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Inpatient Hospital and Post-Acute Care for Vertebral Fractures in Women

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ABSTRACT

Objective: Approximately 700,000 vertebral fractures occur annually in the United States. Available estimates on hospital costs and length of stay for vertebral fractures do not reflect current practice patterns, nor has post-acute care utilization been reported in sufficient detail. This paper provides new estimates on acute care charges, length-of-stay (LOS), and distribution patterns of post-acute care for osteoporotic vertebral fractures in women aged 50 years and older in the United States.

Methods: The Nationwide Inpatient Sample (NIS) database (1997) was used to identify admissions with a primary diagnosis of vertebral fracture. Decision rules based on clinical criteria were developed to identify vertebral fracture cases considered to be osteoporosis-related. Charges, LOS and discharge disposition were analyzed according to patient demographics and hospital characteristics.

Results: In 1997, there were 53,066 hospital admissions for osteoporotic vertebral fractures in women. Mean charges and LOS were $9,532 and 6.2 days, respectively, while US totals were $506 million and 329,000 days. More than 40% were discharged to long-term care (LTC); another 24.3% required other follow-up care. Charges and LOS were inversely related to age. Female patients aged 75 or more were more than five times as likely to be discharged to LTC compared to women between the ages of 50 and 64. Charges and LOS were in general, significantly higher for patients in the Northeast, urban areas, teaching hospitals and in larger hospitals, and for patients transferred from other acute care hospitals.

Conclusions: Vertebral fractures are more expensive and resource-intensive than previously reported. Furthermore, total costs may be much greater when the components of post-acute care are fully captured.

Keywords: hospital charges, length-of-stay, long-term care, osteoporosis, post-acute care, vertebral fractures.

Introduction

Approximately 700,000 vertebral fractures occur annually in men and women in the United States at an estimated cost of $746 million [1,2,3]. Vertebral fractures are an important outcome of osteoporosis. They are common among post-menopausal women and signal an increased risk for future fracture events of all types [4,5,6]. However, the majority of vertebral fractures are believed to be asymptomatic, as only about 35% to 50% come to clinical attention [7,8]. Furthermore, of those vertebral fracture cases receiving medical care, the proportion requiring acute inpatient hospital care ranges from 8% to 50% [8,9,10]. Consequently, the prevailing view by health-care payers and providers is that vertebral fractures are relatively unimportant and have little cost consequence, especially when compared to hip fractures.

Previous acute-care total charge estimates for vertebral fractures range from approximately $2300 to $6000 [11,12,13]. Available estimates on mean length of hospital stay from Phillips et al. (1988) using 1986 data indicate 10.1 days for spontaneous vertebral fractures (ICD-9 code 733.1) and 10.7 days for accident related vertebral fractures (ICD-9 code 805.0). However, these estimates may

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not reflect current practice patterns, as there have been substantial changes in the US health-care delivery system and economic incentives facing hospitals over the past 10 to 15 years. Furthermore, the use of post-acute care for vertebral-fracture patients has not been reported in sufficient detail.

The purpose of this study was to provide new estimates on hospital charges, length of stay and post-acute care for osteoporotic fractures of the vertebrae in women using recent data from a large, national hospital discharge database. These new estimates may be useful for measurement of the potential cost impact of vertebral fractures due to osteoporosis, modeling the cost-effectiveness of osteoporosis therapies and estimating the total burden of osteoporosis.

Methods

Vertebral Fracture Hospital Discharges

The Nationwide Inpatient Sample (NIS) Release 6, 1997 database was used for this analysis. The NIS database is part of the Healthcare Cost and Utilization Project (HCUP) sponsored by the Agency for Healthcare Research and Quality. The NIS Release 6 is the most recent version available, and it contains inpatient hospital stay records from more than 1000 US community hospitals across 22 states, totaling about 7.1 million records in 1997. The inpatient records include many clinical and resource use data fields found in hospital discharge abstracts. The NIS database also includes hospital and discharge weights, used to produce national and state-level estimates. All admissions for women aged 50 and older with vertebral fracture as the primary diagnosis were identified according to ICD-9 codes 733.13 (pathologic), 805.2 (thoracic), 805.4 (lumbar), and 805.8 (unspecified). To increase the likelihood that vertebral fractures in these patients were causally related to osteoporosis rather than to metastatic neoplasm or severe trauma, individuals fulfilling the following criteria were excluded: 1) any malignant neoplasm as a secondary diagnosis (ICD9 codes from 140 through 208); and 2) accident codes or "E-codes" on their discharge record consistent with severe trauma as a secondary diagnosis. The E-codes of excluded patients were: E800-E848 transportation accidents; E916-E923 struck, objects, machines, instruments, firearms, explosions; E928.8-E928.9 other, unspecified; E950-E978 suicide, homicide, legal intervention; E988 undetermined injury; and E999, war.

