The Effect of Hospital Setting and Teaching Status on Outcomes After Hip Fracture

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Abstract

This study used the National Inpatient Sample database for 1998 through 2003 to identify patients who were aged 65 years or older and had undergone surgical treatment for an isolated femoral neck or intertrochanteric hip fracture. Hospital setting (urban vs rural) and teaching status (teaching vs nonteaching) were the primary independent variables studied. The final cohort consisted of 226,239 patients.

Overall in-hospital mortality was 2.6%. Higher in-hospital mortality risk was associated with increased number of in-hospital complications, increased number of comorbidities, male sex, longer surgical delay, and age 85 years or older. The overall surgical complication rate was 10.1%; there was little effect for any of the studied factors on risk for in-hospital complication.

Contrary to expectation, hospital setting and teaching status were generally not as relevant to in-hospital outcomes as other factors were.

Hip fractures are a cause of substantial morbidity and mortality in the elderly.[1-6] In the United States, the incidence of hip fractures is more than 250,000 per year at an estimated cost of $5.4 billion.[2] In addition to the financial cost, hip fractures are associated with 1-month mortality of 5% to 10% and 1-year mortality as high as 30%.[7]

These common injuries are treated in a wide range of hospital types and settings, but there is controversy regarding the effect of hospital demographics, specifically regarding hospital setting (urban vs rural) and teaching status, on treatment outcomes for some medical diagnoses.[8-14] Although variation in outcomes across hospital settings and teaching status has been found for many procedures, no national, population-based studies have been conducted in the United States to compare hip fracture outcomes across hospital characteristics.

In the present study, we used a nationally representative database to compare in-hospital mortality and morbidity outcomes after hip fracture surgery based on hospital setting and teaching status, adjusting for other patient, hospital, and treatment factors.

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Methods

Data Source

This study used the National Inpatient Sample (NIS) database for 1998 through 2003. The data in this database are for a subset of hospitals scientifically sampled

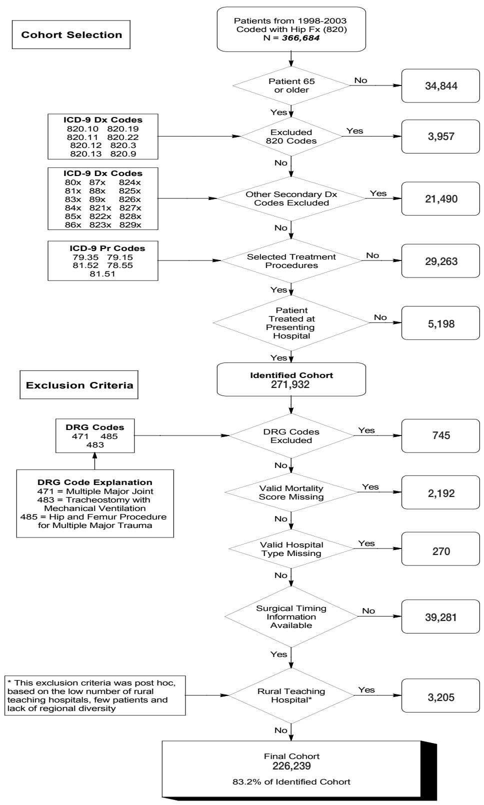

Figure. Summary of cohort identification and exclusion criteria.

Table I. Summary of *ICD–9* Codes Used to Identify Medical and Surgical Complications

Medical Complications		Surgical Complications	
Code	**Description**	**Code**	**Description**
41511	Iatrogenic pulmonary embolism	9954	Shock due to anesthesia
4582	Iatrogenic hypertension	99586	Malignant hyperthermia
45829	Postoperative hypertension	99666	Infect D/T joint prosth
5121	Iatrogenic pneumothorax	99667	Infect D/T ortho dev NEC
5184	Postoperative pulmonary edema	99670	Complication of internal prosthetic device
5185	Post trt pulmonary insufficiency	99677	Complication NEC D/T joint prosth
5644	Postoperative GI funct dis NEC	99678	Complication NEC orth dev NEC
5982	Postoperative urethral strict	99679	Other complications of ortho device
99664	Infected D/T urethral catheter	99700	Nervous system complication unspecified
99702	Postoperative stroke	99701	Central nervous system complication
9980	Postoperative shock	99709	Other nervous system complication
99811	Hemorrhage complication Px	9971	Surgical complication: heart
99881	Emphysema resulting from a procedure	9972	Surgical complication: peripheral vasc
99889	Oth spec postoperative complication NEC	9973	Surgical complication: resp NEC
9992	Thromboembolism or thrombophlebitis	9974	Surgical complication: digestive
9993	Other infection	9975	Surgical complication: urinary NEC
9994	Anaphylactic shock due to serum	99791	Surgical complication: hypertension
9995	Other serum reaction	99799	Surgical complication: oth syst NEC
9996	ABO incompatibility reaction	99812	Hematoma complicating a procedure
9998	Transfusion reaction NEC	99813	Seroma complicating a procedure
9999	Unspecified complication of medical care	9982	Accident puncture/laceration during procedure
E8705	Accidental cut/puncture/perforation during aspiration	9983	Postoperative wound disruption
E8708	Accidental cut/puncture/perforation during other medical procedure	99831	Disruption of internal operation wound
E8711	Foreign object left in body during infusion	99832	Disruption of external operation wound
E8735	Inappropriate temperature in local application	9984	Foreign body accidentally left in patient
E8768	Other specified misadventure during medical care	99851	Infected postoperative seroma
E8769	Unspecified misadventure during medical care	99859	Postoperative infection NEC
E8790	Abnormal reaction due to cardiac catheterization	9986	Persistent postoperative fistula
E8791	Abnormal reaction due to kidney dialysis	99883	Nonhealing surgical wound
E8792	Abnormal reaction due to radiographic procedure	9989	Surgical complication not otherwise specified
E8793	Abnormal reaction due to shock therapy	E8700	Accidental cut/puncture/perforation during surgery
E8794	Abnormal reaction due to aspiration of fluid	E8710	Foreign object left in body during surgery
E8796	Abnormal reaction due to urinary catheterization	E8749	Mechanical failure of instrument during procedure
E8797	Abnormal reaction due to blood sampling	E8765	Performed inappropriate operation
E8798	Abnormal reaction due to other specified procedure	E8780	Abnormal patient reaction to surgery
E8799	Abnormal reaction due to unspecified procedure	E8781	Abnormal patient reaction to surgical implantation device
		E8782	Abnormal patient reaction to surgical implantation material
		E8783	Abnormal patient reaction: formation of stoma
		E8784	Other restorative surgery
		E8785	Unplanned amputation of limb
		E8786	Unplanned organ removal
		E8788	Other specified unplanned surgery or procedure
		E8789	Unspecified unplanned surgery or procedure

