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Hospitalizations for osteoporosis-related fractures: Economic costs and clinical outcomes

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ABSTRACT

Background: Osteoporotic fractures frequently require inpatient care, and are associated with elevated risks of morbidity, mortality, and re-hospitalization. A comprehensive evaluation of healthcare costs, resource utilization, and outcomes associated with osteoporosis (OP)-related fractures treated in US hospitals was undertaken.
Methods: A retrospective analysis using the Premier Perspective Database (2010 − 2013) was conducted. Study population comprised patients aged ≥50 years hospitalized with a principal diagnosis of a closed or pathologic fracture commonly associated with OP; the first qualifying hospitalization was designated the "index admission". Patients with evidence of major trauma, malignancy, or other non-OP conditions that may lead to pathologic fracture during the index admission were excluded. Study measures included healthcare costs (in 2013 USD), length of stay (LOS), intensive care unit (ICU) use, and mortality during the index admission, as well as 60-day fracture-related readmission.
Results: A total of 268,477 patients were admitted to hospital (n = 548 hospitals) with a principal diagnosis of an OP-related fracture; mean (SD) age was 78 (11) years, 75% were female, 69% had ≥2 comorbidities, and 82% of patients had a diagnostic code for accidental fall. Among all OP-related fracture admissions, mean (95% CI) hospital cost was $12,839 (12,784–12,893) and LOS was 5.1 (5.1–5.1) days; during the admission, ICU use was 7.4% (7.3–7.5) and mortality was 1.5% (1.5–1.6), and during the 60-day post-discharge period, fracture-related readmission was 2.3% (2.2–2.4).
Conclusions: Hospital costs associated with the acute treatment of OP-related fractures are substantial, especially among patients with fractures of the hip, femur, and spine. Among patients with vertebral fractures—the second most common reason for admission—mortality and ICU use were notably high, and costs and LOS were higher than among those with non-vertebral fractures (excluding hip). Interventions that are effective in reducing fracture risk have the potential to yield substantial cost savings.

1. Introduction

Osteoporosis (OP) is a condition of decreased bone density that affects aging Americans, especially post-menopausal women (U.S. Department of Health and Human Services, 2004). In older Americans, OP is the most common cause of bone fracture, often termed "fragility fractures" (U.S. Department of Health and Human Services, 2004). These fractures typically result from minimal injury, such as a fall from standing height or less that is insufficient to fracture a normal bone (Brown and Josse, 2002).

Abbreviations: OP, osteoporosis; LOS, length of stay; ICU, intensive care unit; DRG, diagnosis-related group; MDC, major diagnostic category; OR, operating room; CPI, Consumer Price Index; AHA, American Hospital Association.

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The clinical and economic burden of fragility fractures has been evaluated in a number of retrospective studies characterizing inpatient and/or ambulatory healthcare utilization, costs, and outcomes (Singer et al., 2015; Shauver et al., 2011; Christensen et al., 2010; Pike et al., 2010; Shi et al., 2009; Bass et al., 2008; Kilgore et al., 2009; Sasser et al., 2005; Lad et al., 2007; Orsini et al., 2005; Russo et al., 2009; King et al., 2009). While these studies are informative, they differ in design, study sample, duration of observation, and/or outcomes considered. Moreover, no recent study has reported hospital costs associated with OP-related fractures by the site of the fracture, and no recent study has reported hospital costs associated with OP-related fractures on an overall basis and by cost component. Such information is especially critical for the efficient allocation of scarce healthcare resources, as the musculoskeletal system is second only to the circulatory system accounting for 14% of total inpatient expenditures (Pfuntner et al., 2013). To address this gap in the literature, we undertook a retrospective study using discharge records from over 500 hospitals to quantify levels of resource

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utilization, attendant healthcare costs, and outcomes associated with OP-related fractures treated in the inpatient setting.

2. Methods

2.1. Study design and data source

This study employed a retrospective cross-sectional/cohort design, and data from the Premier Perspective Database spanning January 1, 2010 to September 30, 2013. The Premier Perspective Database includes validated discharge files from all inpatient admissions from >500 geographically diverse US hospitals. For each inpatient admission, available data include patient demographics; admission and discharge dates; admission type and source; diagnoses and procedures; medications; laboratory, diagnostic, and therapeutic services; diagnosis-related group (DRG); major diagnostic category (MDC); DRG-based severity measures; discharge disposition; and total (actual) costs associated with treatment. Selected physician characteristics (e.g., specialty) and hospital characteristics (e.g., bed size, location, teaching status) are also available. A detailed description of the data source, and methods employed to identify the study population and define study variables, may be found in Online supplement.

