A commentary by Paul A. Anderson, MD, is linked to the online version of this article at jbjs.org.

Pelvic Fragility Fractures

An Opportunity to Improve the Undertreatment of Osteoporosis

Christian T. Smith, MS, David W. Barton, MD, Amit S. Piple, BS, and Jonathan J. Carmouche, MD

Investigation performed at the Virginia Tech Carilion School of Medicine, Roanoke, Virginia

Background: Osteoporosis is often undiagnosed until patients experience fragility fractures. Pelvic fractures are common but underappreciated sentinel fractures. Screening patients with a pelvic fracture for osteoporosis may provide an opportunity to initiate appropriate treatments such as anti-osteoporosis therapy to prevent additional fractures.

Methods: This retrospective cohort review examined the management of osteoporosis after pelvic fractures at a large tertiary care center without an established secondary fracture prevention program. Data were extracted from electronic medical records of all new patients with a pelvic fracture who were ≥50 years of age from this center and its affiliated community hospitals from 2008 to 2014. Outcome measures included the initiation of anti-osteoporosis therapy before the fracture, within the year following the fracture, >1 year following the fracture, or never and new osteoporotic fractures within 2 years after a pelvic fracture.

Results: From 2008 to 2014, 947 patients presented with pelvic fractures. Of these patients, 27.1% (257 patients) were taking anti-osteoporosis medications before the fracture. Four percent of treatment-naïve patients began anti-osteoporosis therapy within 1 year of fracture, with 1.2% (11 patients) starting after 1 year. Of the treatment-naïve patients, 92.3% (637 patients) were never prescribed anti-osteoporosis therapy. Treatment rates were consistent over time. Within 2 years, 41.0% (388 patients) developed fragility fractures at secondary sites: 12.0% (114 patients) experienced a hip fracture, and 16.4% (155 patients) experienced a vertebral fracture.

Conclusions: Osteoporosis screening and initiation of secondary fracture prevention after a pelvic fracture were inadequate in the study population. Of the patients in this study, 909 (96.0%) never underwent a dual x-ray absorptiometry (DXA) scan during the study period. Of the 690 treatment-naïve patients, 637 (92.3%) were never administered anti-osteoporosis medications. Within 2 years, 41.0% of all patients developed additional osteoporotic fractures. This study demonstrates an opportunity to improve bone health by screening for and treating osteoporosis in patients with a pelvic fragility fracture.

Level of Evidence: Prognostic Level IV. See Instructions for Authors for a complete description of levels of evidence.

Osteoporosis remains undertreated and causes substantial long-term morbidity, mortality, and health-care expenditure. Fifty percent of women and 20% of men will experience a fragility fracture[1]. Osteoporosis often goes undiagnosed and untreated until after fractures occur, sometimes in multiple locations. Vertebral, wrist, and hip fractures are traditionally recognized fragility fractures; however, 40% of fragility fractures occur at other sites. Pelvic fractures account for 7% of annual fragility fractures in the United States, the largest percentage of these other fractures[2]. Further, pelvic insufficiency fractures may be more directly associated with osteoporosis than traditional osteoporotic fractures. Morris et al.[3] found that 115 patients (93%) with pelvic fractures had a Singh index of ≤4, consistent with osteopenia or osteoporosis, compared with 67.9% of patients with femoral neck fractures in a separate study by Pogrund et al.[4]. Pelvic fractures are therefore an underappreciated sentinel fracture in the geriatric population.

Pelvic fracture is a heterogeneous fracture category that can occur from both high-energy and low-energy fracture

Disclosure: The authors indicated that no external funding was received for any aspect of this work. The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (http://links.lww.com/JBJS/G219).

mechanisms. Although more attention has been devoted to studying high-energy unstable pelvic ring injuries in young patients, 64% of pelvic fractures are low-energy and osteoporotic in nature. In patients who were >60 years of age, 94% of pelvic fractures were low-energy[5]. The incidence of pelvic insufficiency fractures is increasing alongside the increasing age of the population[6]. Projections by Burge et al. have predicted an overall increase in osteoporotic fracture incidence in the United States by >48% (>3 million fractures) and an increase in associated costs from $209 billion from 2006 to 2015 to $228 billion from 2016 to 2025[2]. Among all osteoporotic fracture types, the largest increases have been predicted in pelvic fractures, with incidence increasing by 56% and costs rising by 60% between 2005 and 2025[2].