Abbreviation: *ICD–9, International Statistical Classification of Diseases and Related Health Problems, Ninth Edition.*

to approximate a stratified sample of US hospitals and are weighted to be nationally representative. A complete description of the NIS database is available at the Web site of the Healthcare Cost and Utilization Project.[15]

Target Population

The cohort of interest was patients who were 65 years or older and had undergone surgical treatment for an isolated femoral neck or intertrochanteric hip fracture.

Inclusion Criteria

The Figure summarizes the *International Statistical Classification of Diseases and Related Health Problems, Ninth Edition* (*ICD–9*) diagnosis and procedure codes that were used to identify patients who were 65 years or older and had received a primary diagnosis of hip fracture (820) but who did not have an open fracture or subtrochanteric fracture; did not sustain fractures in other body regions (skull, spine, upper or lower extremities) or internal injuries (intracranial, thoracic, abdominal, pelvic); were treated surgically with open or closed reduction and internal fixation, hemiarthroplasty, or total hip arthroplasty; and were treated at the hospital where they initially presented.

Exclusion Criteria

As also summarized in the Figure, patients in the identified cohort were excluded when a diagnosis-related group (DRG) code indicated that treatment was inconsistent with care for a patient with an isolated hip fracture (eg, DRG 471, which indicates bilateral or multiple major joint procedures of the lower extremity) or when relevant outcomes or mediating variables (eg, mortality status, hospital type, surgical timing) were not included in the database.

Table II. Weighted Summary of Patient, Treatment, and Hospital Demographics

Demographic, %	All (N = 226,239)	Hospitals: Teaching (Urban) (n = 72,989)	Hospitals: Nonteaching Urban (n = 115,075)	Hospitals: Nonteaching Rural (n = 38,175)	Statistic	*P*<
Age, y					χ^2_2 = 5.47	.065
65–79	32.70	33.01	32.62	32.34		
80+	67.30	66.99	67.38	67.66		
Female Sex	76.21	76.40	76.14	76.06	χ^2_2 = 11.38	.004
Race					χ^2_{10} = 10,022.83	.0001
White	90.32	87.72	90.69	94.52		
Black	3.41	5.31	2.44	2.60		
Hispanic	3.64	3.60	4.31	1.48		
Asian/Pacific	1.19	1.59	1.10	0.67		
Native American	0.14	0.09	0.16	0.20		
Other	1.31	1.69	1.30	0.53		
Missing[a]	14.25	—	—	—		
Comorbidities[b]					χ^2_4 = 109.93	.0002
0	45.49	46.05	45.41	44.69		
1	32.06	31.57	32.22	32.55		
2+	22.44	22.37	22.37	22.76		
Surgical Delay					χ^2_6 = 4,100.80	.0001
Same day	27.13	26.43	26.39	30.42		
1 day	49.10	47.34	50.15	49.46		
2–4 days	21.05	22.69	21.07	17.86		
5+ days	2.73	3.54	2.39	2.16		
In-Hospital Complications					χ^2_4 = 188.84	.0001
0	89.90	89.74	90.18	89.37		
1	7.62	7.58	7.50	7.98		
2+	2.49	2.68	2.32	2.65		
Hospital Volume					χ^2_4 = 184,060.00	.0001
Low: 50 or fewer	21.33	7.68	19.68	51.84		
Moderate: 51–149	55.74	56.35	59.04	45.33		
High: 150+	22.93	35.98	21.28	2.83		
Hospital Bed Size					χ^2_4 = 26,295.48	.0001
Small	12.76	16.62	12.69	5.64		
Medium	28.35	31.07	29.12	21.03		
Large	58.89	52.31	58.19	73.33		
Hospital Region					χ^2_6 = 12,139.20	.0001
Northeast	22.91	30.93	20.36	15.27		
Midwest	15.55	19.27	10.33	24.19		
South	43.91	35.41	47.48	49.40		
West	17.63	14.39	21.83	11.14		

[a]Missing not included in test statistic. These high rates of missing codes resulted from race information not being uniformly available to National Inpatient Sample coders across all states for each year.
[b]Deyo-Charlson Comorbidity Index.