2.2. Study population

The study population comprised all patients aged ≥50 years who, from March 2010 through September 2013, were hospitalized for the treatment (i.e., discharged with a first-listed diagnosis) of selected closed or pathologic fractures commonly associated with OP ("OP-related fractures"), including: hip, femur, vertebral, and other non-vertebral (including humerus, ankle, pelvis, tibia/fibula, distal radius/ulna, proximate radius/ulna, and clavicle). The first such hospitalization during the period of observation was designated the "index admission".

Patients with evidence of major trauma, malignancy, or other conditions associated with pathologic fracture—except for OP—and those transferred to hospital from another acute-care facility were excluded from the study population. Patients who were hospitalized with a first-listed or second-listed diagnosis code for any type of fracture (ICD-9-CM 800-829, 733.1x) within the 60-day period prior to the index hospitalization also were excluded.

2.3. Study measures

Hospital costs, overall and by component of care (e.g., room/board, operating room [OR], laboratory, pharmacy, radiology, supplies) were determined from clinical and billing records, and represent the hospital's internal assessment of the actual cost to the hospital of delivering goods and services. Hospital costs were adjusted—as warranted—to 2013 US dollars based on the hospital component of the Consumer Price Index (CPI) (Statistics, n.d.). Other study measures ascertained during the index hospitalization (i.e., from admission to discharge) included the number of days in hospital (i.e., hospital length of stay [LOS]), inpatient mortality (died vs. alive), intensive care unit (ICU) use (yes vs. no), and ICU days. Re-hospitalization for any fracture (first/second-listed diagnosis) during the 60-day period following discharge from the index admission also was evaluated.

2.4. Statistical analyses

Characteristics of patients, their admission, and their hospital for the index admission were descriptively analyzed. Patient characteristics included: age, gender, and race/ethnicity, primary payer, and comorbidity profile. Admission characteristics included: DRG/MDC, DRG-severity index, admission source, admission type, and calendar year of admission. Hospital characteristics included: hospital bed size, hospital location, hospital type, and hospital geographic region. Categorical variables were reported as counts and percentages; for continuous variables, means, standard deviations, and medians were reported.

Hospital costs, hospital LOS, hospital mortality, ICU use, and re-hospitalization were summarized using means, percentages, and corresponding 95% confidence intervals. For binary measures, confidence intervals were computed using the Wilson score interval; confidence intervals for continuous measures were computed using a normal distribution. Analyses were conducted using data from all patients who qualified for inclusion in the study population, and within subgroups defined therein on the basis of fracture type (i.e., hip, femur, vertebral, and other non-vertebral).

