Incidental Vertebral Fractures on Chest Radiographs

Recognition, Documentation, and Treatment

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BACKGROUND: Recognition of incidental vertebral fractures may be an important opportunity for identifying and treating osteoporosis.

OBJECTIVE: To assess osteoporosis documentation rates in patients with vertebral fractures, and to define patient and hospitalization characteristics associated with osteoporosis management.

DESIGN: Hospital and outpatient records were abstracted for patients with vertebral fractures on inpatient radiograph reports. The primary outcome of interest was discharge summary fracture documentation. Covariates associated with fracture documentation and treatment were examined with multivariate regression models. Secondary outcomes included osteoporosis documentation and management 6 months following discharge.

PATIENTS: Women ≥ 50 years hospitalized at an academic medical center.

RESULTS: Among 10,291 women with chest radiographs, 142 (1.4%) had vertebral fractures reported. Among patients with a reported fracture, 58 (41%) had their fracture noted in the findings section but not in the final impression. Only 23 (16%) discharge summaries documented a vertebral fracture. Factors associated with documentation of the fracture in the discharge summary included notation of the fracture in the impression section (odds ratio [OR] 3.7, 95% confidence interval [CI] 1.0 to 13.1), tobacco use (OR 3.7; 95% CI 1.1 to 12.2), discharge from a medical service (OR 7.6; 95% CI 0.9 to 66.2) and glucocorticoid use (OR 3.7; 95% CI 0.8 to 17.0). Only 36% of patients were using any osteoporosis medications at discharge. Fracture notation in the impression section was associated with fracture documentation in subsequent outpatient notes (OR 3.6, 95% CI 0.9 to 13.8). Discharge summary fracture documentation was associated with an increased likelihood of starting an osteoporosis medication by 6 months (OR 2.8; 95% CI 0.8 to 9.2).

CONCLUSIONS: Incidental vertebral fractures from inpatient chest radiographs may represent a missed opportunity for osteoporosis management.

KEY WORDS: diagnosis; osteoporosis; health service research; women's health; hospital medicine.

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It is estimated that there are more than 1.3 million osteoporotic fractures each year in the United States¹; the majority of all fractures in people older than 45 years of age are secondary to osteoporosis. These fractures have enormous health consequences, as a patient with a hip fracture may have a 1-year mortality as high as 20%.² In postmenopausal

women, a history of vertebral fracture is highly predictive of future vertebral and hip fractures,³⁻⁶ even independent of bone mineral density (BMD),^{5,7} and is associated with increased mortality.⁸ These fractures are highly prevalent,^{9,10} and help establish the diagnosis of "established or severe osteoporosis" by World Health Organization criteria.¹¹ Their recognition is critical since women with such fractures who receive medications in randomized controlled trials have the largest reduction in future fracture risk.^{12,13} Unfortunately, they are infrequently diagnosed in typical clinical practice.^{13,14}

Recent analyses of patients presenting to the emergency room¹⁵ as well as those admitted to the hospital¹⁶ showed that approximately 15% had vertebral fractures on lateral chest radiographs, yet radiologists reported only a small fraction. In addition, reporting vertebral fractures may not translate into higher rates of diagnosis or treatment. Physicians caring for patients may not be aware of the findings, particularly if the fracture was omitted from the final impression of the radiologist's report or if it was unrelated to the reason for admission. Findings may not be communicated to outpatient physicians, or treatment may be intentionally deferred until hospital discharge. It is also not known how often osteoporosis therapy may be stopped, intentionally or unintentionally, during an acute-care hospitalization.

We examined medical records, discharge summaries and prescriptions, and subsequent outpatient records of postmenopausal patients with incidental vertebral fractures reported on chest radiographs to assess how often these fractures are documented at discharge, and to define which patient and admission characteristics were associated with osteoporosis management.