Primary Factors

Hospital setting (urban vs rural) and teaching status (teaching vs nonteaching) as coded in the NIS database were the primary independent variables in the study.

Potential Outcome Mediators

Patient, hospital, and treatment factors—age, sex, race, comorbidity status, surgical delay, region of country, hospital size, and hospital volume—were *potential outcome* mediators.

The NIS database coded race as white, black, Hispanic, Asian/Pacific, Native American, other, or missing. Comorbidity status was defined on the basis of reported *ICD–9* codes using the Deyo-Charlson Comorbidity Index.[16] Surgical delay was defined as number of calendar days between hospital admission and surgery.

Hospital regions coded in the NIS database were Northeast, Midwest, South, and West. Hospital size was based on number of beds and was classified using the NIS criteria (which described size as small, medium, or large based on cut points), so that approximately one-third of the hospitals in a given region, and setting (urban vs rural), and with a given teaching status (teaching vs nonteaching), would fall in each bed size category. Hospital volume (number of hip fracture surgeries per

Table III. Summary of Weighted Unadjusted and Adjusted Relative Risks for In-Hospital Mortality

Variable and Levels	Mortality Rate, %	Contrast	Relative Risk (95% Confidence Interval) Unadjusted	Relative Risk (95% Confidence Interval) Adjusted for All Variables in Model
Hospital Setting & Teaching Status				
RNT = Rural & Nonteaching	2.86	RNT (reference UNT & UTH)	1.14 (1.10–1.17)	1.03 (1.00–1.07)
UNT = Urban & Nonteaching	2.49	RNT (reference UNT)	1.15 (1.11–1.18)	1.04 (1.00–1.07)
UTH = Urban & Teaching	2.55	UTH (reference UNT)	1.02 (1.00–1.05)	1.01 (0.98–1.04)
Sex				
Male	4.26	Male (reference female)	2.08 (2.03–2.13)	1.72 (1.68–1.77)
Female	2.04	—	—	—
Age, y				
65–79	1.83	—	—	—
80+	2.93	80+ (reference 65–79)	1.61 (1.57–1.66)	1.76 (1.71–1.80)
Comorbidities[a]				
0	1.24	—	—	—
1	2.75	1 (reference 0)	2.23 (2.16–2.30)	2.00 (1.94–2.06)
2+	5.01	2+ (reference 0)	4.05 (3.92–4.17)	3.36 (3.26–3.47)
Surgical Delay				
Same day	2.07	—	—	—
1 day	2.32	1 day (reference same day)	1.12 (1.09–1.16)	1.07 (1.04–1.10)
2–4 days	3.29	2–4 days (reference same day)	1.59 (1.54–1.64)	1.35 (1.31–1.40)
5+ days	6.54	5+ days (reference same day)	3.14 (2.98–3.30)	2.20 (2.09–2.32)
In-Hospital Complications				
0	1.79	—	—	—
1	7.90	1 (reference 0)	4.42 (4.29–4.54)	3.95 (3.84–4.06)
2+	14.43	2+ (reference 0)	8.06 (7.79–8.35)	7.04 (6.80–7.29)
Hospital Volume				
Low: 50 or fewer	2.81	Low (reference moderate)	1.08 (1.05–1.11)	1.07 (1.04–1.11)
Moderate: 51–149	2.60	Low (reference high)	1.24 (1.19–1.28)	1.24 (1.19–1.30)
High: 150+	2.28	Moderate (reference high)	1.15 (1.11–1.18)	1.16 (1.12–1.20)
Hospital Bed Size				
Small	2.52	Small (reference medium)	0.97 (0.93–1.01)	0.96 (0.92–1.00)
Medium	2.57	Small (reference large)	0.97 (0.94–1.01)	0.91 (0.88–0.95)
Large	2.58	Medium (reference large)	1.00 (0.97–1.03)	0.95 (0.93–0.98)
Hospital Region				
Northeast	2.67	Northeast (reference rest)	1.06 (1.03–1.09)	1.01 (0.98–1.04)
Midwest	2.84	Midwest (reference rest)	1.15 (1.12–1.19)	1.13 (1.09–1.17)
South	2.56	South (reference rest)	1.00 (0.98–1.03)	1.10 (1.07–1.12)
West	2.21	West (reference rest)	0.82 (0.79–0.85)	0.80 (0.78–0.83)

[a]Deyo-Charlson Comorbidity Index.

year) was classified as low (counts in lowest quintile), moderate (2nd to 4th quintile), or high (highest quintile). This classification was similar to that reported by Dimick and Finlayson.[10]

Outcomes of Interest

The outcomes of interest included in-hospital mortality, in-hospital complications (based on *ICD–9* codes), hospital length of stay (LOS), and total hospital charges (adjusted for inflation and reported in 2003 dollars[17]).

