

Fragility Fractures and the Osteoporosis Care Gap: An International Phenomenon

L. Giangregorio, PhD,* A. Papaioannou, MD,FRCPC,[†] A. Cranney, MD,FRCPC,[‡] N. Zytaruk, RN,[§] and J.D. Adachi, MD, FRCPC[¶]

OBJECTIVES To describe practice patterns in the management of osteoporosis after fragility fracture.

METHODS Systematic review of articles in MEDLINE, EMBASE, Cochrane, and CINAHL databases (1996 to February 2005). Diagnostic outcomes included clinical osteoporosis diagnoses, laboratory tests, and bone density scans. Treatment outcomes included initiation of calcium, vitamin D, hormone replacement therapy, bisphosphonates, calcitonin, raloxifene and falls assessments.

RESULTS Thirty-five studies met our inclusion criteria and demonstrated that adults who experience fragility fracture are not receiving osteoporosis management. An osteoporosis diagnosis was reported in 1 to 45% of patients with fractures; laboratory tests were ordered for 1 to 49% and 1 to 32% of patients had bone density scans. Calcium/vitamin D and pharmacological therapy was reported in 2 to 62% and 1 to 65% of patients, respectively. Osteoporosis treatment was recommended more often in women than men, and more often in patients with vertebral fractures than in patients with nonvertebral fractures. Older patients were more likely to be diagnosed with osteoporosis, but treatment was more likely in younger patients. A history of prior fracture was reported in 7 to 67% of patients. Between 1 and 22% of patients had a subsequent fracture during follow-up periods of 6 months to 5 years. Falls assessments were not often reported; when they were, they were infrequently performed. A greater proportion of patients were diagnosed/treated during follow-up studies than in studies evaluating diagnosis/treatment on discharge from acute care.

CONCLUSIONS The majority of individuals who sustain fragility fractures are not receiving adequate osteoporosis management. Future research should address barriers to appropriate management and the efficacy of implementation strategies designed to close the osteoporosis care gap.

RELEVANCE This article is of particular importance to health care professionals who provide care for patients with fragility fracture.

Semin Arthritis Rheum 35:293-305 © 2006 Elsevier Inc. All rights reserved.

KEYWORDS osteoporosis, fracture, diagnosis, treatment

*Assistant Professor, Department of Kinesiology, University of Waterloo, Waterloo, Canada and Adjunct Scientist, Toronto Rehabilitation Institute, Toronto, Canada; and Adjunct Assistant Professor, Department of Kinesiology, McMaster University;

[†]Associate Professor, Department of Medicine, Hamilton Health Sciences–McMaster University, Hamilton, Canada;

[‡]Associate Professor, Department of Medicine, University of Ottawa, Ontario, Canada and Department of Clinical Epidemiology, Ottawa Health Research Institute, Ottawa, Canada;

[§]Clinical Research Coordinator, Department of Clinical Epidemiology and Biostatistics, McMaster University, Hamilton, Canada; and

[¶]Professor, Department of Medicine, St. Joseph's Healthcare–McMaster University, Hamilton, Canada.

Funding Sources: Grant-in-Aid from Merck Frosst.

Address reprint requests to: Dr. Lora Giangregorio, Department of Kinesiology, University of Waterloo, 200 University Avenue W., Waterloo, ON N2L3G1.

E-mail: lmgiangr@uwaterloo.ca

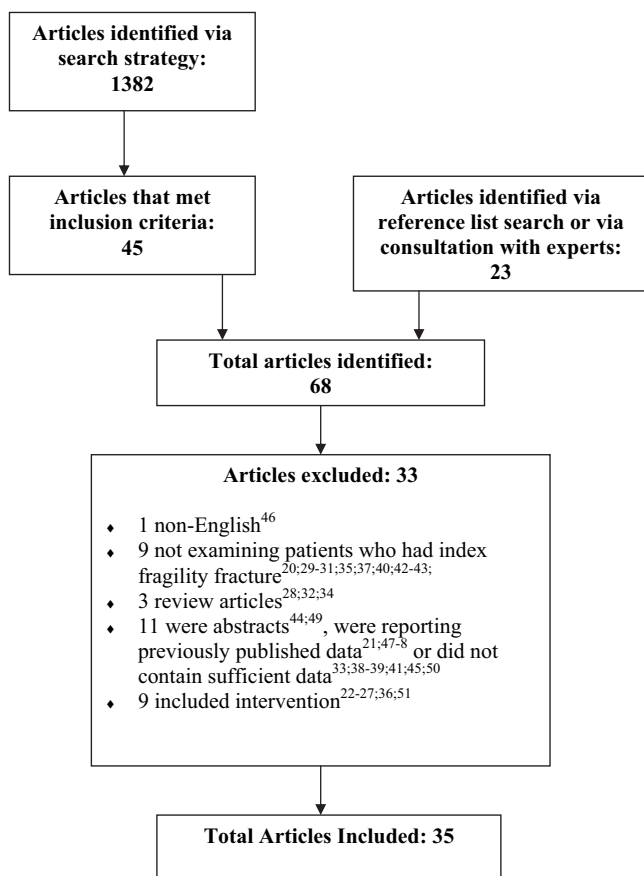


Figure 1 Flow chart of articles retrieved, included, and excluded.

Osteoporosis is a skeletal disorder characterized by compromised bone strength, predisposing a person to an increased risk of fracture (1). Bone mineral density (BMD) can be used to predict an individual's risk of an osteoporosis-related fracture. Although BMD is an important component of assessing fracture risk, other factors should also be considered, including prior fracture, age, family history of osteoporotic fracture, or long-term glucocorticoid therapy (2, 3). A history of fragility fracture after age 40 years is associated with a 1.5- to 9.5-fold increased risk of future fracture, depending on the patient's age and the number and site of prior fractures (4).

The number of hip fractures worldwide has been estimated to increase to 6.3 million in 2050 due to the aging population (5). The 1-year mortality rate after hip fracture is up to 25% (6). Approximately 50% of community-living individuals do not regain their prefracture level of mobility and become dependent on assistive devices post hip fracture (7). Vertebral fractures are associated with functional impairment, reduced quality of life, and increased mortality (8). Despite their high prevalence, only about 30% of vertebral fractures are diagnosed in clinical practice because a diagnosis depends on the patient seeking medical attention, the physician suspecting a fracture, and a report of pain that triggers the clinician to order a radiograph (8).

Therapeutic options can reduce the number of new vertebral compression fractures by 40 to 60% within the first year in individuals with a fracture (3). Calcium and vitamin D supplementation also have been shown to reduce hip frac-

tures in elderly women (9). Despite the availability of these therapies, recent research has suggested that osteoporosis management following fragility fracture is inadequate (10-19). It is unknown if falls assessment or interventions are being implemented in fracture patients. The purpose of this systematic review was to summarize the available literature regarding the osteoporosis care gap on an international scale and to address the following questions: (1) What is the prevalence of a prior fragility fracture among patients in studies of osteoporosis management after fracture? (2) What factors influence osteoporosis diagnosis and treatment rates? (3) What proportion of patients in these studies had subsequent fractures? (4) What proportion of patients received falls assessments? (5) Did the length of time postfracture that outcomes were assessed or the time period of patient observation influence diagnosis and treatment rates?