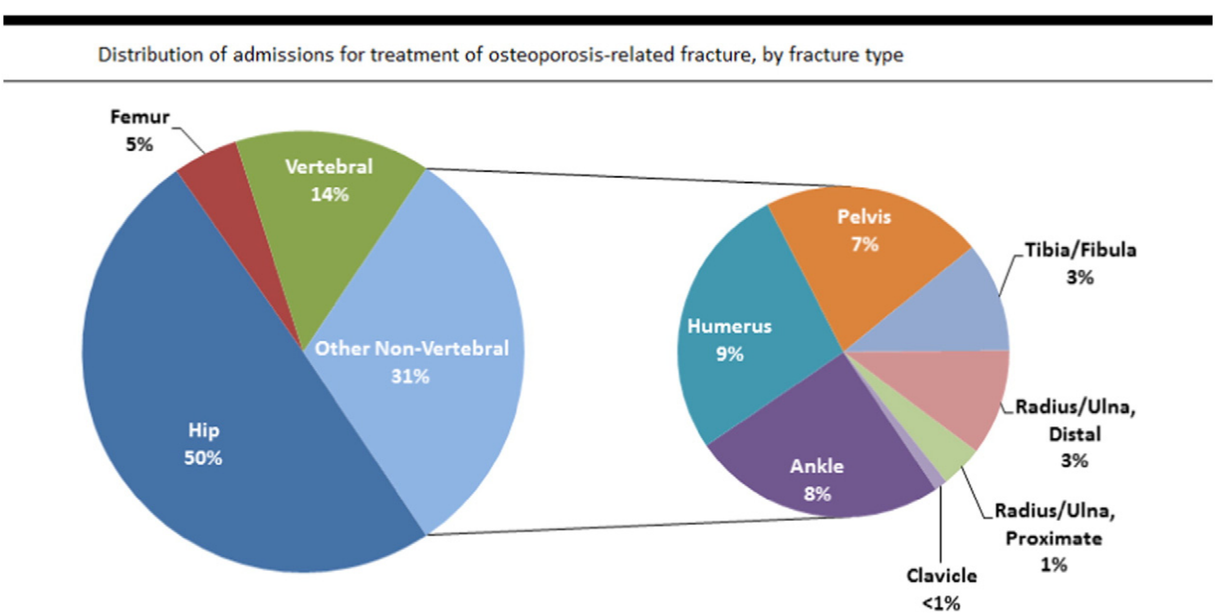

Fig. 1. Distribution of admissions for treatment of osteoporosis-related fracture, by fracture type.

3. Results

3.1. Patient characteristics

The study population included 268,477 patients who were hospitalized for the treatment of selected closed or pathologic OP-related fractures and met all other inclusion/exclusion criteria (Online supplement, Tables 1–2). One-half of all patients were hospitalized for hip fracture; other non-vertebral/non-femoral fractures (31%), vertebral fractures (14%), and femur fractures (5%) accounted for the remainder (Fig. 1). Among patients admitted for other non-vertebral fractures, principal sites were humerus (9%), ankle (8%), and pelvis (7%).

Mean (SD) age of the study population was 78 (±11) years, and ranged from 73 (±12) years (other non-vertebral/non-femoral) to 80 (±9) years (hip) (Table 1). Cardiovascular disease was the most common comorbidity (46%), followed by osteoporosis/osteopenia (27%); conditions associated with pain or physical impairment also were prominent (osteoarthritis, 22%; mobility impairments, 20%), as was evidence of fall (82%). Almost 75% of all patients were admitted from a non-healthcare facility; 14% were admitted via the emergency department.

3.2. Costs and outcomes

On an overall basis (i.e., for all OP-related fractures), mean total hospital costs were $12,839, and mean hospital LOS was 5.1 days (Fig. 2); mean LOS was 5.6 days for men, and was 4.9 days for women. Hospital costs and LOS were highest for femoral fractures ($16,423 and 5.8 days,

Table 1
Characteristics of patients admitted to hospital for treatment of osteoporosis-related fracture.

	Type of fracture				
	All (N = 268,477)	Hip (N = 133,424)	Femur (N = 12,811)	Other non-vertebral[a] (N = 83,759)	Vertebral (N = 38,483)