The specific *ICD–9* codes associated with in-hospital medical and surgical complications were based in part on the work of Guller and colleagues[18] and Kreder and colleagues[19] and are summarized in Table I. For the purposes of analysis, the medical and surgical complications all were considered in-hospital complications, as in many cases, *ICD–9* coding made exact classification of a complication as medical or surgical difficult. For example, postoperative hypertension is a medical complication but may be directly related to the surgery.

Both LOS and total charges presented challenges in analysis because these variables tend to demonstrate marked skew. For hip fracture, LOS often is less than a week but can be more than a month, and hospital charges can range from $0 to hundreds of thousands of dollars. Therefore, we dichotomized these variables to produce variables thought to be clinically relevant. LOS was coded 0/1 (1 = LOS at or above median), and hospital charges were coded 0/1 (1 = total charges at or above 75th percentile).

Table IV. Summary of Weighted Unadjusted and Adjusted Relative Risks for Having an In-Hospital Complication

Variable and Levels	In-Hospital Complication Rate, %	Contrast	Relative Risk (95% Confidence Interval) Unadjusted	Adjusted for All Variables in Model
Hospital Setting & Teaching Status				
RNT = Rural & Nonteaching	10.65	RNT (reference UNT & UTH)	1.06 (1.04–1.08)	1.01 (0.99–1.02)
UNT = Urban & Nonteaching	9.82	RNT (reference UNT)	1.08 (1.06–1.10)	1.04 (1.02–1.05)
UTH = Urban & Teaching	10.26	UTH (reference UNT)	1.04 (1.03–1.06)	1.06 (1.05–1.08)
Sex				
Male	12.16	Male (reference female)	1.28 (1.27–1.30)	1.25 (1.23–1.27)
Female	9.46	—	—	—
Age, y				
65–79	9.64	—	—	—
80+	10.33	80+ (reference 65–79)	1.07 (1.06–1.09)	1.11 (1.09–1.12)
Comorbidities[a]				
0	8.78	—	—	—
1	10.75	1 (reference 0)	1.23 (1.21–1.24)	1.21 (1.19–1.23)
2+	11.86	2+ (reference 0)	1.36 (1.34–1.38)	1.31 (1.29–1.33)
Surgical Delay				
Same day	9.55	—	—	—
1 day	10.01	1 day (reference same day)	1.05 (1.03–1.06)	1.04 (1.03–1.06)
2–4 days	10.64	2–4 days (reference same day)	1.11 (1.09–1.13)	1.07 (1.05–1.09)
5+ days	13.18	5+ days (reference same day)	1.38 (1.33–1.42)	1.25 (1.21–1.30)
Hospital Volume				
Low: 50 or fewer	10.29	Low (reference moderate)	1.00 (0.98–1.02)	0.96 (0.94–0.98)
Moderate: 51–149	10.22	Low (reference high)	1.03 (1.01–1.04)	0.94 (0.92–0.96)
High: 150+	10.00	Moderate (reference high)	1.02 (1.01–1.04)	0.98 (0.96–0.99)
Hospital Bed Size				
Small	11.03	Small (reference medium)	1.10 (1.08–1.12)	1.12 (1.10–1.14)
Medium	10.09	Small (reference large)	1.18 (1.16–1.20)	1.22 (1.19–1.25)
Large	9.30	Medium (reference large)	1.07 (1.06–1.09)	1.09 (1.07–1.11)
Hospital Region				
Northeast	10.95	Northeast (reference rest)	1.08 (1.07–1.10)	1.09 (1.07–1.10)
Midwest	10.19	Midwest (reference rest)	0.98 (0.97–1.00)	0.97 (0.95–0.98)
South	9.34	South (reference rest)	0.88 (0.87–0.89)	0.89 (0.88–0.90)
West	10.82	West (reference rest)	1.07 (1.05–1.09)	1.07 (1.05–1.09)

[a]Deyo-Charlson Comorbidity Index.

Plan of Analysis

Preliminary analyses focused on the relationships of hospital setting and teaching status with patient demographics and other factors thought to be related to the in-hospital outcomes being studied. These relationships were explored with χ^2 tests.

As all 4 outcomes of interest (in-hospital mortality and complications, LOS, total hospital charges) were coded 0/1 and essentially reflected "count" data, the relationships between hospital setting and teaching status and outcomes were evaluated with weighted generalized linear modeling specifying a Poisson distribution and a log link. The weighting variable provided in the NIS data was used so that the cohort results could be considered nationally representative. This model specification produced relative risk (RR) estimates. Unadjusted RRs, and RRs adjusted for patient, treatment, and hospital factors, were summarized. Confidence intervals (CIs) around the unadjusted and adjusted RR estimates were used both to identify statistically significant results (ie, statistically significant at $P<.05$ if the 95% CI did not include 1.0) and to provide readers with information for interpreting the magnitude of the reported effects. All analyses were performed with SAS version 9.1.2 (SAS Institute, Cary, North Carolina) on Windows XP. Probability values were 2-tailed, and type I error rate was set at 0.05.