Methods

Study Search and Selection

A literature search was conducted in MEDLINE, EMBASE, Cochrane, and CINAHL databases, from 1996 until February 2005. The search strategy included the terms hip fracture [intertrochanteric, subtrochanteric, trochanteric, femoral neck], spinal fractures, vertebral fractures, wrist fractures, osteoporosis [diagnosis, prevention, and control; diet therapy; drug therapy; surgery; therapy], and secondary prevention. Additional articles were identified by consultation with experts and hand searching of bibliographic reference. Two reviewers examined results of the search for potentially relevant articles. For those that fulfilled the eligibility criteria, the full article texts were retrieved.

Inclusion Criteria

All primary studies including an evaluation of the diagnosis and/or treatment of osteoporosis in individuals aged 40 years and older after experiencing a fracture were retrieved. A physician's clinical diagnosis, radiographs, bone biochemical markers, and/or BMD were considered as diagnostic outcomes. Treatment outcomes included the initiation of calcium, vitamin D, multivitamins, hormone replacement therapy (HRT), bisphosphonates, calcitonin, selective estrogen receptor modulators (SERMs, raloxifene), and any nonpharmacological intervention (ie, falls risk assessment). Articles were excluded if they were non-English, if they did not include patients with fractures, if they did not include sufficient primary data, or if the article was evaluating an intervention to improve practice (Fig. 1) (20-51). Fragility fracture was defined as a fracture at sites typically associated with low bone density (ie, hip, pelvis, wrist, or spine). Several studies did not exclude, or failed to indicate if they excluded, patients who fractured due to trauma or malignancy. These studies were not excluded; however, the inclusion/exclusion criteria were recorded during abstraction (Table 1).

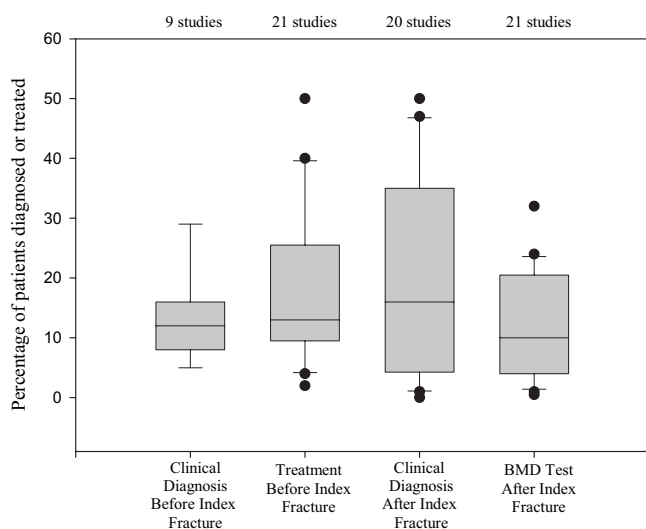


Figure 2 The range of percentages reported for the diagnosis and treatment of fracture patients before the index fracture, and diagnosis after fracture. The dots outside of any box plot represent outliers. The number of studies included in each box plot is indicated above the box plot. Treatment before index fracture may include drug intervention and/or calcium and vitamin D.

Abstraction of Data and Analysis

Two reviewers abstracted data from each study using a predeveloped piloted data abstraction form. Patient demographic data, any relevant clinical characteristics, and details on study design were abstracted. The number and percentage of patients diagnosed with or treated for osteoporosis/falls were recorded. Any discrepancies were resolved by consensus. We did not conduct a meta-analysis due to the heterogeneity in study design and reporting of results. Results are presented as percentages. The ranges for a number of outcomes are presented as box and whisker plots (Sigma Plot 9.0, Systat Software Inc., 2004). To evaluate whether there was a trend toward increasing use

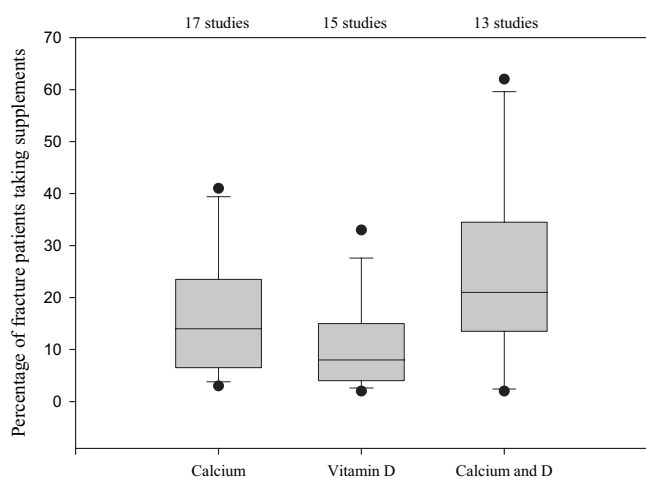


Figure 3 The range of percentage of patients reported to be taking calcium, vitamin D, or both after the index fracture. The dots outside of any box plot represent outliers. The number of studies included in each box plot is indicated above the box plot.

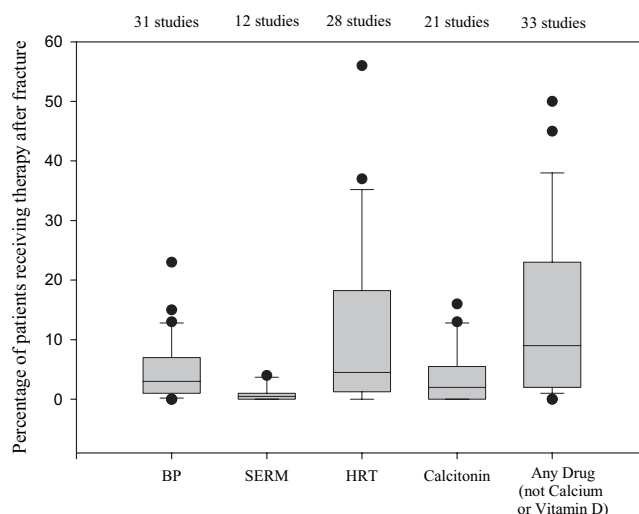


Figure 4 The range of percentages reported for patients receiving pharmaceutical intervention after fracture. BP = bisphosphonate, SERM = selective estrogen receptor modulator, HRT = hormone replacement therapy. The dots outside of any box plot represent outliers. The number of studies included in each box plot is indicated above the box plot.

of bisphosphonate or BMD testing with time, scatter plots were created by plotting the percentage of patients treated with bisphosphonate (or given a BMD test) in each study versus the last year of patient observation for that study. The last year of patient observation was chosen to represent the total time period in which observation of patient management occurred because this time period was variable among studies (from 1 to 10 years).