Data Analysis

A descriptive analysis was conducted on mean hospital charges, hospital length of stay (LOS), and percent of patients discharged to four types of post-acute care: long-term care (LTC) facility; short-term acute care (STAC) hospital; other type of facility, and home health care (HHC). Mean charges from 1997 were updated to year 2000 values according to inpatient hospital price increases from the Inpatient Hospital Services component of the Urban Consumer Price Index (CPI; Bureau of Labor Statistics, US Department of Labor). A long-term care facility was defined as a skilled nursing facility or an intermediate care facility, while other facilities included rehabilitation, hospice medical care, domiciliary health care, and psychiatric facilities. The analysis was stratified by key patient demographics and hospital characteristics. In all analyses of discharges to a LTC or to an "other" facility, patients from the West region were excluded because California hospitals combined reporting for these two discharge categories.

For the analysis of hospital charges and LOS, means within each stratum were compared to a reference group using generalized linear models for complex surveys. Statistical significance was determined using two-sided p-values = .05. The analysis of post-acute care was conducted by comparing proportions for subgroups within each stratum to an arbitrarily selected reference group. Odds ratios (ORs) were calculated from chi-square tests, and significance testing was at p-values = 0.05. Within each stratum, the logistic regression model included an intercept and the stratification variable. All analyses were conducted using Sudaan version 8 for complex sample surveys. Weights and sample design were assigned as specified in HCUP documentation.

Multivariate regression models were used to evaluate the independent effects of each key patient demographic and hospital factor, holding all other variables constant, on charges and LOS. The dependent variables were log-transformed following an analysis of residuals, which found this form to be the best fit to a normal distribution. The regression models were estimated using linear regression procedures in SAS version 6.04 (SAS Institute, Cary, NC, USA).

Results

Descriptive Analysis: Patient Demographics

Table 1 shows the total number of inpatient hospital admissions due to vertebral fracture and the rate

Table 1 Total inpatient hospital admissions for vertebral fractures and rate per 10,000 women in the United States, 1997

	Acute inpatient hospital admissions, 1997			
Age	Population*	Total†	Percent	per 10,000 women
50–54	8,451,097	1,274	2.4	1.5
55–64	12,249,297	2,388	4.5	1.9
65–74	10,028,435	8,597	16.2	8.6
75–84	7,282,153	22,659	42.7	31.1
85+	2,891,285	18,149	34.2	62.8
Total	40,902,267	53,066	100.0	13.0

*Total US population for women in 1997. Source: US Census Bureau.
†Source: Health Care Utilization Project, Nationwide Inpatient Sample, Release 6, 1997.

per 10,000 women aged 50 and older in 1997. Overall, there were 53,066 acute inpatient hospital admissions for a primary diagnosis of osteoporotic vertebral fracture. Women aged 75 to 84 accounted for 42.7% of all admissions, while those aged 85 and older comprised another 34.2% of the total. In terms of incidence per 10,000 women, the rate increased with age, jumping substantially after age 74 from 8.6 per 10,000, among women aged 65 to 74, to 31.1 per 10,000 in those aged 75 to 84.

Table 2 provides results of mean charges and LOS according to patient age, race, location, primary payer, and source of admission. Hospital admissions for vertebral fractures in women aged 50 and older during 1997 resulted in a mean charge of $9532 (updated to year 2000) and a mean LOS of 6.2 days. More than 77% of all admissions were for patients aged 75 and older: 43% aged 75 to 84; 34% aged 85 or older. Mean charges decreased with age, falling from $13,073 among 50- to 64-year-olds to $8,132 for those 85 or older. Mean charge values for all age groups were significantly different from the highest mean for the 50- to 64-year-old group. Mean LOS decreased with age from 6.5 days to 6.1 days, although there were no statistically significant differences across age groups.