Given that any fragility fracture doubles the risk of experiencing future fragility fractures, osteoporosis screening in patients with a pelvic fracture provides an opportunity to intervene before additional fractures occur. Despite the success of programs to improve osteoporosis management after a fracture and secondary fracture prevention, the 2014 Medicare National Committee for Quality Assurance (NCQA) reported that, nationally, <30% of patients presenting with a fragility fracture were diagnosed with or were treated for osteoporosis. Further elucidation of the osteoporosis care gap following pelvic fractures is therefore warranted. In this study, we explore osteoporosis screening and treatment following pelvic fractures, which we believe to be an underappreciated fragility fracture type. We hope that this research might allow better recognition of osteoporosis in a previously missed subset of patients, thereby narrowing this care gap.

One element of this care gap that has been explored is the composition of the care team involved in the workup and management of osteoporosis following a fragility fracture. In a 2008 prospective randomized trial, Miki et al.[6] investigated the difference in the rates of early osteoporosis treatment after hip fracture between patients given the usual care, defined as osteoporosis education by their primary care physicians, and patients for whom an in-house assessment of osteoporosis was initiated by an orthopaedic surgeon (with follow-up treatment at a dedicated osteoporosis clinic). The study found that the percentage of these patients prescribed pharmacological therapy for osteoporosis at 6 months after the fracture was significantly higher when the evaluation was initiated by an orthopaedic surgeon and the patient was managed in an osteoporosis clinic (58%) compared with the usual referral to the primary care physician for osteoporosis management (29%)[6]. This highlights the importance of an active role by the orthopaedic service in managing osteoporosis after sentinel fractures.

Materials and Methods

This retrospective cohort review examined the management of osteoporosis after a pelvic fracture at a large tertiary care center with 6 affiliated community hospitals without a formal secondary fracture prevention program. Institutional review board approval was obtained. Data were retrospectively extracted from the electronic medical records of all patients presenting with a pelvic fracture to the emergency department at the age of ≥50 years. The resulting data set contained both inpatient and outpatient records for the entire health system over a 7-year period, including >1,000 physicians and a large majority of dual x-ray absorptiometry (DXA) scanners within a 2-hour radius.

Incident pelvic fractures were defined as any code from the International Classification of Diseases, Ninth Revision (ICD-9) beginning with 808. Only the first recorded pelvic fracture visit was counted as the incident pelvic fracture. Of note, the code contains pelvic ring and acetabular fractures, but not sacral fractures, which are commonly associated with pelvic fracture. Data were captured from July 2008 (the implementation of the current electronic medical record system) to September

Fig. 1

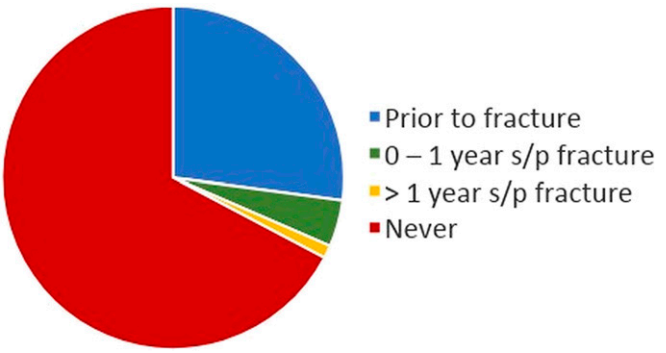

Fig. 2

Fig. 1 Incidence of DXA scanning ≤2 years prior to the fracture (2.3% [22 patients]), ≤1 year after the fracture (0.8% [8 patients]), >1 year after the fracture (0.8% [8 patients]), or never (96.0% [909 patients]). s/p = status post. **Fig. 2** The rate of pharmacotherapy with an FDA-approved medication for osteoporosis and the distribution of the documented start times of anti-osteoporosis pharmacotherapy using a medication approved by the FDA for osteoporosis relative to the incident pelvic fracture. Individuals were classified on the basis of whether they received their first documented treatment with an FDA-approved medication ≤2 years prior to the fracture (27.1% [257 patients]), ≤1 year after the fracture (4.4% [42 patients]), >1 year after the fracture (1.2% [11 patients]), or never (67.3% [637 patients]). s/p = status post.

2014, 2 years before the transition to the International Classification of Diseases, Tenth Revision (ICD-10), for simplicity.

Mechanisms of injury were examined by searching ICD-9 codes for injury mechanisms (i.e., gunshot wound, motor vehicle accident) and by examining other fractures coded in the same emergency department encounter[7].