Results

Description of Studies

Thirty-five studies met the eligibility criteria (Fig. 1). Three distinct study types were identified (Table 1). Twelve studies investigated diagnosis/treatment outcomes at the time of hospital discharge only (52-63). Three of these studies are listed twice as they examined 2 distinct patient groups (53,54,59). Thirteen studies assessed diagnosis/treatment outcomes using an administrative database or from a chart review at a specified time after the fracture (64-76) and 7 studies assessed diagnosis/treatment outcomes via patient/physician interview at a specified time after the fracture (77-83). Three studies investigated outcomes both at discharge and by patient interview during a specified follow-up period (84-86).

Diagnosis and Treatment of Osteoporosis Before and After Fragility Fracture

Figure 2 depicts the extent to which fracture patients received a clinical diagnosis, osteoporosis-related diagnostic tests, or treatment before their index fracture or after their index fracture in the studies reviewed. A clinical diagnosis of osteoporosis was reported in less than 30% of patients

Table 1 Trial Characteristics

Trial (First Author, Year)	Population (n)/Sex	Index Fracture Site Ino. (%)	(Month/Year)
Andrade 2003	3492 F	Hip = 1572 (45) Vertebrae = 300 (9) Wrist = 1620 (46)	10/1994-09/1996
Bahl 2003	172 F 81M	Hip = 253 (100)	1995 and 2000
Bellantonio 2001	60 F	Hip = 60 (100)	1995
Briancon 2004	106 F	Wrist = 31 (29) Hip = 30 (28) Ankle = 20 (19) Other = 25 (24)	03/1999-05/2000
Castel 2001	ER: 147 F, 36 M Admitted: 87 F, 26 M	Wrist = 62 (34) Humerus = 48 (26) Ankle = 27(15) Hip = 13 (7)	One month each in 1998 and 1999
Colon-Emeric 2000	114 M	Hip = 114 (100)	01/1994-09/1998
Cuddihy 2002	303 F	Wrist = 303 (100)	1993-1997
Davidson 2001	174 F 50 M	Hip = 224 (100)	05/1998-04/1999
Feldstein 2003	3812 F 1750 excluded	Hip = 560 (15) Vertebrae = 526 (14) Wrist = 345 (9) Other = 2381 (63)	01/1998-06/2001
Feldstein 2003	2264 F 540 M	Hip = 490 (18) Vertebrae = 269 (10) Other = 2044 (73)	1998-1999
Follin 2003	75 F 43 M	Hip = 118 (100) Follow-up = 88 (75)	01/1993-12/1998
Freedman 2000	1162 F	Wrist = 1162 (100)	07/1994-06/1997

after fracture in the majority of studies. BMD scans were performed in less than 15% of patients in 15 of the 23 studies that reported BMD testing. Figure 3 depicts the percentages reported for patients taking calcium and vitamin D after fracture. More than half of the studies reported that 30% or less of fracture patients were taking calcium and vitamin D, and in a number of studies, much less. The extent to which pharmaceutical interventions were reported in the studies reviewed is depicted in Figure 4.

Prior History of Fractures and Subsequent Fractures

The proportion of patients who experienced fractures before the index fracture ranged from 7 to 67% (Table 2). Subsequent fractures during a follow-up period were reported in 10 studies (Table 2) and ranged from 1 to 22% during follow-up periods of 6 months to 5 years. In 1 study, patients with a history of fracture were more likely to have a documented osteoporosis diagnosis than those without a history (86). Another study reported

Table 1 Continued

Duration/Type Follow-Up Postfracture	Setting/Patients	Exclusion Criteria
1 year Review of pharmacy dispensing files	Patients from 7 HMOs, USA	Trauma and pathologic fractures, <60 yrs, male, benefits plan < 1 yr
Discharge data only Chart review	Medical center, USA	Not reported
11-25 months Patient survey	Patients returning to community living, USA	Male, discharged to nursing home, <65 yrs
3 months Physician survey	Community hospital, France	<50 years, male, trauma, fractures of skull, hands, feet, not first fracture
6 months Chart review	ER and admitted patients at a teaching hospital, Israel	Trauma and pathologic fractures, <50 yrs
Discharge data only Chart review	Medical center, USA	Trauma and pathologic fractures, female
1 year Database review	Population-based Olmsted County, Minnesota, USA	High-impact fractures, <45 yrs, male
1 year Patient survey	Community hospitals, New Zealand	Not reported
6 months Review of HMO Database	Non-profit HMO patients, USA	Face, digit, ankle, open fractures; 2nd fracture within 6 months; in other trials; <50 yrs; had pharmacy benefits; male
6 months Review of HMO database	Non-profit HMO patients, USA	Trauma, skull, face, digit, ankle, open fracture; noncontinuous Medicare
1 year Chart review discharge and follow-up	Teaching hospital, USA	Not reported
6 months Database review	Managed care database (claims database), USA	<55 yrs, noncontinuous Medicare, Medicare supplement

that patients with prior fragility fracture or subsequent fracture were not more likely to be receiving osteoporosis treatment than patients without prior or subsequent fracture (79).

Falls Assessments

Three studies indicated that falls risk assessments had been performed in 3, 63, and 19% of patients, respectively (69,73,84). Feldstein and coworkers reported that 39% of fracture patients studied were at risk for a fall (67). Rud and coworkers reported that hip protectors were recommended for 4% of patients (84).

Influence of Age on Practice Patterns

Patients with a clinical diagnosis of osteoporosis were significantly older than those who did not receive a diagnosis (81 ± 10 versus 74 ± 16 , 76 versus 68 years) (53,77). Interestingly, 1 study reported that the proportion of women with a diagnosis of osteoporosis after their fracture increased significantly with age, but the prevalence of BMD testing decreased with age (64). Although older patients were more likely to have a diagnosis, 4 studies revealed that younger patients were more likely to receive

Table 1 Continued

Trial (First Author, Year)	Population (n)/Sex	Index Fracture Site Ino. (%)	(Month/Year)
Gardner 2002	220 F 80 M	Hip = 300 (100)	1997-2000
Gehlbach 2000	138 F	Vertebrae = 138 (100)	10/1995-03/1997
Gunter 2003	658 F	Hip = 189 (29) Wrist = 226 (34) Vertebrae = (127) Rib = 116 (18)	01/1996-12/1998
Hajcsar 2000	96 F 12 M	Hip = 17 (7.5) Wrist = 165 (72) Vertebrae = 1 (0.4) Humerus = 45 (20)	2 weeks in 1996 2 weeks in 1997
Harrington 2002	414 F 88 M 565 excluded	Hip = 502 (100)	04/1997-12/1999
Juby 2002	Acute care: 224 F, 87 M Rehab: N = 205	Hip = 293 (100)	01/1997-01/1998
Kamel 2000	127 F 43 M	Hip = 170 (100)	01/1996-13/1998
Khan 2001	93 F 19 M 44 excluded	Wrist = 112 (100)	04/1997-03/1998, 01/1999
Kiebzak 2002	N = 168: 195 did not complete follow-up	Hip = 168 (100)	01/1996-12/2000
Kroth 2004	113 F	Vertebrae = 113 (100)	06/1992-05/2002
Miller 2001	121 F 62 M	Hip = 183 (100)	08/1998-06/1999
Neuner 2003	147 F 59 M	Vertebrae = 206 (100)	01/1997-12/1998

treatment for osteoporosis than older patients (67,68,70,75). Neuner and coworkers found that women less than 50 years or older than 90 years of age were less likely to be diagnosed with osteoporosis than women between those age groups (71), and Panneman and coworkers reported that patients between 65 and 84 years of age were more likely to receive treatment relative to patients 50 to 64 years of age (72). Another study reported that the

proportion of women who filled prescriptions decreased with age (64).