Within the race stratum of those with an identifiable race, white patients accounted for the majority of cases (93.7%), followed by Hispanic patients (2.9%) and black patients (1.6%). Patients of

Table 2 Demographic stratification of mean acute/inpatient hospital charges and length of stay for vertebral fracture cases in the United States

		Charges ($)*			Length of stay (days)		
Stratum	N	Mean	SE	†	Mean	SE	†
Total	53,066	9,532	177	—	6.2	0.10	—
Age							
50–64‡	3,161	13,073	743	—	6.5	0.25	—
65–74	8,665	10,994	319	†	6.2	0.12	
75–84	22,877	9,613	217	†	6.3	0.11	
85+	18,362	8,132	180	†	6.1	0.18	
Race							
White‡	40,031	9,469	199	—	6.4	0.12	—
Black	699	17,118	2742	†	8.9	1.13	†
Hispanic	1,222	13,967	1017	†	7.2	0.46	
Other§	750	11,318	1286		7.0	1.09	
Region							
Northeast‡	11,019	11,661	596	—	8.2	0.34	—
Midwest	15,857	7,852	245	†	5.7	0.11	†
South	16,483	8,843	244	†	5.5	0.08	†
West	9,707	10,987	354		6.3	0.33	†
Payer							
Medicare‡	47,078	9,316	180	—	6.2	0.10	—
Medicaid	787	16,115	2072	†	7.6	0.65	†
Commercial	4,440	10,394	510	†	5.5	0.18	†
Self-pay	346	14,864	2465	†	15.5	7.29	
Other	369	8,072	763		4.6	0.34	†
Admission source‖							
Emergency	29,488	9,192	212		5.7	0.10	†
Other hospital	3,079	13,705	686	†	12.3	0.48	†
Other facility	1,014	10,809	779		6.4	0.34	
Routine‡	16,948	9,643	281	—	6.1	0.19	—

*Mean charges updated from 1997 to 2000 values using Inpatient Hospital component of the Urban Consumer Price Index (CPI). Source: Bureau of Labor Statistics, US Department of Labor.
†Significance level of Wald F noted if $p < .05$ for variable in overall model and for contrast with referent category.
‡Referent category.
§Combines Native American, Asian/Pacfic Islander and other.
‖Data not shown on a small number of cases reporting court/law enforcement as admission source or with missing information.

various less common racial origin were combined in a single category: other. Mean charges were significantly higher among black patients ($17,118) and Hispanic patients ($13,967) compared to the reference group of white women ($9469). Mean LOS was highest for black patients (8.9 days) and was significantly different from white patients (6.4 days).

Among regions, the highest charges and longest LOS were in the Northeast ($11,661 and 8.2 days). Difference in mean charges and LOS between the Northeast and the other three regions all reached statistical significance, except when compared to charges for the West. Patients in the Midwest had the lowest mean charges ($7852), while LOS was shortest (5.5 days) in the South.

About 89% of patients admitted to a hospital for osteoporotic vertebral fractures reported Medicare as the primary payer. Medicaid patients incurred the highest mean charges: $16,115; self-pay patients, $14,864; patients covered by commercial payers, $10,394; Medicare patients, $9,316. Self-pay patients, by definition, are not covered by third-party insurance and cannot command volume or other contractual discounts from hospitals. Thus they are usually billed for higher totals for the same care when compared to patients with private or government health insurance. Compared to Medicare, differences in mean charges for these payers were statistically significant. Differences in mean LOS were also statistically significant for Medicaid (7.6 days) and commercial payers (5.5 days) when compared with Medicare (6.2 days).

The source designation for a majority of patients (55%) was emergency, followed by routine admission (32%). Patients admitted from "other hospitals" (i.e., transferred from another, usually acute-care, hospital) had statistically, significantly higher charges (about 30%) compared to routine admissions ($13,705 vs. $9,643). LOS was significantly longer for other hospital transfer cases compared to routine cases (12.3 vs. 6.1 days), while emergency patients had statistically significant and slightly shorter stays in the unadjusted analysis. Both the higher charges and longer LOS in cases transferred from other hospitals may reflect the greater severity of these fractures, as the hospital of origin may not have had the necessary intensive care resources to treat these patients.

Results from the logistic regression models predicting discharges to post-acute care are shown in Table 3. More than 40% of all hospital patients with osteoporosis-related vertebral fractures were discharged to a LTC facility, 1.7% to a different STAC hospital, 9.5% to another type of facility, and 13.1% were discharged with HHC. Thus, nearly 65% of these patients were discharged to one of the four post-acute care settings. The proportion of vertebral fracture patients discharged to a LTC facility increased dramatically with age, rising from 12% in women aged 50 to 64 to more than 51% in those aged 85 or older. An analysis of the odds ratios for each age group compared to the 50- to 64-year-old group reinforces this rising trend toward more LTC. Women 65 to 74 years of age are approximately 2.9 times more likely to be discharged to a LTC facility compared to those aged between 50 and 64 years, while women 75 to 84 years old and those 85 years and older are nearly 5.0 and 7.9 times more likely to receive post-acute care in a LTC facility, respectively. Discharge to another STAC hospital was most frequent among 50- to 64-year-olds (3.1%), while the highest proportion of patients discharged to an "other" facility (10.1%) and to HHC (14.4%) was found among those 85 or older and among 75- to 84-year-olds, respectively. Also, the use of any type of post-acute care increased with age: 35% for those aged 50 to 64; 53% for those aged 65 to 74; 66% for patients aged 75 to 84, and 74% in patients 85 and older.