Patient characteristics					
Age (years)					
Mean (SD)	77.5 (10.9)	79.9 (9.4)	75.8 (11.1)	73.4(12.0)	78.8 (10.0)
Median	81	83	78	75	82
Gender, %					
Female	75.4	72.9	82.8	79.4	72.7
Male	24.6	27.1	17.2	20.6	27.3
Race/ethnicity, %					
White	78.9	79.9	75.4	77.9	79.0
Black	4.3	3.9	7.5	5.1	3.1
Hispanic	1.1	1.0	1.3	1.2	1.2
Other	15.6	15.2	15.8	15.8	16.7
Primary payer, %					
Medicare	82.3	87.6	81.5	72.2	86.3
Medicaid	2.7	2.1	3.1	3.6	2.6
Other government provider	0.5	0.4	0.5	0.0	0.4
Managed care	7.7	4.9	8.0	0.0	5.7
Non-managed care commercial	2.9	2.2	3.0	0.0	2.3
Other payer	3.9	2.7	3.8	0.0	2.7
Commercial	10.6	7.1	11.1	17.4	8.0
Other	4.3	3.1	4.3	6.9	3.1
Evidence of fall, %	82.4	87.8	82.9	86.3	55.2
Comorbidities, %[b]					
Cardiovascular disease	45.7	50.4	44.4	37.2	48.1
Osteoporosis/Osteopenia	27.1	25.2	32.2	21.4	44.5
Diabetes	24.7	23.2	30.2	27.0	23.5
Osteoarthritis	21.6	21.8	29.0	19.8	22.6
Hypothyroidism	21.0	21.2	22.3	20.2	21.5
Lung disease	19.8	22.2	17.6	15.2	22.1
Mobility impairments	19.6	19.9	23.1	19.0	18.9
Renal disease	15.7	17.8	16.7	13.0	13.6
Depression	15.6	15.1	15.3	16.1	16.2
Dementia and related conditions	14.0	18.2	11.6	8.7	11.6
Vision impairments	8.0	8.9	7.7	6.5	8.0
Rheumatoid arthritis	3.0	2.6	4.6	2.8	4.2
Parkinson's disease	2.4	3.0	1.6	1.7	2.6
Liver disease	2.4	2.1	2.3	2.6	3.1
Muscle atrophy/muscle weakness/sarcopenia	0.4	0.4	0.3	0.3	0.5
Number of comorbidities, %					
0	10.9	8.1	8.7	17.1	7.5
1	19.8	18.6	18.2	22.7	17.9
2	23.6	24.2	23.6	22.5	23.9
≥3	45.8	49.1	49.4	37.7	50.6
Admission characteristics					
Admission source, %					
Emergency room	13.7	14.2	14.4	12.9	13.7
Non-health care facility	74.3	73.7	73.5	75.3	74.5
Clinic	4.4	3.4	3.9	5.7	5.4
Transfer from another non-acute facility	3.3	4.3	3.9	2.1	2.4
Other/unknown	4.3	4.5	4.3	4.0	4.0