Influence of Gender on Practice Patterns

Two studies examined osteoporosis management in men exclusively, and in the other 20 studies men represented 10 to 36% of patients. Women were more likely than men to receive osteoporosis diagnoses and/or medication after fracture (54,59,69,72,75,85).

Table 1 Continued

Duration/Type Follow-Up Postfracture	Setting/Patients	Exclusion Criteria
Discharge data only Chart review	Database of 2 Medical centers and 1 hospital, USA	Low trauma fracture, <50 yrs, premenopausal
Discharge data only Chart review	Medical center: patients with radiographs, USA	Not reported
6 months Database review	Managed care organization, USA	<50 yrs, discontinuous enrollment for 6 months prior and 6 months postfracture, not member of commercial health plan
1 year Patient survey	Three fracture clinics in community hospitals, Canada	Trauma, conditions associated with bone loss, <18 yrs
Discharge data only Database review	Community, teaching hospitals (4), USA	Trauma, if receiving care at another site, <40-50 yrs (site- dependent)
Discharge data only Chart review	Acute care and rehab patients at one teaching hospital, Canada	<65 yrs
Discharge data only	Teaching hospital, USA	<65 yrs
6 months-3 years Patient survey	Teaching hospital, Canada	Trauma and compound fractures
1 to 5 years Discharge data and patient survey	Teaching hospital, USA	<50 yrs, trauma, pathologic, missing charts, no MD consent
Discharge data only	Teaching hospital, USA	<40 years, metastasis, no coding of vertebral fracture on radiograph, had less than 2 visits after radiograph
Discharge data only Chart review	Teaching hospital, Australia	Pathologic fracture, nonsurgical
Median follow-up 592 days, Chart review	Teaching hospital, USA	Trauma or pathologic fractures, not seen 2 yrs prior to x-ray, non-English, cognition <7/10

Other Factors Reported to Influence Practice Patterns

Individuals in residential care were less likely than individuals living at home to have a BMD test (5% versus 14%, $P < 0.05$) or be on osteoporosis treatment (5% versus 12%, $P <$

0.05) (80). Regarding fracture type, 4 studies revealed that patients with vertebral fractures were more likely to have received treatment than those with nonvertebral fractures (67,72,76,86). Fractures of the ankle were less likely to be reported as related to osteoporosis (77).

Table 1 Continued

Trial (First Author, Year)	Population (n)/Sex	Index Fracture Site Ino. (%)	(Month/Year)
Panneman 2004	1189 F 465 M 454 excluded	Hip = 751 (45) Vertebrae = 84 (5) Wrist = 61 (4) Other = 890 (54)	1998-2000
Papaioannou 2000	396 F 131 M 23 excluded	Hip = 527 (100)	04/1995-03/1996
Pro-Risque 2004	58 F 28 M	Head/Neck = 2 (2.9) Upper ext. = 49 (46) Lower ext. = 55 (52)	06/2000-10/2001
Riley 2002	41 M 12 excluded	Hip = 53 (100)	01/1993-07/1999
Rothberg 2000	Cases: 701 F Con: 1385 F	Wrist = 701 (100)	1995-1998
Rud 2005	147 F No follow-up for 13	Wrist = 147 (100)	05/2001-04/2002
Simonelli 2003	227 F	Hip = 160 (70) Vertebrae = 16 (7) Wrist = 12 (5) Humerus = 28 (12) Other = 11 (5)	06/1996-12/1997
Smith 2001	170 F 48 M	Hip = 91 (42) Wrist = 127 (58)	1998-2000
Solomon 2003	19075 F 2135 M	Hip = 11,835 (56) Wrist = 17,327 (82)	1995 and 2000
Torgerson 1998	300F	Hip = 100 (33) Wrist = 100 (33) Vertebrae = 100 (33)	1995
Ulahannan 1997	62 F	Hip = 37 (60) Wrist = 17 (27) Vertebrae = 1 (2)	12/1994-03/1995

F, female; M, male; HMO, Health Maintenance Organization;
ER, emergency room.

Influence of Time Postfracture or Time of Observation on Diagnosis and Treatment Rates

The proportion of patients given pharmacological therapy at discharge ranged from 1 to 15% (except Kroth and

coworkers, 50%, (52)), whereas when patients were evaluated during follow-up the range of patients treated was 3 to 65%. One study reported a significant increase in the number of patients who received osteoporosis treatment between discharge and follow-up (85). Figure 5 suggests

Table 1 Continued

Duration/Type Follow-Up Postfracture	Setting/Patients	Exclusion Criteria
1 year Database review	Population-based database: 25 regions in the Netherlands	MVA or external force injuries, <50 yrs, follow-up information available for 1 year
1 year Discharge data	4 Teaching hospitals, Canada	Treated in psychiatric facility, trauma, or pathologic fracture, <50 yrs, discharge outside Hamilton-Wentworth
6 months Patient interview	Medical center, USA	<51 years
6 months Chart review	Medical center, USA	High impact or traumatic fracture, <18 yrs, nonsurgical <50 yrs
Up to 3 years Database review	Managed care Database: South Africa	<50 yrs
6-18 months Chart review and follow-up with patient and/or physician	Teaching hospital, Denmark	<45 yrs, trauma, bone metastases, dementia, avulsion, death during follow-up
1 year Discharge data and patient survey	Community hospital, USA	High impact and pathologic fractures, premenopausal
Up to 2 years Patient survey	Teaching hospital, Australia	<40 or >85 yrs
6 months Database review	Pharmaceutical benefits database, USA	Enrolled in Medicare and benefits for 2 consecutive yrs.
1 year Database review	General practice research database, United Kingdom	Not reported
Discharge data only Chart review	Community hospital, United Kingdom	Traumatic fracture

that the percentage of patients treated with bisphosphonates may be increasing, but there are too few recent studies that reported bisphosphonate management to ascertain whether practice patterns are improving. Figure 6 demonstrates a similar pattern for the percentage of patients sent for BMD testing.