The rates of DXA scanning were extracted from the system through medical record numbers (MRNs) to quantify osteoporosis screening (Fig. 1). Scans completed within 2 years before the incident fracture were included as potentially constituting a valid basis for initiating new treatment; scans completed within 1 year following the fracture were included as potentially constituting a valid basis for screening for osteoporosis after the pelvic fracture. The time between the DXA scan and the incident pelvic fracture was assessed.

Treatment rates were assessed via the rate of prescription of U.S. Food and Drug Administration (FDA)-approved osteoporosis medications including bisphosphonates, teriparatide, denosumab, raloxifene, and calcitonin. Abaloparatide and romosozumab were approved after the study period, and strontium ranelate has not been approved by the FDA. Prescription rates were analyzed within the mutually exclusive time periods of prior to the fracture, from the fracture to 1 year after the fracture, >1 year after the fracture, and never (Fig. 2, Table I). Individuals who had been previously prescribed any of these medications constituted the prior treatment group. Those without prior prescriptions were considered to be treatment-naïve. Delayed treatment was defined as the first anti-osteoporosis prescription occurring >1 year after the initial pelvic fracture. The calcium and vitamin D supplementation rate was assessed both before and after the fracture by comparing the initial prescription date with the date of the incident fracture (Fig. 3).

The number of patients prescribed particular classes of anti-osteoporosis medications was examined within the first 2 years after the fracture.

Patients were subdivided by the year of the incident pelvic fracture, and the rate of treatment initiation among treatment-naïve individuals was calculated. Simple logistic regression examining the treatment rate as a percentage by year without covariates was used to test for a trend in treatment rates over time. This was conducted as a 2-sided test using an alpha of 0.05 (Fig. 4).

TABLE I Frequency of Prescriptions of Various Anti-Osteoporosis Medications in the Study Population

Medication	No. of Patients Who Received Prescriptions*
Bisphosphonates	267
Calcitonin	74
Raloxifene	40
Denosumab	19
Teriparatide	5
Any	310

*Categories were not mutually exclusive; some individuals took >1 medication concurrently.

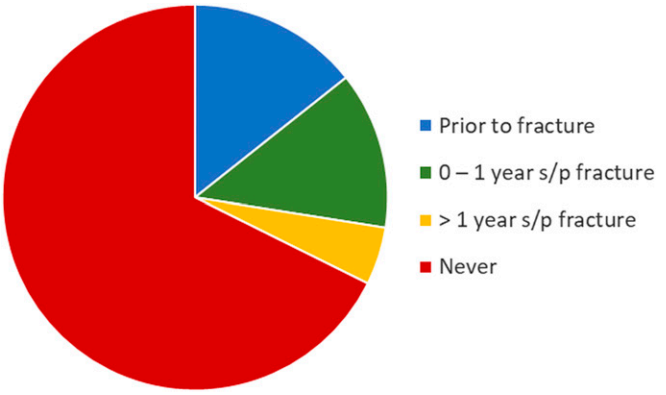

Fig. 3

The rate of calcium and vitamin D supplementation and the distribution of the documented start times of calcium and vitamin D supplementation relative to the incident pelvic fracture. Individuals were classified on the basis of whether they received their first documented treatment with calcium and vitamin D supplementation ≤2 years prior to the fracture, ≤1 year after the fracture, >1 year after the fracture, or never. s/p = status post.

The all-cause mortality rate was assessed using institutional electronic health records of patient deaths. Mortality rates were counted from the injury to 30 days after the fracture and from injury to 2 years after the fracture. These rates were not mutually exclusive.

Refracture rates within 2 years were assessed through new emergency department encounters for a vertebral fracture (ICD-9: 805 or 806), pelvic fracture (ICD-9: 808), hip fracture (ICD-9: 820), femoral fracture (ICD-9: 821), forearm fracture (ICD-9: 813), humeral fracture (ICD-9: 812), wrist fracture (ICD-9: 814), patellar fracture (ICD-9: 822), or ankle fracture (ICD-9: 824) within 730 days of the incident pelvic fracture (Table II). New visits for pelvic fractures (ICD-9: 808) within 90 days of the incident pelvic fracture were not included. Refracture categories were not mutually exclusive.

Statistical analysis was conducted in R version 3.3.2 (R Foundation for Statistical Computing).