SD: standard deviation.
[a] Non-vertebral excluding hip and femur fractures.
[b] Comorbidities for which prevalence < 10%: vision impairments, rheumatoid arthritis, Parkinson's disease, liver disease, and muscle atrophy/muscle weakness/sarcopenia.

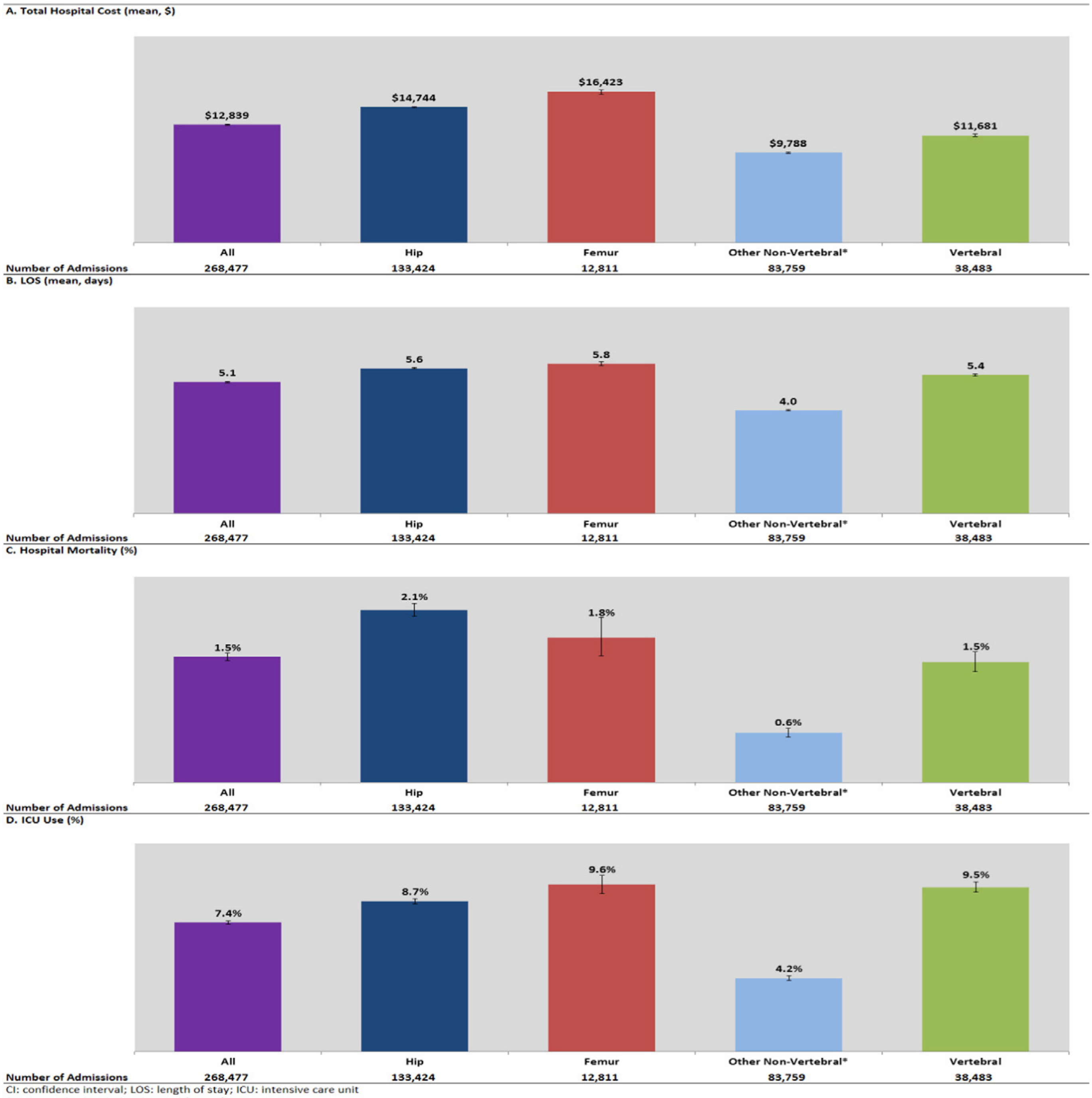

Fig. 2. Economic costs and clinical outcomes among patients admitted to hospital for treatment of osteoporosis-related fracture.

respectively) and lowest for other non-vertebral fracture ($9788 and 4.0 days, respectively). Among the subgroup of other non-vertebral fractures, mean costs ranged from $6387 for pelvis fracture to $11,760 for humerus fracture (Online supplement, Table 3).

Room and board accounted for approximately one-third of total hospital costs, while supply costs (23%) and OR costs (18%) accounted for over 40% of total costs; pharmacy costs accounted for 6% of total costs, and comprised—in large part—hospital solutions (e.g., IV/parenteral sodium chloride) (13%), hemostatic modifiers (12%), anti-infectives (12%), and analgesics (11%) (Fig. 3). Most patients (82%) underwent surgery; this percentage was highest for hip fracture (96%) and lowest for vertebral fracture (54%).

More than one-half (54%) of all fracture patients were discharged to a skilled/long-term care facility, 27% were discharged to home, and 14% were discharged to a rehabilitation facility; 2% died in hospital. Discharge to a skilled/long-term care facility was highest for pelvic fracture (65%), hip fracture (62%), and femur fracture (60%), and was notably high (53%) among fracture patients who were admitted to hospital from non-healthcare facilities (who account for 74% of all fracture patients), especially among hip fracture patients (61%) and femoral fracture patients (60%). Readmission within 60 days with evidence of fracture was 2.3% on an overall basis, and was highest for vertebral fracture (5.7%); 7% of all fracture patients were admitted to the ICU.