In terms of the race stratum, white patients were most frequently discharged to LTC. Patients of other races were significantly less likely to be discharged to a LTC facility compared to white patients, ranging from about one-third (black) to one-half (other) as likely. The proportion of patients discharged to other types of post-acute care were generally higher in black and Hispanic patients versus white patients, although statistically significant differences in discharge destinations existed only for black patients discharged to STAC compared to the reference group (4.5% vs. 1.7%; OR = 2.80).

Patients from the Midwest were discharged in highest proportion to LTC, and patients there were about 53% more likely to be discharged to a LTC facility than patients in the Northeast (46.8% vs. 36.4%; OR = 1.53). The opposite was found for patients discharged to other facilities, as Midwest patients had the lowest proportion (6.6%) and were least likely to be discharged to other facilities (OR = 0.62). Discharge proportions for HHC ranged from 11.3% in the Northeast to 16.1% in the West, and patients in the West were 50% more likely to receive HHC upon discharge compared to patients in the Northeast (OR = 1.5). The highest proportion of patients to be discharged to one of the four types of post-acute care were from the Midwest

Table 3 Discharge disposition for vertebral fracture hospital cases in the United States by demographic strata

		Discharge disposition*											
		Long-term care			Short-term care			Other facility			Home health care			Routine discharge		
Stratum	N	%	OR	†	%	OR	†	%	OR	†	%	OR	†	%	OR	†
Total	53,066	40.4	—		1.7	—		9.5	—		13.1	—		33.7	—	
Age																
50–64‡	3,161	12.0	—		3.1	—		6.8	—		12.7	—		61.7	—	
65–74	8,665	28.1	2.87	†	2.7	0.85		8.4	1.27		14.3	1.15		44.7	0.50	†
75–84	22,877	40.3	4.97	†	1.2	0.39	†	9.9	1.51	†	14.4	1.16		32.7	0.30	†
85+	18,362	51.7	7.89	†	1.4	0.46	†	10.1	1.55	†	10.8	0.84		25.0	0.21	†
Race																
White‡	40,031	42.2	—		1.7	—		9.5	—		12.8	—		32.6	—	
Black	699	20.9	0.36	†	4.5	2.80	†	14.1	1.56		12.0	0.93		42.7	1.54	†
Hispanic	1,222	22.0	0.39	†	2.4	1.46		14.1	1.57		17.4	1.43		39.7	1.36	†
Other§	750	25.7	0.47	†	2.5	1.55		8.9	0.93		10.6	0.80		44.2	1.64	†
Region																
Northeast‡	11,019	36.4	—		1.3	—		10.2	—		11.3	—		39.3	—	
Midwest	15,857	46.8	1.53	†	1.9	1.51		6.6	0.62	†	11.5	1.02		32.1	0.73	†
South	16,483	37.0	1.02		1.7	1.33		11.9	1.18		14.0	1.28	†	34.7	0.82	
West	9,707	—	—		1.6	1.26			—		16.1	1.50	†	28.3	0.61	
Payer																
Medicare‡	47,078	42.3	—		1.6	—		9.8	—		13.1	—		31.6	—	
Medicaid	787	15.3	0.25	†	1.9	1.19		7.8	0.77		15.6	1.22		54.4	2.59	†
Commercial	4,440	26.4	0.49	†	1.6	1.01		6.5	0.64	†	12.1	0.91		48.5	2.04	†
Self-pay	346	11.7	0.18	†	4.0	2.85	†	4.7	0.45	†	13.9	1.07		61.3	3.43	†
Other	369	16.1	0.26	†	4.5	3.53	†	7.9	0.78		11.9	0.89		59.9	3.24	†
Admission source‖																
Emergency	29,488	43.0	1.35	†	1.2	0.67	†	10.3	1.13		12.5	0.95		30.7	0.73	†
Other hosp.	3,079	21.3	0.48	†	5.4	3.20	†	7.0	0.74		28.3	2.64	†	39.9	1.10	
Other fac.	1,014	54.7	2.17	†	1.4	0.79		9.6	1.04		10.3	0.77		20.9	0.44	†
Routine‡	16,948	35.8	—		1.8	—		9.2	—		13.0	—		37.6	—	

*Within category percentages may not add to 100%. Residual discharge types are not shown and include: missing data, left against medical advice, or died.
†Significance level of OR (odds ratio) noted if $p < .05$ for variable in overall model and for comparison with referent category.
‡Referent category. OR relative to referent category.
§Combines Native American, Asian/Pacfic Islander and other.
‖Data not shown on a small number of cases reporting court/law enforcement as admission source or with missing information.