Discussion

The current systematic review provides evidence that individuals in the United Kingdom, New Zealand, Australia, South Africa, Israel, Denmark, France, Canada, the Netherlands, and the United States who experience fragility fracture

Table 2 Proportion of Patients with Fractures Prior and Subsequent to Index Fracture

Author (Ref.)	Number of Subjects (M = male, F = female)	% with Fracture Prior to Index	Duration of Follow-up Postfracture	% with Subsequent Fracture
Bellantonio (79)	60 F	33	11–25 months	22
Colon-Emeric (55)	114 F	17	No follow-up	—
Cuddihy (25,66)	303 F	33	Discharge data only	—
Follin (69)	88	67	12 months	13
Hajcsar (81)	108, 12 M, 96 F	40	12 months	3
Juby (59)	311, 87 M, 224 F	29	Discharge data only	1
Kamel (32,33,60)	170, 43 M, 127 F	11	Discharge data only	—
Khan (82)	112, 19 M, 93 F	39	6 months to 3 years	14
Kiebzak (13,85)	168	13	1 to 5 years	14
Neuner (71)	206, 59 M, 147 F	11	Median 592 days	—
Papaioannou (6,8,18,62)	527, 131 M, 396 F	—	12 months	10
Pro-Risque (78)	106, 37 M, 69 F	33	6 months	—
Riley (15,73)	41 M	32	6 months	10
Rothberg (74)	701 F	—	Up to 3 years	2
Rud (84)	112 F	28	6 to 18 months	—
Simonelli (86)	227 F	45	12 months	8
Smith (83)	218, 48 M, 170 F	38	Up to 2 years	—
Solomon (75)	21,192	49	6 months	—
Ulahannan (63)	2135 M, 19,075 F 62 F	7	Discharge data only	—

are not receiving adequate osteoporosis management. Many patients had a history of fracture or went on to experience subsequent fractures. The proportion of patients diagnosed or treated appeared to be greater in follow-up studies than in studies that evaluated outcomes at discharge. Also, several studies suggest that factors such as age and gender may influence whether a patient receives adequate osteoporosis management (67,68,70,75).

The prevalence of BMD measurements or physician follow-up among individuals experiencing a fragility fracture

was less than 50%, and in most cases, much less. At the time the studies were conducted, bisphosphonates and HRT were recommended therapies for the treatment of osteoporosis; however, only a small proportion of fragility fracture patients were prescribed these medications. One study reported that the only predictors of pharmacological intervention in fracture patients were the number of risk factors and the BMD test result (83). Similarly, it was reported that individuals with an osteoporosis diagnosis were more likely to receive treatment on discharge (53,59). A previous distal forearm fracture was reported to be the only significant predictor of

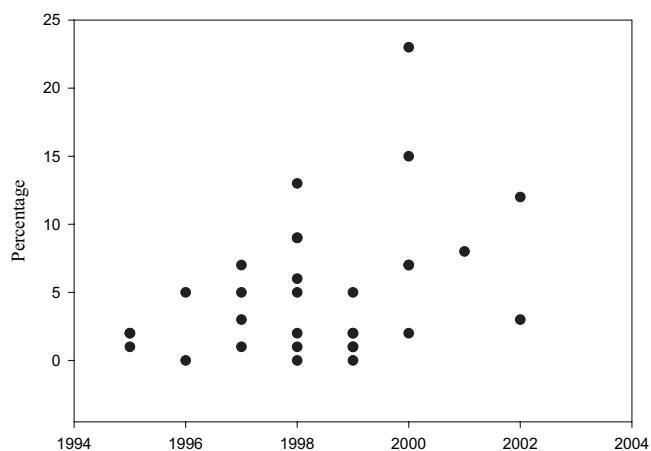


Figure 5 Percentage of patients reported to have been given bisphosphonate after fracture plotted against the LAST year of patient observation in each study. The duration of the time period in which patient management was observed in each study ranges from 1 year to several years. To be conservative, the percentage of patients treated with bisphosphonate was plotted against the last year of patient observation, independent of the duration of the observation period.

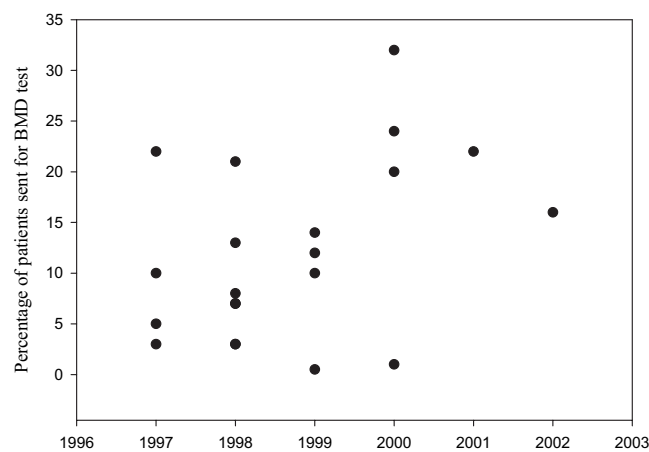


Figure 6 Percentage of patients reported to have had a bone density test after fracture plotted against the LAST year of patient observation in each study. The duration of the time period in which patient management was observed in each study ranges from 1 year to several years. To be conservative, the percentage of patients sent for a BMD test was plotted against the last year of patient observation, independent of the duration of the observation period.

receiving treatment recommendations; however, in this study 67% of women with a recurrent distal forearm fracture in that study did not receive treatment advice (66).

Supplemental calcium prescription was similarly low among the studies we reviewed. Vitamin D supplement prescription was low despite research indicating that many elderly individuals are deficient (25-hydroxyvitamin D levels <40 nmol/L) (87). Between October and March, vitamin D production is minimal in northwestern Europe, the northern United States, and Canada due to inadequate ultraviolet light (UV) exposure, so dietary and supplementary vitamin D becomes the primary source (87). Given the prevalence of vitamin D deficiency in the elderly, 800 IU of vitamin D in combination with calcium supplementation should be recommended to patients presenting with fragility fracture (3).

Osteoporosis management differs between genders; men were less likely than women to receive osteoporosis diagnosis or treatment after fracture (54,59,69,72,75,85). The fact that men may be overlooked with respect to osteoporosis care is disconcerting considering that, among studies that included both genders, men represented 10 to 36% of patients, and the mortality rate associated with hip fractures is higher in men than in women (88). A recent study demonstrated that fewer men than women are referred for bisphosphonate therapy, and men who *are* referred present with more severe osteoporosis, indicating that a gender bias is prevalent with respect to osteoporosis management (89).

Our findings are in accordance with another published review that identified the osteoporosis care gap (90). Our study differed in that we chose to explore additional key questions related to osteoporosis management after fracture, such as the influence of age and gender on practice patterns, the prevalence of prior fragility fractures, and whether falls risk assessments were reported. We did not include studies that have evaluated interventions aimed at improving osteoporosis management after fracture, and the current data suggest that there is a need for intervention (23,25,36,91).