Results

Sample Summary

As summarized in the Figure, 271,932 patients listed in the NIS database for 1998 through 2003 met the inclusion criteria—they were 65 years or older and had sustained an isolated femoral neck or intertrochanteric hip fracture that was treated surgically at the presenting hospital (ie, the patient was not transferred from another hospital for treatment). Of these patients, 226,239 (83.2%) were retained after applying the exclusion criteria.

Although not originally considered an exclusion criterion, patients in rural teaching hospitals were excluded

Table V. Summary of Weighted Unadjusted and Adjusted Relative Risks for Hospital Length of Stay More Than 5 Days (Above the Median)

Variable and Levels	Long Stay, %	Contrast	Relative Risk (95% Confidence Interval) Unadjusted	Adjusted for All Variables in Model
Hospital Setting & Teaching Status				
RNT = Rural & Nonteaching	49.24	RNT (reference UNT & UTH)	1.06 (1.05–1.07)	1.02 (1.01–1.03)
UNT = Urban & Nonteaching	44.17	RNT (reference UNT)	1.11 (1.10–1.11)	1.06 (1.05–1.07)
UTH = Urban & Teaching	47.90	UTH (reference UNT)	1.08 (1.08–1.09)	1.08 (1.07–1.09)
Sex				
Male	50.38	Male (reference female)	1.12 (1.11–1.13)	1.05 (1.04–1.06)
Female	44.93	—	—	—
Age, y				
65–79	44.55	—	—	—
80+	47.04	80+ (reference 65–79)	1.06 (1.05–1.06)	1.07 (1.06–1.08)
Comorbidities[a]				
0	39.78	—	—	—
1	48.28	1 (reference 0)	1.21 (1.21–1.22)	1.14 (1.13–1.14)
2+	56.34	2+ (reference 0)	1.41 (1.40–1.42)	1.26 (1.25–1.27)
Surgical Delay				
Same day	27.53	—	—	—
1 day	41.54	1 day (reference same day)	1.51 (1.50–1.52)	1.48 (1.47–1.49)
2–4 days	74.78	2–4 days (reference same day)	2.71 (2.69–2.73)	2.58 (2.56–2.60)
5+ days	96.61	5+ days (reference same day)	3.50 (3.45–3.54)	3.18 (3.13–3.22)
In-Hospital Complications				
0	43.77	—	—	—
1	66.40	1 (reference 0)	1.51 (1.50–1.53)	1.46 (1.44–1.47)
2+	73.33	2+ (reference 0)	1.67 (1.65–1.70)	1.59 (1.57–1.62)
Hospital Volume				
Low: 50 or fewer	50.73	Low (reference moderate)	1.10 (1.10–1.11)	1.12 (1.11–1.13)
Moderate: 51–149	45.96	Low (reference high)	1.19 (1.18–1.20)	1.26 (1.24–1.27)
High: 150+	42.74	Moderate (reference high)	1.07 (1.07–1.08)	1.12 (1.11–1.13)
Hospital Bed Size				
Small	44.47	Small (reference medium)	0.96 (0.95–0.97)	0.95 (0.94–0.96)
Medium	46.10	Small (reference large)	0.95 (0.95–0.96)	0.90 (0.89–0.90)
Large	46.68	Medium (reference large)	0.99 (0.99–1.00)	0.95 (0.94–0.95)
Hospital Region				
Northeast	52.15	Northeast (reference rest)	1.22 (1.21–1.22)	1.13 (1.13–1.14)
Midwest	43.43	Midwest (reference rest)	0.95 (0.94–0.96)	0.98 (0.97–0.99)
South	47.22	South (reference rest)	1.07 (1.06–1.07)	1.07 (1.07–1.08)
West	38.50	West (reference rest)	0.81 (0.80–0.82)	0.84 (0.83–0.84)

[a]Deyo-Charlson Comorbidity Index.

when initial examination of the data indicated that the number of these patients was relatively low and lacked regional diversity.

Patient and Hospital Demographics

As summarized in Table II, mean patient age was 82.6 years, 67.3% of patients were 80 years or older, and 76.2% of patients were women. Race coding was not included in the database for several states, but, for states that did include race coding, the vast majority of patients were white (90.2%) followed by African American (3.7%) and Hispanic (3.7%). Comorbidity status, based on *ICD–9* diagnostic codes using methods described by Deyo and colleagues,[16] indicated that 45.5% of patients had no comorbidities, 32.1% had 1 comorbidity, and 22.4% had 2 or more. For 27.1% of patients, there was no surgical delay (ie, surgery was performed on day of admission); surgery was delayed 1 day for 49.1% of patients, 2 to 4 days for 21.1%, and 5 or more days for 2.7%. For 89.9% of patients, there were no in-hospital complications; 7.6% of patients had 1 complication, and 2.5% had 2 or more.