(66.8%) followed by patients from the South (64.6%), and those least likely to receive post-acute care were from the Northeast (59.2%).

Medicare patients were discharged in highest proportion to LTC (42.3%), while Medicaid and self-pay patients were least likely to be discharged to LTC (15.3% and 11.7%). Compared to Medicare patients, patients of all other payer types were less frequently discharged to LTC, with statistically significant odds ratios that ranged from 0.18 to 0.49. The proportion of patients being discharged to any type of post-acute care ranged from a high of 66.8% (Medicare) to a low of 34.3% (self-pay).

The distribution of post-acute care discharges by admission source shows that patients admitted to acute care hospitals from other facilities (e.g. skilled nursing facilities) were greater than two times more likely to be discharged to a LTC facility versus patients considered as routine admissions. Almost 80% of the patients admitted from another facility were discharged to some form of post-acute care. Patients admitted from another acute-care facility were discharged in lowest proportions to a LTC facility, but were those most frequently discharged to another STAC facility (5.4%), to home with HHC (28.3%), or as a routine discharge (39.9%).

Descriptive Analysis: Hospital Characteristics

Table 4 presents results by several hospital stratifications. Results according to hospital location indicate that nearly 23% of vertebral fractures were in rural hospitals and 77% were in urban hospitals. Mean charges and LOS were significantly lower in rural hospitals ($6,053 vs. $10,562; 5.4 days vs. 6.5 days). Approximately 76% of all cases were in non-teaching hospitals. Mean charges and LOS were lower in non-teaching than in teaching hospitals ($8,786 vs. $11,975; and 6.0 days vs. 7.0 days).

For patients treated in rural hospitals, the number of cases, mean charges, and mean LOS all increased with hospital bed size. Mean charges and LOS in small hospitals were lower compared with those in the largest rural hospitals ($4,490 vs. $6,979; 4.8 vs. 5.9). In urban non-teaching hospitals, mean charges and LOS ranged from $9123 to $10,204 and 6.1 to 6.9 days, respectively, but no statistically significant differences were found in comparison to the reference group (large urban non-teaching). Charges and LOS were the highest

Table 4 Mean charges and length of stay for vertebral fracture hospital cases in the United States by hospital location, teaching status, bed size, and ownership type

		Charges*			Length of stay		
Stratum	N	Mean ($)	SE	†	Mean	SE	†
Total	53,066	9,532	177	—	6.2	0.10	—
Location							
Rural	12,249	6,053	177	†	5.4	0.13	†
Urban‡	40,742	10,562	219	—	6.5	0.13	—
Type							
Non-teaching‡	40,658	8,786	174	—	6.0	0.10	—
Teaching	12,334	11,975	518	†	7.0	0.31	†
Bed size							
Rural							
Small (1–49)	3,206	4,490	117	†	4.8	0.15	†
Medium (50–99)	4,061	6,142	439		5.3	0.18	†
Large (100+)‡	4,982	6,979	225	—	5.9	0.25	—
Urban—non-teaching							
Small (1–99)	3,408	9,123	734		6.9	0.55	
Medium (100–199)	9,417	9,805	366		6.4	0.27	
Large (200+)‡	15,679	10,204	309	—	6.1	0.12	—
Urban—teaching							
Small (1–299)	3,380	11,163	761		6.4	0.44	
Medium (300–499)	4,546	11,379	828		6.6	0.63	
Large (500+)‡	4,311	13,311	1049	—	7.7	0.39	—
Ownership							
Government	6,402	8,226	405	†	6.0	0.21	
Private nonprofit‡	38,929	9,638	220	—	6.3	0.12	—
Private for-profit	7,660	10,092	375		5.8	0.32	

*All mean charges were updated from 1997 to 2000 values using the Inpatient Hospital Services component of the Urban Consumer Price Index (CPI). Source: Bureau of Labor Statistics, US Department of Labor.
†Significance level of Wald F noted if $p < .05$ for variable in overall model and for contrast with referent category.
‡Referent category.

for urban teaching hospitals among all hospital strata. However, within the urban teaching category, there were no statistically significant differences in means.

Results by ownership control show that more than 73% of all vertebral fractures were treated in private, nonprofit hospitals, while the remainder was split between government (12%) and private, for-profit hospitals (15%). Mean charges were highest in private, for-profit hospitals ($10,092) and lowest in government-controlled hospitals ($8,226). Mean charges in private nonprofit hospitals were $9638 and differed significantly compared to mean charges in government hospitals.