METHODS

Study Design

Eligible patients were admitted to a large academic medical center in the northeast United States with 725 beds with an annual admission volume of approximately 34,000 patients. All female patients over the age of 50 admitted between June 30, 2000 and July 1, 2002 who had a lateral chest radiograph were identified by querying an electronic medical records database. These radiology reports were text-searched for the keywords "fracture," "compression," and "wedge," and "wedging." Identified reports were individually reviewed by 1 author (C.M.) to include only those studies with reference to vertebral body abnormalities rather than other fractures. We searched both the "findings" and "impression" sections of radiology reports.

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Patients with a malignancy as a primary diagnosis upon hospital discharge were excluded, as a vertebral fracture in this setting could not reliably be attributed to osteoporosis. Only radiographs obtained during a hospitalization were included in the analysis. When multiple reports identified a fracture during the same admission, only the first report was included.

A board-certified radiologist with expertise in spine and musculoskeletal radiology and familiar with published criteria for determining vertebral fractures¹⁷ re-interpreted a subset of 100 lateral radiographs, 50 from the study population with reported fractures and 50 selected from same initial cohort of hospitalized postmenopausal women without reported fractures. Inpatient medical records including admission notes and discharge summaries as well as any outpatient or emergency room records for the 6 months subsequent to hospital discharge were obtained. Outpatient records were limited to visits to providers affiliated with the medical center. Medications were identified from admission notes, discharge summaries, and outpatient visit notes and medication lists in the electronic medical record. The study was approved by the hospital's Institutional Review Board.

Outcomes

Our primary outcome was mention of the vertebral fracture in the hospital discharge summary. Secondary endpoints included the initiation and continuation of osteoporosis medications (calcium and vitamin D supplementation, alendronate, calcitonin, hormone replacement therapy [HRT], pamidronate, raloxifene and risedronate) at or within 6 months of hospital discharge. We also collected information on BMD testing within 6 months of hospital discharge.

Statistical Analysis

Patient and admission populations were characterized with descriptive statistics. We then calculated the prevalence of treatment with osteoporosis medications at discharge. We collected data on several patient characteristics, including age, race, discharge diagnoses, tobacco use, history of osteoporosis, and medications on admission. Other hospitalization characteristics included length of stay, admitting service, and where in the radiology report the fracture was mentioned. Agreement between original radiograph reading and re-interpretation was performed using κ statistic and interpreted according to Altman.¹⁸ Associations between potential predictors of care and the outcomes of interest were examined in unadjusted models using Fisher's exact test. All variables with $P \leq .2$ in unadjusted analyses (with at least 5 patients per cell to satisfy convergence criterion) as well as age and race were included in the multivariable logistic model. All analyses were performed in SAS (release 9.1, SAS Institute, Cary NC).

RESULTS

Among women 50 years of age or older, there were 22,139 admissions and 10,291 lateral chest radiographs performed. Only 173 patients had "compression" or "fracture" of vertebral body noted in the report. Fifty-nine additional patients were reported to have "wedging" or "wedge" vertebrae. Seventy-five patients had a diagnostic code for a malignancy and were excluded, for a total of 157 patients. Medical chart review excluded another 15 patients (4 with known malignancy, 4 who

had died during hospitalization, 3 with an admitting diagnosis of vertebral fracture, 2 with vertebral osteomyelitis, and 2 duplicate patients). The remaining 142 patients were the basis of the analysis.

There was good agreement between the official radiology reports and the re-interpretation performed by the board-certified radiologist ($\kappa=0.61$). However, among the subset of 50 radiographs from hospitalized postmenopausal women without a fracture noted in the report, the radiologist identified the presence of a vertebral fracture in 13 (26%).

The baseline characteristics of the 142 patients are presented in Table 1. The majority of the patients were white (79%) and were admitted to medical services (70%). Of the 142 chest radiograph reports, 58 (41%) had the fracture noted in the "findings" portion but not included in the "final impression" section.