Very few studies reported whether falls risk assessments were performed, despite its relevance in older individuals who fracture. Interventions that can prevent falls in elderly individuals have been described, but it is not known if they are effective for reducing fracture risk (92).

A few limitations of our study should be acknowledged. Several studies were excluded because they were non-English, were abstracts, or did not contain adequate data. Chart reviews and patient interviews were the main sources of data. Chart reviews may miss data that were not recorded and patient interviews rely on patient recall, which can be inaccurate. Many of the studies reviewed are several years old. Future research should evaluate whether practice patterns are improving, and whether interventions can address some of the barriers to appropriate care. In addition, future studies should report the percentage of patients who receive either BMD or osteoporosis drug.

Despite the availability of a number of therapeutic options, a gap exists between the occurrence of a fracture and the delivery of adequate osteoporosis management. Several factors may influence osteoporosis care in fracture patients, in-

cluding patient age and gender, having an osteoporosis diagnosis, and fracture type. The osteoporosis care gap needs to be addressed to reduce the burden of fractures. This issue requires evaluation of knowledge translation strategies in the form of an osteoporosis disease management model. Osteoporosis disease management needs to be integrated into standard postfracture care, such that individuals over 40 years of age who present with fragility fracture should trigger a process of osteoporosis diagnosis and treatment to reduce the risk of another fracture in the future.

Acknowledgments

This research was supported by a grant-in-aid provided by Merck Frosst. L. Giangregorio is the recipient of a Health Research Partnership Award from the Ontario March of Dimes and the Canadian Institutes of Health Research. A. Cranney holds a research salary award from the Canadian Institutes of Health Research.

References

1. Osteoporosis prevention, diagnosis and therapy. NIH consensus statements. 2000;17(1):1-45.
2. Physician's Guide to the Prevention and Treatment of Osteoporosis. National Osteoporosis Foundation. 2003. Washington D.C.
3. Brown JP, Josse RG. 2002 clinical practice guidelines for the diagnosis and management of osteoporosis in Canada. Canadian Medical Association Journal 2002;167:S1-34.
4. Klotzbuecher CM, Ross PD, Landsman PB, Abbott TA III, Berger M. Patients with prior fractures have an increased risk of future fractures: a summary of the literature and statistical synthesis. J Bone Miner Res 2000;15:721-39.
5. Cooper C, Campion G, Melton LJ III. Hip fractures in the elderly: a world-wide projection. Osteoporos Int 1992;2:285-9.
6. Papaioannou A, Wiktorowicz ME, Adachi JD, Goeree R, Papadimitropoulos E, Bedard M, et al. Mortality, independence in living and re-fracture, one year following hip fracture in Canadians. J Soc Obstet Gynaecol Can 2000;22:591-7.
7. Wiktorowicz ME, Goeree R, Papaioannou A, Adachi JD, Papadimitropoulos E. Economic implications of hip fracture: health service use, institutional care and cost in Canada. Osteoporos Int 2001;12:271-8.
8. Papaioannou A, Watts NB, Kendler DL, Yuen CK, Adachi JD, Ferko N. Diagnosis and management of vertebral fractures in elderly adults. Am J Med 2002;113:220-8.
9. Chapuy MC, Arlot ME, Duboeuf F, Brun J, Crouzet B, Arnaud S, et al. Vitamin D3 and calcium to prevent hip fractures in the elderly women. N Engl J Med 1992;327:1637-42.
10. Castel H, Bonneh DY, Sherf M, Liel Y. Awareness of osteoporosis and compliance with management guidelines in patients with newly diagnosed low-impact fractures. Osteoporos Int 2001;12:559-64.
11. Freedman KB, Kaplan FS, Bilker WB, Strom BL, Lowe RA. Treatment of osteoporosis: are physicians missing an opportunity? J Bone Joint Surg Am 2000;82-A:1063-70.
12. Gardner MJ, Flik KR, Moar P, Lane JM. Improvement in the under-treatment of osteoporosis following hip fracture. J Bone Joint Surg Am 2002;84-A:1342-8.
13. Kiebzak GM, Beinart GA, Perser K, Ambrose CG, Siff SJ, Heggeness MH. Undertreatment of osteoporosis in men with hip fracture. Arch Intern Med 2002;162:2217-22.
14. Onder G, Pedone C, Gambassi G, Landi F, Cesari M, Bernabei R. Treatment of osteoporosis among older adults discharged from hospital in Italy. Eur J Clin Pharmacol 2001;57:599-604.
15. Riley RL, Carnes ML, Gudmundsson A, Elliott ME. Outcomes and secondary prevention strategies for male hip fractures. Ann Pharmacother 2002;36:17-23.