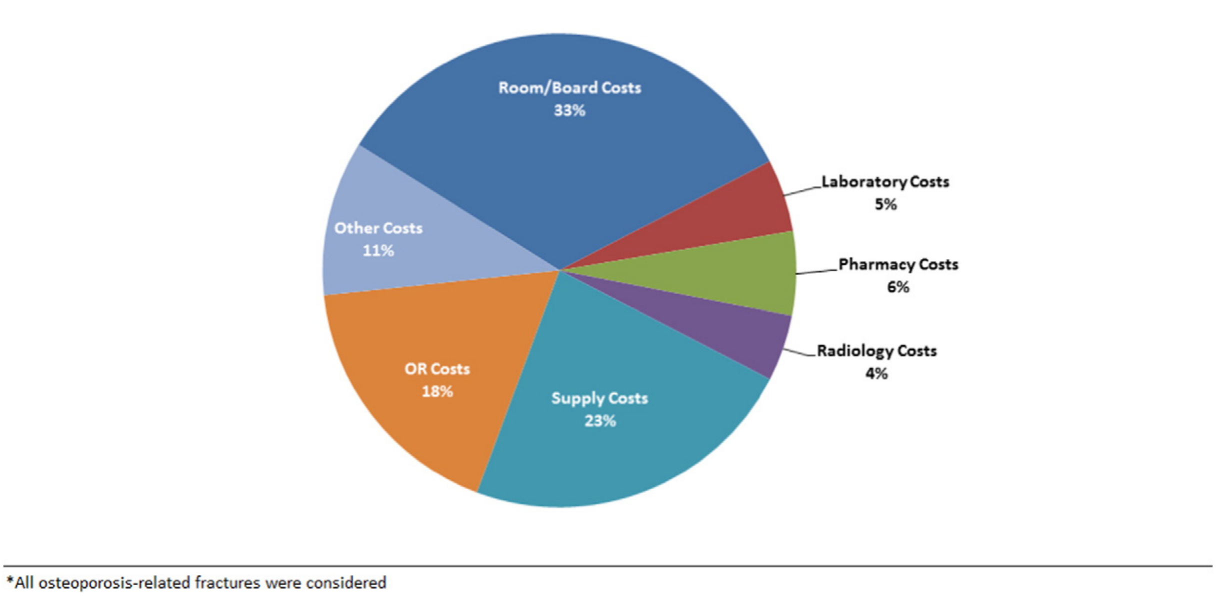

Fig. 3. Distribution of total hospital costs for treatment of osteoporosis-related fracture, by component of care.*

4. Discussion

Using the discharge records on over 250,000 patients from over 500 hospitals, we quantified levels of resource utilization, healthcare costs, and outcomes associated with OP-related fractures treated in the inpatient setting. Study results suggest that fractures treated in hospital are costly, averaging—across all fracture types—nearly $13,000 per patient, the large majority of which was attributable to room and board, supplies, and the OR. Hip fractures (50%) were, by far, the most common reason for hospital admission, and most of these patients (96%) had OR-related expenses. Femoral fractures (5%), while less frequent than hip fractures, had the highest mean total cost ($16,423), OR-related costs ($3091), and supply costs ($4406)—and the longest hospital stay (5.8 days). Among patients with vertebral fractures—the second most common reason for admission (14%)—mortality and ICU use were notably high, and costs and LOS were higher than among those with non-vertebral fractures (excluding hip).

The importance of these fractures extends well beyond the immediate short-term economic consequences. Hospitalization, immobility, receipt of anesthesia, and fluid replacement can exacerbate underlying conditions (e.g., cardiovascular disease) or cause new ones such as urinary or thrombotic complications in patients with hip fractures, and 90% of the study population had at least one comorbidity (46% had ≥3) (Carpintero et al., 2014). Fractures also can compound the overall pain and functional burden of patients, especially those with metabolic and other musculoskeletal conditions, and hip fractures—in particular—often lead to loss of muscle mass/strength during the operative and healing process and extended physical therapy (Visser et al., 2000). Associated functional impairment is a major reason for admission to skilled nursing facilities (Luppa et al., 2010). Along these lines, it is notable that in our study, while nearly 75% of all fracture patients were admitted from non-healthcare facilities, 53% were discharged to a skilled/long-term care facility and 14% were discharged to a rehabilitation facility.

While this study is the only recent evaluation to report hospital costs and outcomes associated with OP-related fractures treated in hospital by site of fracture and cost component, we note that our results are generally consistent with those from other published studies, notwithstanding differences in study design, study sample, duration of observation, and/or outcomes considered (Singer et al., 2015; Shauver et al., 2011; Christensen et al., 2010; Pike et al., 2010; Shi et al., 2009; Bass et al., 2008; Kilgore et al., 2009; Sasser et al., 2005; Lad et al., 2007; Orsini et al., 2005; Russo et al., 2009; King et al., 2009). In the study by Singer and colleagues (Singer et al., 2015), for example, mean hospital LOS (in 2008–2011) and mean hospital cost (2011US$) for hip fracture were reported to be ~6 days (vs. 5.6 days in our study) and ~$15,000 (vs. $14,744 in our study), respectively; comparable estimates also were reported for vertebral fracture (LOS: ~5.5 vs. 5.4; cost: ~$12,500 vs. $11,681), femoral fracture (LOS: ~6 vs. 5.8; cost: ~$17,500 vs. $16,423), as well as other fractures. In the study by Russo et al. (Russo et al., 2009), mean hospital LOS and mean hospital cost for hip fracture in 2006 were reported to be 5.7 days and $12,100, while in the study by King and colleagues (King et al., 2009), estimates of mean hospital LOS were similar (hip, 6 days; vertebral, ~5 days; wrist, ~3 days; and pelvic, ~5 days). A summary of methods employed in prior research is provided in Table 4 of Online supplement.