Admission Medications

Thirteen admission notes were unavailable for review of admission medications. Review of the remaining 129 admission notes found 46 (36%) patients were taking any prescription or nonprescription medications for osteoporosis at time of admission (Tables 1 and 2). Calcium was the most common medication, either as monotherapy or in combination with vitamin D or with 1 or more prescription agents. Only 5 patients (4%) were taking calcium and vitamin D in addition to a prescription medication.

Discharge Summary Analysis

All patients had discharge summaries available for review. Of these, 23 (16%) patients had their vertebral fracture mentioned (Table 1). A total of 50 patients (36%) were discharged from the hospital on any osteoporosis medication, prescription or nonprescription (Table 2). Only 3 patients (2%) were discharged on calcium, vitamin D and a prescription medication. Among the 83 patients without documented osteoporosis medication use at admission, 11 (13%) were discharged on medications, most commonly calcium and vitamin D. Among the 46 patients admitted on any osteoporosis medication, 11 (24%) were not discharged on medications. Twenty-one of 142 (14%) of patients were discharged on oral glucocorticoids.

Outpatient Records After Hospitalization

Eighty-five of 142 patients had outpatient records in the electronic medical record; of these, 48 had single surgical subspecialty or emergency room visits and 38 patients had outpatient encounters at least once in the Internal Medicine, Rheumatology, or Endocrine clinics (Table 3). Patients seen in the Internal Medicine, Rheumatology, or Endocrine clinics had nearly twice the rate of osteoporosis medication use by 6 months (64% vs 36%).

Predictors of Care

In unadjusted analyses, discharge from a medical service, tobacco or oral glucocorticoid use, admission for a pulmonary diagnosis, use of an osteoporosis medication on admission and mention of fracture in the final impression of the radiology report were all associated with an increased likelihood of vertebral fracture notation in the discharge summary (Table 4).

Table 1. Characteristics of Patients with and Without Notation of Incidental Vertebral Fracture in Discharge Summary

Patient Characteristic	All Patients, n=142 (% total)	Patients with Fracture Noted in Discharge Summary (% total)	Patients Without Fracture Noted in Discharge Summary (% total)
Total	142	23 (16)	119 (84)
Age ≥ 75	102 (72)	13 (57)	89 (75)
White	112 (79)	17 (74)	95 (80)
History of osteoporosis*	31 (24)	5 (24)	26 (24)
Ever smoker†	40 (38)	12 (60)	28 (38)
Length of stay > 4 d	81 (57)	12 (58)	69 (52)
Admitting service			
Medicine	100 (70)	21 (91)	79 (66)
Orthopedic surgery	12 (8)	0 (0)	12 (10)
Other‡	30 (21)	2 (9)	28 (24)
Admitting diagnosis			
Cardiovascular	39 (27)	1 (4)	38 (32)
Pulmonary	17 (12)	6 (26)	11 (9)
Fractures, any type	10 (7)	0 (0)	10 (8)
Syncope/dizziness	28 (20)	5 (22)	23 (19)
Gastrointestinal	9 (6)	2 (9)	7 (6)
Genitourinary (including UTI)	7 (5)	1 (4)	6 (5)
Musculoskeletal, nonfracture	7 (5)	4 (17)	3 (3)
Other	25 (28)	4 (17)	21 (16)
Vertebral fracture mentioned in final impression of radiograph report	84 (59)	17 (74)	67 (56)
Any prescription medication or calcium or vitamin D*	46 (36)	10 (48)	36 (33)
Glucocorticoid use	21 (14)	7 (30)	14 (12)

*Out of 129 available admission notes.

†Out of 108 people; 26 admit notes failed to note smoking status.

‡General surgery, vascular surgery, gynecology, and neurology.

UTI, urinary tract infection.

When these factors were included in a multivariable logistic regression model along with age and race, 2 factors (tobacco use and fracture notation in the impression section of the report) were significantly associated with notation of the vertebral fracture in the discharge summary ($P < .05$). Two additional variables (glucocorticoid use, $P = .08$ and discharge from a medical service, $P = .06$) showed a trend toward significance.

