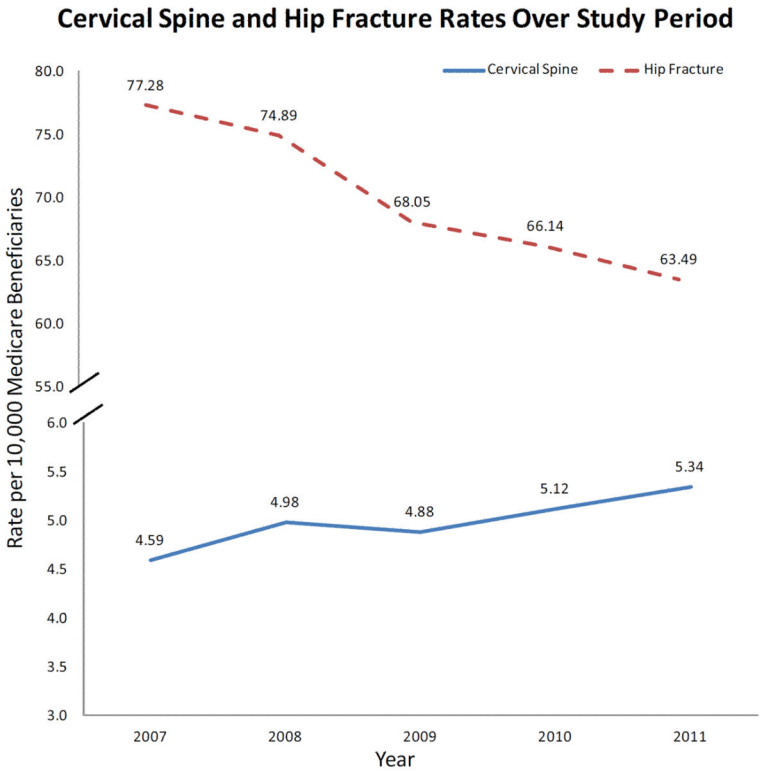

Figure 1.

Rates of Cervical Spine and Hip Fractures in Older Medicare Beneficiaries after Falls 2007–2011

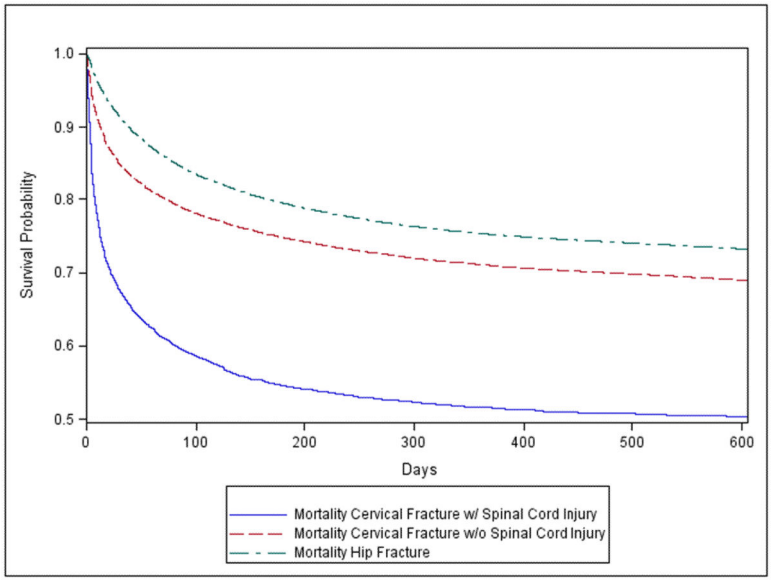

Figure 2.
Survival of elderly Medicare beneficiaries with cervical and hip fracture after fall

Table 1

Characteristics of Patients with Cervical Fracture and Hip Fracture*

		Cervical fracture without spinal cord injury (N=67,162) %	Cervical fracture with spinal cord injury (N=5,693) %	Hip fracture (N=1,009,738) %
Age (years)	65–69	10.4	17.0	5.8
	70–79	28.8	36.6	24.2
	80+	60.8	46.4	70.0
Race	White	92.8	87.7	93.2
	Black	3.9	7.9	3.5
	Others	3.3	4.4	3.4
Gender	Male	42.8	61.7	27.1
	Female	57.2	38.3	72.9
Comorbidities	Dementia	1.4	0.8	2.3
	CHF	18.4	14.4	19.8
	CAD	12.0	11.4	11.4
	Renal Failure	17.1	16.3	17.7
	Diabetes	16.4	16.1	15.7
	COPD	13.3	10.8	16.5
Injury Severity Score	0–9	78.2	30.6	93.0
	10–24	19.6	52.3	6.5
	≥25	2.2	17.0	0.4

Injury Severity Score: 0–9=low; 10–24= moderate; ≥25 = severe

CHF = Congestive Heart Failure, CAD = Coronary Artery Disease, COPD = Chronic Obstructive Pulmonary Disorder.

*All differences are statistically significant across groups ($p<0.001$).

Table 2

Characteristics of Hospitals where Patients with Cervical Fracture and Hip Fracture Receive Care*

		Cervical fracture without spinal cord injury (N=67,162) %	Cervical fracture with spinal cord injury (N=5,693) %	Hip fracture (N=1,009,738) %
Hospital Size	Small (<100 beds)	3.4	1.9	12.0
	Medium (100–399 beds)	42.5	38.7	59.9
	Large (≥ 400 beds)	54.1	59.4	28.1
Major Teaching	Yes	40.0	49.3	13.4
Trauma Center Level	Regional	38.5	46.3	13.3
	Community	33.0	30.0	34.6
	Rural and Others	28.5	23.7	52.1
Hospital Region	Northeast	20.3	22.9	18.7
	Midwest	26.4	22.9	24.7
	South	37.7	36.9	41.2
	West	15.6	17.4	15.4
Profit Status	For profit	9.1	8.6	13.1
	Not for profit	76.4	73.8	75.0
	Public	14.5	17.7	11.9
Disproportionate Share Hospital †		13.2	16.5	8.1

*All differences statistically significant across groups (p<0.001).

†The top decile in Disproportionate Share Hospitals Index.

Table 3

Adjusted Mortality and Composite Mortality and Readmissions after Cervical and Hip Fracture

		Cervical fracture without spinal cord injury (N=67,162) %	Cervical fracture with spinal cord injury (N=5,693) %	Hip fracture (N=1,009,738) %	P value
Mortality	30-day	13.0	28.4	8.1	<**0.001**
	90-day	18.5	35.6	14.7	<**0.001**
	360-day	24.5	41.7	22.7	<**0.001**
Composite mortality and readmissions	30-day	31.6	50.1	29.7	<**0.001**
	90-day	43.3	62.8	42.1	<**0.001**
	360-day	59.5	73.4	59.3	<**0.001**