A few limitations of this study are noteworthy. Because there is no specific diagnosis code for OP-related fractures, attention was limited to fractures that are more likely to be caused by OP based on whether the fracture was closed (vs. open) or pathologic in nature, whether the fracture was non-traumatic (vs. traumatic), whether the patient had no evidence of non-osteoporotic conditions associated with a pathologic fracture (e.g., malignancy), and age (≥50 years)—consistent with methods employed in other published studies. It is undoubtedly the case, however, that some OP-related fractures were missed while some non-OP-related fractures were erroneously included in analyses. A formal assessment of the accuracy of the algorithm for identifying OP-related fracture is beyond the scope of this study.

While the study database includes the principal diagnosis for each admission—which is identified at discharge as the principal reason the patient was admitted to hospital—it is possible that some patients who fractured while in hospital, and those who were admitted with fracture but for another reason, may have been (e.g., in error or for reasons of reimbursement) assigned a principal diagnosis of OP-related fracture and thus were erroneously included in the study population. Because the study database is left-truncated (i.e., hospitalizations before January 2010 are unobservable), and includes admissions only to Premier member hospitals, it is unknown whether the first observed hospitalization (i.e., the "index" admission) during the period of observation (i.e., March 2010 thru September 2013) for some patients occurred for the treatment of a new fracture, fracture of the same site as a previous one, or fracture of a different site. Moreover, because the study database includes data on admissions that occurred in member hospitals only, the percentage of patients re-admitted for fracture-related reasons following the index admission may be underestimated somewhat.

It is not possible to separate hospital costs attributable to the treatment of OP-related fracture versus other diseases/conditions that might be present at the time of hospitalization (or that develop while in hospital). Accordingly, fracture-related costs will undoubtedly include resources related to the treatment of other conditions and thus the total burden of fractures may be somewhat overestimated. Hospitalization costs represent the hospital's internal assessment of the actual cost to the hospital of delivering goods and services, and thus do not represent charged or reimbursed amounts. Because these internal assessments may not be completely standardized among member hospitals and are not reflective of cost structures in non-member hospitals, caution should be exercise in generalizing estimates of economic costs beyond Premier member hospitals.

Finally, the Premier Perspective Database contains data from about one in every five hospital discharges in the US, and has been found to be comparable with NHDS hospitals (a stratified random sample of all US acute-care, non-Federal hospitals) in terms of patient age, gender, length of stay, mortality, primary discharge diagnosis, and primary procedure groups. While some differences have been noted with respect to the characteristics of Premier member hospitals (vs. American Hospital Association [AHA] member hospitals), we believe patients (admissions) and clinical outcomes should be—roughly speaking—comparable to those in other US facilities.

5. Conclusion

The clinical and economic burden of fragility fractures is high when in-hospital treatment is required, especially among patients with fractures of the hip and femur. Even after hospital discharge, however, the downstream consequences may be substantial as a high proportion of patients require care in skilled nursing facilities or rehabilitation facilities. Accordingly, interventions that are effective in reducing fracture risk have the potential to yield substantial cost savings.

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Declaration of financial/other relationships

Rebecca Bornheimer and Derek Weycker are employed by PAI. Rich Barron and David Chandler are employed by Amgen Inc. Xiaoyan Li was employed by Amgen Inc. during the conduct of this study.

Authors' contributions

Authorship was designated based on the guidelines promulgated by the International Committee of Medical Journal Editors (2004). All persons who meet criteria for authorship are listed as authors on the title page. The contribution of each of these persons to this study is as follows: (1) conception and design (Li, Weycker), acquisition of data (Li, Weycker), analysis or interpretation of data (all authors); and (2) preparation of manuscript (Bornheimer, Weycker), critical review of manuscript (Barron, Chandler, Li).

The study sponsor reviewed the study research plan and study manuscript; data management, processing, and analyses were conducted by PAI, and all final analytic decisions were made by study investigators. All authors have read and approved the final version of the manuscript.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.bonr.2016.07.005.

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