In analysis of the secondary endpoints, only use of an osteoporosis medication at admission was associated with treatment at discharge (odds ratio [OR] 29; 95% confidence interval [CI] 8.9 to 93.0) in a multivariable logistic regression model.

Small sample sizes precluded multivariable logistic regressions for the other treatment endpoints. However, in unadjusted analyses, discharge from an orthopedic service (OR 5.1; 95% CI 1.1 to 22.5) and notation of the fracture in the impression section of the radiology report (OR 7.7, 95% CI 1.0 to 61.9) were associated with an increased likelihood of initiating any new osteoporosis medication at time of discharge. Among those patients not discharged on any osteoporosis medications, having the fracture mentioned in a discharge summary (OR 2.8; 95% CI 0.8 to 9.2) was associated with an increased likelihood of being on a drug by 6 months in univariate analyses. Fracture notation in the impression section was also as-

Table 2. Comparison of Use of Osteoporosis Medications from Admission to Discharge in Patients with Incidental Vertebral Fractures

Osteoporosis medication	Use at Admission, Number (%) (Total = 129)*	Use at discharge, Number (%) (Total = 142)
Any medication	46 (36%)	50 (36%)
Calcium†	28 (22%)	26 (18%)
Vitamin D	9 (7%)	11 (8%)
Bisphosphonate	20 (16%)	14 (10%)
HRT	13 (10%)	11 (8%)
Calcitonin	5 (4%)	7 (5%)
SERM	1 (1%)	3 (2%)
Any prescription medication and (calcium + vitamin D)	5 (4%)	3 (2%)

*Thirteen admission notes were unavailable for analysis.

†Calcium monotherapy or in combination with any of the other medications listed.

HRT, hormone replacement therapy; SERM, selective estrogen receptor modifier.

Table 3. Review of All Available Outpatient Electronic Medical Record Notes 6 Months After Discharge

Characteristic	Patients with Any Visit Data	Patients Seen in IM, Endocrine, or Rheumatology (% Total)	Other Visit* (% Total)
N	85	37 (44)	48 (56)
Index admission to IM service	61	27 (44)	33 (56)
Osteoporosis medication by 6 mo	36	23 (64)	13 (36)
Vertebral fracture in notes	15	7 (47)	9 (53)
BMD test mentioned	7	6 (86)	1 (14)
Vertebral fracture noted in discharge summary	14	8 (58)	7 (42)
Vertebral fracture noted in impression section of radiology report	49	17 (35)	32 (65)

*Other medical or surgical subspecialty or emergency department visit. IM, internal medicine; BMD, bone mineral density.

Table 4. Multivariable Regression Analysis: Characteristics Associated with Notation of Vertebral Fracture in The Discharge Summary

Patient Characteristic	Adjusted OR (95% CI)
Total	
Age ≥ 75	0.8 (0.2 to 2.6)
White	1.5 (0.4 to 6.6)
Ever smoker	3.7 (1.1 to 12.2) [†]
Admitting Service	
Medicine	7.6 (0.9 to 66.2)
Other*	Reference
Admitting diagnosis	
Pulmonary	0.7 (0.1 to 3.8)
Other	Reference
Vertebral fracture mentioned in final impression of radiograph report	3.7 (1.0 to 13.1) [†]
Any prescription medication or calcium or vitamin D	1.3 (0.4 to 3.9)
Glucocorticoid use	3.7 (0.8 to 17.0)

*General surgery, vascular surgery, gynecology, and neurology.

[†] $P < .05$.

OR, odds ratio; CI, confidence interval.

sociated with mention of the fracture in outpatient notes in the 6 months following hospital discharge (OR 3.6, 95% CI .9 to 13.8).