Cut scores for surgical volume resulted in low volume being defined as 50 or fewer hip fracture surgeries per year, moderate volume as 51 to 149, and high volume as 150 or more. In this cohort, 21.3%, 55.7%, and 22.9% of patients underwent surgery at low-, moderate-, and high-volume hospitals, respectively. For hospital size, based on number of beds, 12.8%, 28.3%, and 58.9% of patients underwent surgery at small, medium, and large hospitals, respectively. Most patients were treated in the South (43.9%), followed by the Northeast (22.9%), the West (17.6%), and the Midwest (15.6%).

Table VI. Summary of Weighted Unadjusted and Adjusted Relative Risks for Total Hospital Charges at or Above $28,500 in 2003 Dollars

Variable and Levels	High Charges, %	Contrast	Relative Risk (95% Confidence Interval): Unadjusted	Relative Risk (95% Confidence Interval): Adjusted for All Variables in Model
Hospital Setting & Teaching Status				
RNT = Rural & Nonteaching	12.20	RNT (reference UNT & UTH)	0.46 (0.45–0.46)	0.45 (0.44–0.45)
UNT = Urban & Nonteaching	29.32	RNT (reference UNT)	0.42 (0.42–0.43)	0.44 (0.43–0.45)
UTH = Urban & Teaching	24.46	UTH (reference UNT)	0.84 (0.84–0.85)	0.96 (0.95–0.97)
Sex				
Male	29.72	Male (reference female)	1.28 (1.27–1.29)	1.14 (1.13–1.15)
Female	23.34	—	—	—
Age, y				
65–79	25.29	—	—	—
80+	24.65	80+ (reference 65–79)	0.97 (0.96–0.98)	1.01 (1.00–1.02)
Comorbidities[a]				
0	20.41	—	—	—
1	25.65	1 (reference 0)	1.26 (1.25–1.27)	1.17 (1.16–1.19)
2+	32.73	2+ (reference 0)	1.61 (1.60–1.63)	1.39 (1.37–1.40)
Surgical Delay				
Same day	15.95	—	—	—
1 day	21.47	1day (reference same day)	1.35 (1.34–1.37)	1.33 (1.32–1.34)
2–4 days	38.41	2–4 days (reference same day)	2.43 (2.41–2.46)	2.23 (2.21–2.26)
5+ days	68.40	5+ days (reference same day)	4.36 (4.28–4.43)	3.79 (3.73–3.86)
In-Hospital Complications				
0	22.87	—	—	—
1	40.95	1 (reference 0)	1.80 (1.78–1.82)	1.67 (1.65–1.69)
2+	47.40	2+ (reference 0)	2.09 (2.05–2.13)	2.03 (1.99–2.06)
Hospital Volume				
Low: 50 or fewer	23.46	Low (reference moderate)	0.92 (0.91–0.93)	1.18 (1.17–1.19)
Moderate: 51–149	25.31	Low (reference high)	0.93 (0.92–0.94)	1.35 (1.33–1.37)
High: 150+	25.06	Moderate (reference high)	1.01 (1.00–1.02)	1.14 (1.13–1.15)
Hospital Bed Size				
Small	19.21	Small (reference medium)	0.83 (0.81–0.84)	0.79 (0.78–0.80)
Medium	23.42	Small (reference large)	0.71 (0.70–0.72)	0.62 (0.62–0.63)
Large	26.83	Medium (reference large)	0.86 (0.86–0.87)	0.79 (0.78–0.80)
Hospital Region				
Northeast	24.06	Northeast (reference rest)	1.06 (1.05–1.07)	0.98 (0.97–0.99)
Midwest	11.56	Midwest (reference rest)	0.39 (0.39–0.40)	0.45 (0.44–0.46)
South	22.16	South (reference rest)	0.94 (0.94–0.95)	0.96 (0.95–0.97)
West	45.98	West (reference rest)	2.51 (2.49–2.54)	2.35 (2.33–2.37)

[a]Deyo-Charlson Comorbidity Index.

In this cohort, most patients were treated at urban nonteaching hospitals (50.9%) followed by urban teaching hospitals (32.3%) and rural nonteaching hospitals (16.9%). Owing to the large sample size, χ^2 tests of independence between hospital setting/teaching status (rural/nonteaching, urban/nonteaching, urban/teaching) and all other patient, treatment, and hospital demographics were statistically significant, except for patient age. Many of these identified "statistical dependencies," however, were judged to have little clinical relevance. For example, the percentages of women treated in urban/teaching, urban/nonteaching, and rural/nonteaching hospitals were 76.4%, 76.1%, and 76.1%, respectively. Thus, the largest magnitude of difference was 0.3% (76.4% to 76.1%). For comorbidity status, differences in percentages within each status level across the hospital setting/teaching status categories were never more than 1.4%. For surgical delay, within-level differences were never more than 4.8%. For in-hospital complications, within-level differences were never more than 0.9%.