Table 5 presents results regarding discharges to post-acute care according to key hospital characteristics. Among urban and rural hospitals, the proportions for each of the four types of post-acute care were statistically significantly different. Rural hospitals discharged a greater proportion of patients to LTC (43.1% vs. 39.5%, OR = 1.16) and to STAC hospitals (2.7% vs. 1.3%, OR = 2.03), while urban hospitals discharged the highest proportion of patients to other facilities (10.6% vs. 6.4%, OR = 0.58) and to HHC (13.9% vs. 10.2%, OR = 0.7). The total overall proportion of patients discharged to post-acute care was greater in urban hospitals (65.3% vs. 62.4%).

In terms of teaching status, the proportion of patients discharged to any type of post-acute care was about 65% in both types of hospitals, although a higher proportion of non-teaching hospital cases were discharged to a STAC hospital, while a larger percentage of teaching hospital patients were discharged to an "other" facility.

The analysis by hospital according to bed size revealed that smaller rural hospitals discharged a higher proportion of patients to LTC (48.7% vs. 39.5%; OR = 1.46) and STAC (4% vs. 2.2%; OR = 1.83) and lower proportions to other facilities (2.7% vs. 9.6%; OR = 0.26) and HHC (5.7% vs. 11%; OR = 0.49). Among urban hospitals, similar patterns were found whereby higher proportions of patients were discharged to LTC from smaller hospitals compared to large hospitals, while the inverse was true for the proportion of patients discharged to other facilities and to HHC.

Compared to government and private for-profit hospitals, private nonprofit hospitals discharged a greater percentage of patients to LTC (41.7%) and to other facilities (10.2%). Government hospitals discharged the highest proportion of patients to STAC hospitals (3.0%) while private for-profit hospitals discharged 15.6% of patients to HHC (OR = 1.21, $p < .05$). Almost 55% of all cases from government hospitals received some type of post-acute care, whereas more than 66% of cases from private, nonprofit hospitals received such care.

Multivariate Regression Results

The coefficients and standard errors from the log of charges and the log of LOS multivariate regression models are presented in Table 6. Most of the percentage effects on charges and LOS were smaller in the multivariate analysis than in the unadjusted analysis. In terms of age, patients 85 and older incurred charges 24% lower than those aged 50 to 64, after semi-logarithmic transformations were applied [14,15], while the unadjusted analysis (Table 1) revealed mean charges that were 61% lower. Results according to patients' race indicate that Hispanic patients had significantly higher charges than white patients, but mean charges were not statistically different when black patients were compared to white patients when all other factors were held constant. In terms of payer type, commercial patients and "other" paying patients incurred lower mean charges compared to Medicare patients, and Medicaid patients had statistically significantly higher charges. The effect of commercial payer status switched from being about 10% above Medicare in the unadjusted, descriptive analysis to about 15% lower in the multivariate analysis. After controlling for all other factors, there was a large and significant impact on charges from patients admitted from another acute-care hospital versus those considered to be routine admissions. However, the relative impact on charges of being admitted from another acute-care hospital was attenuated in the multivariate analysis compared to the descriptive analysis (42% versus 35% higher). Finally, the effect on charges of being in a private for-profit hospital versus a private nonprofit setting, became statistically significant, while the statistically significant difference with government controlled hospitals was lost in the multivariate regression estimation.

The magnitude of the coefficients in the LOS regression analysis was generally reduced compared to the descriptive analysis. However, the coefficient on admission source from another acute hospital was highly significant and the percentage effect more than doubled compared to the unadjusted analysis. The simultaneous control of patient demographics and hospital characteristics resulted in some variables becoming statistically significant

Table 5 Discharge disposition for vertebral fracture hospital cases in the United States by location, teaching status, bed size, and ownership type