CONCLUSIONS

Our analysis demonstrates several trends in the care of patients with incidental vertebral fractures found on inpatient chest radiographs. Radiology reports documenting vertebral fractures mentioned these fractures in the impression section only 60% of the time. The fractures were rarely mentioned in discharge summaries. Only a third of patients were discharged from the hospital on any osteoporosis medications, and only 2% of patients were discharged on calcium, vitamin D, and an Food and Drug Administration (FDA)-approved prescription medication for osteoporosis, standard osteoporosis regimens proven in clinical trials to reduce future fractures.^{11,19} Surprisingly, therapy was stopped in as many patients as it was initiated. Notation of the fracture in the impression section of the radiology report was associated with an increased likelihood of both documentation of the fracture in the discharge summary and initiation of osteoporosis medications.

Our findings contribute to the existing literature on osteoporosis management in patients with vertebral fractures. A lack of documentation of vertebral fractures has also been found among hospitalized women, and 1 study reported a non-significant trend towards increased discharge summary documentation if the fracture was identified anywhere in the radiology report.¹⁵ Our repeat reading of a subset of chest radiographs suggested that a substantial number of vertebral fractures go unrecognized, at rates similar to those published elsewhere.^{15,20} Studies of patients after hip and other fragility fractures have shown very low rates of osteoporosis treatment, comparable to our findings.²¹ Our data suggest that a lack of awareness of the fracture among physicians providing direct patient care contributes to low documentation and treatment rates at discharge. Low treatment rates might be partially explained by an intentional deferral of treatment to the outpatient setting. Bed-bound patients may not be appropriate candidates for therapies such as bisphosphonates and there

is a theoretical risk that these drugs could interfere with bone remodeling if given immediately after a fracture. However, initiation of calcium and vitamin D is a must, and alternative therapies such as raloxifene or calcitonin were available during the study period. The lack of any mention of osteoporosis or fracture suggests that doctors were not even aware of this issue. Our findings that smokers are more likely to have fractures documented in discharge summaries may be explained by increased clinical attention to the chest radiograph findings relative to patients without a smoking history.

These data are subject to several limitations. Discharge notes may be insensitive for documentation of osteoporosis or fractures. However, the discharge summary is an important tool for communicating clinically relevant information to those not involved in the hospitalization, and may be used by a primary care physician to guide posthospitalization management. The percent of patients with reported vertebral fractures in our data set was less than previously established prevalent rates of vertebral fractures, though similar to more recent data. We included a mix of incident and prevalent fractures. While we could not determine the age of the fractures, the lack of a documented history of vertebral fracture in our population suggests that the majority of these fractures were clinically unrecognized. We also assumed that treatment of patients with vertebral fractures was appropriate care without an assessment of BMD, an approach supported by professional organizations.^{22,23} The low rate of BMD testing revealed in our chart review suggests it is unlikely physicians were deferring treatment for these assessments. Finally, our analysis of outpatient records was restricted only to those patients seeing providers affiliated with the same medical center; we were not able to comment upon the follow-up care of those patients who received posthospitalization outside this network.

This research identifies several potential targets for quality improvement. Radiologists should report vertebral compression fractures, particularly in the final impression, even if the fracture is not directly relevant to the study indication. In addition, documentation not only suffers from under-reporting but also lacks a standardized language, as fractures were variably described as "compressions," "fractures," or "wedging." Physicians need to be educated about the clinical significance of a fragility fracture in this patient population and the range of treatment options available, including newer therapies such as parathyroid hormone and intravenous bisphosphonates.^{24,25} In addition to educational interventions there are potential systems-level interventions that may improve patient care. Text-searching applications could be used to search radiology reports in an effort to identify and direct attention to vertebral fractures. Findings and impressions from radiology reports could be automatically abstracted into discharge summaries or to ensure transmission and communication of these findings to clinicians providing postdischarge care. Automated order entry systems could prevent admission medications from being omitted from discharge medications. Finally, the presence of a fragility fracture could trigger an automated prompt suggesting osteoporosis medications to the clinical team. Systems interventions such as these are important to test and implement to improve care in this at-risk population.

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