16. Simonelli C, Chen YT, Morancey J, Lewis AF, Abbott TA. Evaluation and management of osteoporosis following hospitalization for low-impact fracture. *J Gen Intern Med* 2003;18:17-22.
17. Torgerson DJ, Dolan P. Prescribing by general practitioners after an osteoporotic fracture. *Ann Rheum Dis* 1998;57:378-9.
18. Papaioannou A, Giangregorio L, Kvern B, Boulos P, Ioannidis G, Adachi JD. The osteoporosis care gap in Canada. *BMC Musculoskelet Disord* 2004;5:11.
19. Siris ES, Bilezikian JP, Rubin MR, Black DM, Bockman RS, Bone HG, et al. Pins and plaster aren't enough: a call for the evaluation and treatment of patients with osteoporotic fractures. *J Clin Endocrinol Metab* 2003;88:3482-6.
20. Al-Allaf AW, Pal B, Reid N. An audit of post fracture rehabilitation with special emphasis on osteoporosis assessment and treatment. *Clin Exp Rheumatol* 1998;16:451-3.
21. Broy SB, Bohren A, Harrington T, Licata A, Shewman D. Are physicians treating osteoporosis after hip fracture? *J Bone Miner Res* 2000;15: S141.
22. Charalambous CP, Kumar S, Tryfonides M, Rajkumar P, Hirst P. Management of osteoporosis in an orthopaedic department: audit improves practice. *Int J Clin Pract* 2002;56:620-1.
23. Chevalley T, Hoffmeyer P, Bonjour JP, Rizzoli R. An osteoporosis clinical pathway for the medical management of patients with low-trauma fracture. *Osteoporos Int* 2002;13:450-5.
24. Content G, Hajela V, Lucas B. Osteoporosis screening and education following distal radial fracture: an expanding role for fracture clinic nurses. *J Orthopaed Nurs* 2003;7:137-40.
25. Cuddihy MT, Amadio PC, Gabriel SE, Pankratz VS, Kurland RL, Melton LJ III. A prospective clinical practice intervention to improve osteoporosis management following distal forearm fracture. *Osteoporos Int* 2004;15:695-700.
26. Curry LC, Hogstel MO. Osteoporosis: education and awareness can make a difference. *AJN Am J Nurs* 2002;102:26-33.
27. Diamond T, Lindenberg M. Osteoporosis detection in the community. Are patients adequately managed? *Aust Fam Physician* 2002;31:751-2.
28. Elliot-Gibson V, Bogoch ER, Jamal SA, Beaton DE. Practice patterns in the diagnosis and treatment of osteoporosis after a fragility fracture: a systematic review. [Review] [55 refs]. *Osteoporos Int* 2004;15(10): 767-78.
29. Fitzsimmons A, Bonner F, Lindsay R. Failure to diagnose osteoporosis. *Am J Phys Med Rehabil* 1995;74:240-2.
30. Gallagher TC, Geling O, Comite F. Missed opportunities for prevention of osteoporotic fracture. *Arch Intern Med* 2002;162:450-6.
31. Gehlbach SH, Fournier M, Bigelow C. Recognition of osteoporosis by primary care physicians. *Am J Public Health* 2002;92:271-3.
32. Kamel HK, Duthie EH. The underuse of therapy in the secondary prevention of hip fractures. *Drugs Aging* 2002;19(1):1-10.
33. Kamel HK, Bida A, Montagnini M. Secondary prevention of hip fractures in veterans: can we do better? *J Am Geriatr Soc* 2004;52(4):647-8.
34. Kaufman JD, Bolander ME, Bunta AD, Edwards BJ, Fitzpatrick LA, Simonelli C. Barriers and solutions to osteoporosis care in patients with a hip fracture. *J Bone Joint Surg Am* 2003;85A:1837-43.
35. Kim N, Rowe BH, Raymond G, Jen H, Colman I, Jackson SA, et al. Underreporting of vertebral fractures on routine chest radiography. *AJR Am J Roentgenol* 2004;182(2):297-300.
36. Majumdar SR, Rowe BH, Folk D, Johnson JA, Holroyd BH, Morrish DW, et al. A controlled trial to increase detection and treatment of osteoporosis in older patients with a wrist fracture. [see comment]. *Ann Intern Med* 2004;141(5):366-73.
37. Masud T, Jordan D, Hosking DJ. Distal forearm fracture history in an older community-dwelling population: the Nottingham Community Osteoporosis (NOCOS) study. *Age Ageing* 2001;30:255-8.
38. Mazanec D. Osteoporosis screening: time to take responsibility. [comment]. *Arch Intern Med* 2004;164(10):1047-8.
39. Ohldin A, Floyd J. Unrecognized risks among Veterans with hip fractures: opportunities for improvements. *J South Orthop Assoc* 2003;12: 18-22.
40. Onder G, Pedone C, Gambassi G, Landi F, Cesari M, Bernabei R. Treatment of osteoporosis among older adults discharged from hospital in Italy. *Eur J Clin Pharmacol* 2001;57:599-604.
41. Pal B. Questionnaire survey of advice given to patients with fractures. *BMJ* 1999;318:500-1.
42. Port L, Center J, Briffa NK, Nguyen T, Cumming R, Eisman J. Osteoporotic fracture: missed opportunity for intervention. *Osteoporos Int* 2003;14:780-4.
43. Sahota O, Worley A, Hosking DJ. An audit of current clinical practice in the management of osteoporosis in Nottingham. *J Public Health Med* 2000;22:466-72.
44. Suarez-Almazor ME, de Geus C, Ilomaki J, Russell AS. Failure to assess or manage osteoporosis (OP) following a hip fracture (HF). *Arthritis Rheumat* 2000;43:S203.
45. Tuck SP, Raj N, Summers GD. Is distal forearm fracture in men due to osteoporosis? *Osteoporos Int* 2002;13:630-6.
46. Wiboe L, Jacobsen IB, Mogensen CB. Osteoporosis prevention in general practice after hospitalisation for hip fracture. *Ugeskrift Laeger* 2002;164:2610-3.
47. Wilkinson TJ, Sainsbury R, Gilchrist NL. Osteoporosis follow-up after fracture. *Arch Intern Med* 2001;161:2633.
48. Wilkinson TJ, Sainsbury R, Gilchrist NL. How well are community-living people treated for osteoporosis after hip fracture? *J Am Geriatr Soc* 2002;50:1914.
49. Zang MD, Calkins BM, Schneyer CR. Laboratory evaluation and pharmacologic treatment of hip fracture patients: a retrospective study. *J Bone Miner Res* 1999;16:S405.
50. Zochling JM, Schwarz JM, March L, Sambrook PN. Is osteoporosis undertreated after minimal trauma fracture? *Med J Aust* 2001;174: 663-4.
51. Ashe M, Guy P, Kruse K, Hughes K, O'Brien P, Janssen P, et al. Wrist-wrist-distal radial fracture as a marker for osteoporosis investigation. *J Hand Ther* 2005;17:324-8.
52. Kroth PJ, Murray MD, McDonald CJ. Undertreatment of osteoporosis in women, based on detection of vertebral compression fractures on chest radiography. *Am J Geriatr Pharmacother* 2004;2(2):112-8.
53. Bahl S, Coates PS, Greenspan SL. The management of osteoporosis following hip fracture: have we improved our care? *Osteoporos Int* 2003;14:884-8.
54. Castel H, Bonneh DY, Sherf J, Liel Y. Awareness of osteoporosis and compliance with management guidelines in patients with newly diagnosed low-impact fractures. *Osteoporos Int* 2001;12:559-64.
55. Colon-Emeric C, Yballe L, Sloane R, Pieper CF, Lyles KW. Expert physician recommendations and current practice patterns for evaluating and treating men with osteoporotic hip fracture. *J Am Geriatr Soc* 2000;48:1261-3.
56. Gardner MJ, Flik KR, Moor P, Lane JM. Improvement in the undertreatment of osteoporosis following hip fracture. *J Bone Joint Surg* 2002;84A:1342-8.
57. Gehlbach SH, Bigelow C, Heimisdottir M, May S, Walker M, Kirkwood JR. Recognition of vertebral fracture in a clinical setting. *Osteoporos Int* 2000;11:577-82.
58. Harrington JT, Broy SB, Derosa AM, Licata AA, Shewmon DA. Hip fracture patients are not treated for osteoporosis: a call to action. *Arthritis Rheumat* 2002;47:651-4.
59. Juby AB, De Geus-Wenceslau CM. Evaluation of osteoporosis treatment in seniors after hip fracture. *Osteoporos Int* 2002;13:205-10.
60. Kamel HK, Hussain MS, Tariq S, Perry HMI, Morley JE. Failure to diagnose and treat osteoporosis in elderly patients hospitalized with hip fracture. *Am J Med* 2000;109:326-8.
61. Miller M, Crotty M, Whitehead C, Daniels L, Finucane P. Nutritional assessment and intervention in patients admitted with a femoral neck fracture: a chronicle of missed opportunities. *Aust J Nutr Diet* 2001; 58:86-91.
62. Papaioannou A, Wiktorowicz ME, Adachi JD, Goeree R, Papadimitropoulos E, Bedard M, et al. Mortality, independence in living and refracture one year following hip fracture in Canadians. *J Soc Obstet Gynaecol Can* 2000;22:591-7.
63. Ulahannan TJ, Lavelle LA. Is systematic osteoporosis prevention and