		Discharge disposition *											
		Long-term care			Short-term acute care			Other facility			Home health care			Routine discharge		
Stratum	N	%	OR	†	%	OR	†	%	OR	†	%	OR	†	%	OR	†
Total	53,066	40.4	—		1.7	—		9.5	—		13.1	—		33.7	—	
Location																
Rural	12,249	43.1	1.16	†	2.7	2.03	†	6.4	0.58	†	10.2	0.70	†	36.9	1.20	†
Urban‡	40,742	39.5	—		1.3	—		10.6	—		13.9	—		32.7	—	
Type																
Non-teaching‡	40,658	41.0	—		1.9	—		8.9	—		12.6	—		34.2	—	
Teaching	12,334	38.7	0.91		0.9	0.49	†	11.5	1.32	†	14.5	1.17		32.1	0.91	
Bed size																
Rural																
Small (1–49)	3,206	48.7	1.46	†	4.0	1.83	†	2.7	0.26	†	5.7	0.49	†	39.4	1.16	
Medium (50–99)	4,061	43.5	1.18		2.2	0.98		5.1	0.51	†	12.7	1.18		36.2	1.01	
Large (100+)‡	4,982	39.5	—		2.2	—		9.6	—		11.0	—		35.9	—	
Urban non-teaching																
Small (1–99)	3,408	40.7	1.04		1.9	2.22	†	4.0	0.33	†	10.6	0.68	†	41.5	1.55	†
Medium (100–199)	9,417	40.0	1.01		2.5	2.95	†	10.7	0.95		13.0	0.86		32.7	1.06	
Large (200+)‡	15,679	39.8	—		0.9	—		11.2	—		14.8	—		31.4	—	
Urban teaching																
Small (1–299)	3,380	43.1	1.45		1.1	0.70		10.2	0.84		13.9	0.94		30.2	0.78	
Medium (300–499)	4,546	40.2	1.29		0.3	0.19		12.3	1.03		15.1	1.04		30.0	0.77	
Large (500+)‡	4,311	34.3	—		1.5	—		11.9	—		14.6	—		35.6	—	
Ownership																
Government	6,402	37.9	0.85	†	3.0	2.20	†	4.9	0.46	†	8.9	0.64	†	42.5	1.59	†
Private nonprofit‡	38,929	41.7	—		1.4	—		10.2	—		13.3	—		31.7	—	
Private for-profit	7,660	36.0	0.79	†	1.8	1.25		9.9	0.97		15.6	1.21	†	36.3	1.23	

*Within category percentages may not add to 100%. Residual discharge types are not shown and include: missing data, left against medical advice, or died.
†Significance level of OR (odds ratio) noted if $p < .05$ for variable in overall model and for comparison with referent category.
‡Referent category; OR relative to referent category.

Table 6 Regression results from total charge and length-of-stay models (log form)

Dependent variable	Log (charges)			Log (length of stay)		
Variable	Coefficient		SE	Coefficient		SE
Intercept	9.1	*	0.07	1.89	*	0.05
Age						
50–64						
65–74	–0.12	*	0.04	–0.08	*	0.04
75–84	–0.17	*	0.04	–0.04		0.04
85+	–0.27	*	0.04	–0.08	*	0.04
Race						
White						
Black	0.10		0.08	0.03		0.07
Hispanic	0.19	*	0.04	0.09		0.05
Asian/Pac Islander	–0.001		0.07	0.01		0.08
Region						
Northeast						
Midwest	–0.36	*	0.05	–0.25	*	0.03
South	–0.21	*	0.05	–0.27	*	0.04
West	–0.001		0.05	–0.35	*	0.04
Payer						
Medicare						
Medicaid	0.12	*	0.06	0.11		0.06
Commercial	–0.16	*	0.04	–0.19		0.03
Self-pay	–0.07		0.11	0.06		0.10
Other	–0.20	*	0.08	–0.23	*	0.07
Admission source						
Routine						
Emergency dept	–0.01		0.02	–0.05	*	0.02
Another hosp.	0.30	*	0.05	0.78	*	0.04
Other facility	0.02		0.06	0.00		0.06
Location						
Urban						
Rural	–0.33	*	0.03	–0.05		0.03
Type						
Non-teaching						
Teaching	0.17	*	0.04	0.07	*	0.03
Bed size†						
Large						
Small	–0.14	*	0.04	–0.08	*	0.03
Medium	–0.08	*	0.03	–0.08	*	0.02
Ownership						
Private nonprofit						
Government	0.04		0.03	0.02		0.03
Private for-profit	0.14	*	0.03	–0.05		0.03
Number of obs.	40,021			40,116		
R-square	0.136			0.133		

*Statistically significant ($p < .05$).
†Each subgroup includes urban and rural hospitals.

(e.g. AGE = 65–74, 85+) or losing statistical significance (RACE = black; PAYER = Medicaid, Commercial; LOCATION = rural; OWNERSHIP = government).