In contrast, differences in hospital setting/teaching status and some other hospital factors were both statistically significant and showed relevant patterns of difference. As might be expected, percentages of patients being treated at low-volume hospitals were substantially higher for rural/nonteaching hospitals than for urban/nonteaching and urban/teaching hospitals (51.8% vs 19.7% and 7.7%, respectively). Percentages of patients being treated at hospitals with small bed size were substantially lower for rural/nonteaching hospitals than for urban/nonteaching and urban/teaching hospitals (5.6% vs 12.7% and 16.6%, respectively). Last, rural/nonteaching hospitals were less common than urban/nonteaching and urban/teaching hospitals in the Northeast and West than in the Midwest and South.

Clinical Outcomes

In-Hospital Mortality. Overall in-hospital mortality for the cohort was 2.6%. Table III summarizes unadjusted and adjusted RRs for in-hospital mortality based on hospital setting and teaching status as well as patient, treatment, and hospital factors. Adjusted RRs reflect adjustment for all variables in the model. Most of the unadjusted and adjusted RRs were statistically significant, owing in part to the large sample size in this study. Adjusted RRs generally were lower than unadjusted RRs. Considering adjusted RR results, in-hospital complications, comorbidity status, sex, surgical delay, and age demonstrated the largest effects. Higher in-hospital mortality risk was associated with increased number of in-hospital complications, increased number of comorbidities, male sex, longer surgical delay, and age 85 years or older.

In-Hospital Complications. The overall in-hospital complication rate was 10.1%. Table IV summarizes unadjusted and adjusted RRs for in-hospital complications. Most of the unadjusted and adjusted RRs were statistically significant, but the magnitudes of these risks generally were small. The largest adjusted RR (1.31) was for number of comorbidities (2+, reference 0).

Hospital Length of Stay. Overall, 46.3% of patients had LOS of more than the median split at 5 days. Table V summarizes unadjusted and adjusted RRs for LOS. All unadjusted and adjusted RRs were statistically significant. Considering adjusted RR results, surgical delay and in-hospital complications had the largest effects. Longer surgical delay and increased number of in-hospital complications were the factors posing the highest risk for LOS of 5 days or more.

Hospital Charges. Overall, 24.9% of patients had in-hospital charges above the 75th percentile (≥$28,500). Table VI summarizes unadjusted and adjusted RRs for increased hospital charges. All unadjusted and adjusted RRs were statistically significant. Considering adjusted RR results, the largest effects were associated with surgical delay, in-hospital complications, comorbidity status, hospital volume, region, hospital size, and hospital setting/teaching status. Risk factors for hospital charges at or above $28,500 were longer surgical delay, increased number of in-hospital complications, increased number of comorbidities, larger hospital size, lower surgical volume, and hospital location in the West region. In contrast, factors protective against higher charges were rural setting and hospital location in the Midwest.

Discussion

Hospital Setting and Teaching Status

Although statistically significant, the patient demographics and treatment factors across hospital settings and teaching status groups were surprisingly similar. There were no relevant differences in age groups, sex, comorbidity status, surgical delay, or in-hospital complication rates. Although race was slightly different, with a higher proportion of whites in rural locations and blacks in urban teaching hospitals, the prohibition of reporting race data in some states sampled in the survey makes it difficult to interpret this result. On the other hand, nonteaching rural hospitals were much more likely to be in the South and have low surgical volume. Patients in rural nonteaching hospitals were much more likely to have been treated in a larger facility.

Contrary to expectation, hospital setting and teaching status generally were not as relevant to in-hospital outcomes as were some of the patient, treatment, and other hospital factors. This was true for in-hospital mortality, in-hospital complications, and LOS even when evaluated in unadjusted analyses. With adjustments, holding for potential covariates, the adjusted risk was never higher than 8% for hospital setting and teaching status. Only with hospital charges did hospital setting or teaching status have any substantial effect, with rural setting less likely to be in the high cost category.

Although several studies have addressed outcomes associated with hospital setting and teaching status, few have focused on a specific orthopedic condition. One study considered all medical and surgical conditions that required hospitalization.[11] One group of studies focused on medical conditions,[12,20-22] another group on general surgical care.[8-10,14] Two studies focused on specific conditions, including hip fracture,[13,23] and 1 study focused exclusively on surgical care for hip fracture.[14]

Maynard and colleagues[12] reported that, for coronary angioplasty, the in-hospital mortality rate was significantly (P = .001) higher for rural hospitals (8.1%) than urban hospitals (6.4%). As pointed out by several authors,[10,24] however, hospital volume and surgeon volume may have had much more of an effect on mortality in this high-risk procedure than hospital setting did. Studying a series of 17,319 patients treated surgically between 1998 and 2003, Galandiuk and colleagues[20] found lower mortality rates for high-volume surgeons, both rural and urban, than for lower volume surgeons performing colon or rectal resections. Urban surgeons treated sicker patients undergoing more extensive procedures, and used fewer consultations, but their patients had more complications and revision surgeries. Overall, performance measures were addressed more consistently by rural surgeons.