- detection possible in a district hospital? *J Clin Effectiveness* 1997;2:43-6.
64. Gunter MJ, Beaton SJ, Brenneman SK, Chen YT, Abbott TA III, Gleeson JM. Management of osteoporosis in women aged 50 and older with osteoporosis-related fractures in a managed care population. *Dis Manage* 2003;6(2):83-91.
 65. Andrade SE, Majumdar SR, Chan KA, Buist DS, Go AS, Goodman M, et al. Low frequency of treatment of osteoporosis among postmenopausal women following a fracture. *Arch Intern Med* 2003;163:2052-7.
 66. Cuddihy MT, Gabriel SE, Crowson CS, Atkinson EJ, Tabini C, O'Fallon WM, et al. Osteoporosis intervention following distal forearm fractures: a missed opportunity? *Arch Int Med* 2002;162:421-6.
 67. Feldstein AC, Nichols GA, Elmer PJ, Smith DH, Aickin M, Herson M. Older women with fractures: patients falling through the cracks of guidelines—recommended osteoporosis screening and treatment. *J Bone Joint Surg* 2003;85:2294-302.
 68. Feldstein A, Elmer PJ, Orwoll E, Herson M, Hillier T. Bone mineral density measurement and treatment for osteoporosis in older individuals with fractures: a gap in evidence-based practice guideline implementation. *Arch Intern Med* 2003;163:2165-72.
 69. Follin SL, Black JN, McDermott MT. Lack of diagnosis and treatment of osteoporosis in men and women after hip fracture. *Pharmacotherapy* 2003;23:190-8.
 70. Freedman KB, Kaplan FS, Bilker WB, Strom BL, Lowe RA. Treatment of osteoporosis: are physicians missing an opportunity? *J Bone Joint Surg* 2000;82A:1063.
 71. Neuner JM, Zimmer JK, Hamel MB. Diagnosis and treatment of osteoporosis in patients with vertebral compression fractures. *J Am Geriatr Soc* 2003;51:483-91.
 72. Panneman MJ, Lips P, Sen SS, Herings RM. Undertreatment with anti-osteoporotic drugs after hospitalization for fracture. *Osteoporos Int* 2004;15:120-4.
 73. Riley RL, Carnes ML, Gudmundsson A, Elliot ME. Outcomes and secondary prevention strategies for male hip fractures. *Ann Pharmacother* 2002;36:17-23.
 74. Rothberg AD, Matshidze PK. Perimenopausal wrist fracture—an opportunity for prevention and management of osteoporosis. *S Afr Med J* 2000;90:1121-4.
 75. Solomon DH, Finkelstein JS, Katz JN, Mogun H, Avorn J. Underuse of osteoporosis medications in elderly patients with fractures. *Am J Med* 2003;115:398-400.
 76. Torgerson DJ, Dolan P. Prescribing by general practitioners after an osteoporotic fracture. *Ann Rheum Dis* 1998;57:378-9.
 77. Briancon D, de Gaudemar JB, Forestier R. Management of osteoporosis in women with peripheral osteoporotic fractures after 50 years of age: a study of practices. *Joint Bone Spine Rev Rhumatis* 2004;71:128-30.
 78. Pro-Risque A, Harris SS, Song L, Rudicel S, Barnewolt B, Dawson-Hughes B. Calcium supplement and osteoporosis medication use in women and men with recent fractures. *Osteoporos Int* 2004;15:689-94.
 79. Bellantonio S, Fortinsky R, Prestwood K. How well are community-living women treated for osteoporosis after hip fracture? *Geriatr Soc* 2001;49:1197-204.
 80. Davidson CW, Merrilees MJ, Wilkinson TJ, McKie JS, Gilchrist NL. Hip fracture mortality and morbidity—can we do better? *NZ Med J* 2001;114:329-32.
 81. Hajcsar EE, Hawker G, Bogoch ER. Investigation and treatment of osteoporosis in patients with fragility fractures. *Can Med Assoc J* 2000;163:819-22.
 82. Khan SA, de Geus C, Holroyd B, Russell AS. Osteoporosis follow-up after wrist fractures following minor trauma. *Arch Intern Med* 2001;161:1309-12.
 83. Smith MD, Ross W, Ahern MJ. Missing a therapeutic window of opportunity: an audit of patient attending a tertiary teaching hospital with potentially osteoporotic hip and wrist fractures. *J Rheumatol* 2001;28:2504-8.
 84. Rud B, Greibe R, Hyldstrup L, Sorensen HA. Does a distal forearm fracture lead to evaluation for osteoporosis? A retrospective cohort study in 147 Danish women. *J Clin Densitom* 2005;8:18-24.
 85. Kiebzak GM, Beinart GA, Perser K, Ambrose CG, Siff SJ, Heggeness MH. Undertreatment of osteoporosis in men with hip fracture. *Arch Intern Med* 2002;162:2217-22.
 86. Simonelli C, Chen YT, Morancey J, Lewis AF, Abbott TAI. Evaluation and management of osteoporosis following hospitalization for low-impact fracture. *J Gen Intern Med* 2003;18:17-22.
 87. Lips P. Vitamin D deficiency and secondary hyperparathyroidism in the elderly: consequences for bone loss and fractures and therapeutic implications. *Endocr Rev* 2001;22:477-501.
 88. Center JR, Nguyen TV, Schneider D, Sambrook PN, Eisman JA. Mortality after all major types of osteoporotic fracture in men and women: an observational study. *Lancet* 1999;353:878-82.
 89. Sawka AM, Adachi JD, Papaioannou A, Thabane L, Ioannidis G, Davison KS, et al. Are there differences between men and women prescribed bisphosphonate therapy in Canadian subspecialty osteoporosis practices? *J Rheumatol* 2004;31:1993-5.
 90. Elliot-Gibson V, Bogoch ER, Jamal SA, Beaton DE. Practice patterns in the diagnosis and treatment of osteoporosis after a fragility fracture: a systematic review. *Osteoporos Int* 2004;15:767-78.
 91. Hawker G, Rideout R, Ricupero M, Jaglal S, Bogoch E. The impact of a simple fracture clinic intervention in improving the diagnosis and treatment of osteoporosis in fragility fracture patients. *Osteoporos Int* 2003;14:171-8.
 92. Gillespie LD, Gillespie WJ, Robertson MC, Lamb SE, Cumming RG, Rowe BH. Interventions for preventing falls in elderly people. *Cochrane Database Syst Rev* 2003;CD000340.