Discussion

This retrospective hospital database analysis identified 53,066 hospital admissions with vertebral fracture as the primary diagnosis among osteoporotic women aged 50 and older in the United States during 1997. Osteoporotic fractures of the vertebrae appear to be considerably more expensive than previously reported, as overall mean charges were $9532 (updated to year 2000 US dollars), and mean length of stay was 6.2 days. Total acute-care hospital charges for osteoporotic vertebral fracture patients in the United States were estimated to be $506 million ($9532 x 53,066) and total inpatient hospital days were 329,009 (6.2 x 53,066). The proportion of patients discharged to a LTC facility was 40%. Furthermore, more than 64% of all cases were discharged to some type of post-acute care setting, implying additional costs.

Earlier US studies using data from the 1980s found inpatient hospital charges and LOS for vertebral fracture patients to be about $2300 to $6000 [11,12,13] and more than 10 days [13], respectively. One possible explanation for these differences could be that our results reflect substantial changes in the

US hospital-care system since the advent of fixed prospective payment for hospital admissions in the mid 1980s and the growth of managed care. These system changes have created powerful incentives to reduce costs per patient by shortening lengths of hospitalizations and treating patients in non-hospital settings, except for the most severe patients. The shorter lengths of stay and high proportion of patients discharged to post-acute care in our study are consistent with the changes in incentive structure facing hospitals and health-care payers. To some degree, health-care financing in the United States may also explain international differences in LOS for vertebral fracture patients. For instance, in Canada a recent study found that the mean LOS was 10.1 days [16], while in European countries LOS was: 9.6 days in Sweden; 15.6 days in Denmark; 19.3 days in the United Kingdom; and 29.4 days in the Czech Republic [17].

The main effects of key patient demographic and hospital characteristics on hospital charges and LOS were assessed using multivariate regression analysis. In general, hospital charges were found to be significantly lower in patients who were older than 65, white, routine admissions, covered by commercial payers and among patients treated in rural, non-teaching hospitals located in the Midwest or South with fewer beds and private, nonprofit ownership. The incremental effects of older age; Midwest, South, or West location; non-teaching status; and fewer beds on LOS were generally negative and statistically significant.

The results of this study represent an important contribution to the literature in terms of understanding hospital resource use and post-acute care for osteoporotic fractures of the vertebrae among women in the United States. They also provide updated information on unit charges, hospital days and practice patterns of care that can be useful in modeling the cost impact of osteoporotic fractures of the vertebrae on payers and on health-care systems in the United States.

There are several limitations to this study, however. First, we used decision rules based on clinical judgment to address the underlying problem of under-recognition and under-reporting of osteoporosis when identifying osteoporotic fractures of the vertebrae. Although osteoporosis is one of the most important risk factors leading to vertebral fractures, we cannot ascertain the proportion of vertebral fractures that are causally related to osteoporosis using the NIS database or claims databases in general, because osteoporosis and vertebral fractures are under-diagnosed and under-reported [18]. We developed decision rules based on clinical conditions to identify only those vertebral fractures most likely to be associated with osteoporosis to overcome the problem of under-recognition of this disease, rather than applying osteoporosis attribution rates as has been done in other studies [3,13,19]. Excluding all patients with secondary diagnoses of cancer or potentially severe trauma resulted in a loss of only 9% of all possible cases. Although we believe our methodology is sound, the use of alternative algorithms with either more restrictive or relaxed criteria could lead to different results. Second, only hospital admissions with a primary diagnosis of vertebral fracture were included. There were approximately 86,000 patients with a secondary diagnosis of vertebral fracture in the NIS database. The inclusion of these cases could substantially increase the total estimate of inpatient resource utilization and charges incurred by vertebral fracture patients. Third, we included only cases aged 50 and older even though osteoporosis does lead to vertebral fractures in younger women. Finally, we used total charge information from hospital discharge data in our analysis rather than cost data. An analysis to estimate the underlying economic costs would require more data pertaining to the underlying technology of the hospital and specific resources used to treat patients with vertebral fracture. Such an effort is beyond the scope of this paper. However, as a rough approximation, cost-to-charge ratios could be applied to the charge estimates, or cost-per-day estimates could be multiplied by mean LOS estimates to generate inpatient cost estimates for these cases. A total US cost estimate could be generated by applying a cost-to-charge ratio of 0.61 to our mean charge figure [20], while calculation of hospital-level cost estimates would require analysis of hospital cost reports to create hospital-specific cost-to-charge ratios.

Conclusion

Patients admitted to acute-care hospitals due to osteoporosis-related vertebral fractures incur relatively high charges and long LOS, and a large proportion require additional post-acute care. Substantial variation in charges, LOS and post-acute care discharge patterns exists within key strata, including age, race, region, payer, location, hospital bed size, hospital teaching status, and ownership type. A more complete understanding of the full cost of vertebral fractures resulting from underlying osteoporosis may lead to more effective use of ther-

apies for prevention and treatment of this disease outcome.

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