Weller and colleagues[14] identified a cohort of 57,315 older patients (age, 50+ years) who sustained a hip fracture and were treated in Ontario, Canada, between

1993 and 1999. Similar to what was done in the present study, hospitals were classified as rural nonteaching, urban nonteaching, or urban teaching care centers. Using logistic regression analyses and controlling for selected patient, hospital, and treatment factors, they reported (1) an 11% protective effect for in-hospital mortality but a 31% increased risk for in-hospital complications in urban teaching hospitals compared with urban nonteaching hospitals, with both differences being statistically significant, and (2) a 26% increased risk for in-hospital morality and a 42% increased risk for in-hospital complications for rural nonteaching hospitals referenced to urban nonteaching hospitals, with the 26% increase a trend and the 42% increase statistically significant. In contrast to their study, we found (1) a nonsignificant risk for in-hospital mortality (1%) and a significant but much reduced risk for in-hospital complications (6%) in urban teaching hospitals referenced to urban nonteaching hospitals and (2) statistically significant but much lower risks for both in-hospital mortality and in-hospital complications (4%) in rural nonteaching hospitals referenced to urban nonteaching hospitals.

The differences in results between the study by Weller and colleagues[14] and our study may reflect differences in patient populations and methodology. Their study lacked a representative national sample (its percentage of patients in rural hospitals was only 1.6%; ours was 16.9%), had a higher in-hospital mortality rate (6.9%; ours, 2.6%), included fewer potential confounders, and used different criteria for defining in-hospital complication rates.

Few comparable studies have evaluated hospital charges and LOS based on hospital setting and teaching status for surgical care. Carbonell and colleagues evaluated general surgery outcomes associated with bariatric surgery[9] and cholecysectomy[8] and reported generally different patterns of results across the 2 cohorts. The one consistent finding was that charges were higher at urban hospitals than at rural hospitals—which agrees with the findings in the present study.

Patient and Other Hospital Factors

Overall in-hospital mortality for the cohort was 2.6%. Higher in-hospital mortality risk was associated with increased number of in-hospital complications, increased number of comorbidities, male sex, longer surgical delay, and age 85 years or older. These results are similar to what Jensen and Tøndevold[25] and Kenzora and colleagues[26] reported—that patients who died before hospital discharge were more likely than not to have had a postoperative complication. Patients with poorly controlled systemic illnesses have been reported to have higher mortality rates after hip fracture.[27,28] Kenzora and colleagues[26] reported a more than twofold increase in mortality in patients with 4 or more medical comorbidities. According to most studies, mortality risk is higher for men who sustain a hip fracture than for women who sustain a hip fracture.[29,30] It generally is accepted that longer surgical delay and older age are associated with higher mortality.[31,32]

The overall in-hospital complication rate in the present study was 10.1%. Most of the factors studied had little effect on occurrence of in-hospital complications. The largest adjusted effect was for 2 or more medical comorbidities; compared with no comorbidities, there was a 31% increased risk for an in-hospital complication. Compared with no surgical delay, a surgical delay of 5 days or more increased the risk for in-hospital complications by 25%. These results can be compared with those reported by Zuckerman and colleagues,[32] who found that a surgical delay of more than 2 calendar days had no significant effect on incidence of in-hospital complications in a series of 367 hip fracture patients, and Orosz and colleagues,[33] who found that a surgical delay of more than 24 hours had no effect on the in-hospital complication rate in a series of 1,200 hip fracture patients.

Overall, 46.3% of patients had LOS of 5 days or more. Longer surgical delay and increased number of in-hospital complications were the factors posing the highest risk for LOS of 5 days or more. These results are consistent with what had been expected and with the literature.[33] Orosz and colleagues[33] found that surgical delay of more than 24 hours was associated with increased LOS.

Overall, 24.9% of patients had in-hospital charges at or above $28,500 (75th percentile). Risk factors for these higher charges were longer surgical delay, increased number of in-hospital complications, increased number of comorbidities, larger hospital size, lower hospital volume, and hospital location in the West region. In contrast, factors protective against higher hospital charges were rural setting and hospitals in the Midwest. As already mentioned, rural hospitals have been found to have low charges.[8,9] Overall, however, the literature provides little guidance for interpreting these hospital charge results.

The strengths of this study are its large patient population and its evaluation of many of the patient and hospital factors that have been reported to influence outcomes after hip fractures.

This study has several limitations, too. First, there are limitations inherent to the retrospective database study design. In particular, database studies do not allow for independent verification of the data, and the data may omit information that could be of particular importance to the research question. For instance, a teaching hospital, as defined in the NIS database, does not necessarily have an orthopedic residency program. In addition, the NIS database tracks in-hospital outcomes, not postdischarge outcomes.

Another major limitation of the NIS database is how it defines rural and urban. Rural and urban definitions are based on metropolitan statistical areas and are reported in dichotomous fashion. This definition does not account for the wide range of community sizes or the functional relationship (commuting patterns) of rural and urban areas. Finally, the NIS database does not provide information on certain factors reported to influence hip fracture outcomes, such as severity of comorbidities and preinjury functional status.

Conclusion

Despite these limitations, this study introduces important considerations for the care of patients who have sustained a hip fracture. Contrary to expectation, hospital setting and teaching status generally were not as relevant to in-hospital outcomes as were comorbidity status, in-hospital complications, and surgical delay. Only with hospital charges did hospital setting or teaching status have any substantial effect, with rural setting protective against higher hospital charges.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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