Results

We identified 36,369 fractures between July 2008 and September 2014. ICD-9 codes for high-energy mechanisms of injury were reported for 58 patients, none of whom had pelvic fractures. No patients with a pelvic fracture had a code of ICD-9 928, a polytrauma code. We identified 947 unique individuals who were ≥50 years of age and had an incident pelvic fracture. The mean age (and standard deviation) at the time of the incident fracture was 77.1 ± 12.7 years. Of the study subjects, 77.1% (730 patients) were

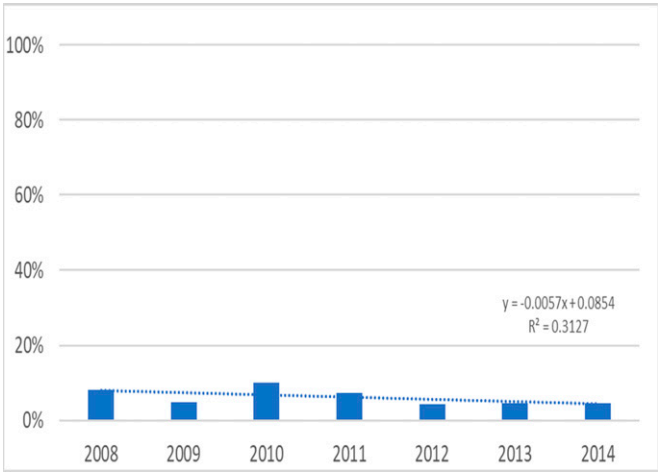

Fig. 4

The percentage of treatment-naïve patients each year with an initial pelvic fracture who received a prescription for a medication approved by the FDA for osteoporosis. Data were only available for parts of 2008 and 2014. The trend line was not significant (p = 0.21).

female and 22.9% (217 patients) were male. With regard to race, 95.0% (900 patients) were White, 4.0% were Black (38 patients), and <1% were Asian (2 patients), Hispanic (2 patients), other (3 patients), or unknown (2 patients). During the same visit as the incident pelvic fracture, 103 patients (10.9%) had ≥1 other fracture. Only 17 of 947 patients were documented as having a sacral fracture on the date of the pelvic fracture; however, over half (52.5% [707]) of the 1,346 total pelvic fractures in our database were of unspecified morphology (ICD-9 808.8 or 808.9).

Within 2 years prior to the incident fracture, 22 patients (2.3%) underwent DXA scanning (Fig. 1). Eight patients (0.8% of remaining patients) received scans in the year following the fracture. Eight patients (0.8% of previously unscanned patients) were scanned >1 year after the fracture. There were 909 patients (96.0%) who never received a DXA scan.

Prior to the pelvic fracture, 257 patients (27.1%) were prescribed FDA-approved anti-osteoporosis agents (Fig. 2). Of the 690 patients with no prior prescription, 42 (6.1%) received a prescription for an anti-osteoporosis medication within 1 year following the fracture. Of those with no prescription in the first year after the fracture, 11 (1.6%) received a prescription for an anti-osteoporosis agent between 1 and 2 years after the fracture. Of the 690 patients, 637 (92.3%) were never prescribed anti-osteoporosis therapy in the 2 years after the pelvic fracture. Table I shows the frequency of prescriptions of anti-osteoporosis medication classes.

There were 140 patients (14.8%) who were prescribed calcium and vitamin D supplementation prior to pelvic fracture (Fig. 3). Of those with no prior supplementation, 110 (13.6%) received prescriptions for calcium and vitamin D supplementation in the first year after the fracture. Of those with no supplementation in this period, 35 (5.0%) began supplementation between 1 and 2 years after the fracture. Within the study period, 662 patients (69.9%) never began supplementation.

Logistic regression of anti-osteoporosis treatment rates in treatment-naïve individuals in the year following the fracture over time found a nonsignificant decrease (p = 0.21) of 0.57% per year in the rate of treatment after the fracture (Fig. 4).

The all-cause mortality rate was 3.8% at 30 days and 9.0% at 2 years after the fracture.

Within 2 years, 41.0% (388) of the patients presenting with a pelvic fracture went on to develop a fragility fracture at a second site (Table II). Twelve percent developed a hip fracture, and 16.4% developed a vertebral fracture.

Discussion

Over the past several decades, several national and international campaigns have focused on raising awareness and encouraging treatment of osteoporosis after fracture. Notably, the Own the Bone program, started by the American Orthopaedic Association (AOA) in 2009, has led to the initiation of >260 fracture liaison service (FLS) programs in the United States. Despite these initiatives, our findings indicate the presence of a profound, persistent treatment gap in an academic health system without formal interventions to address osteoporosis after a fracture.

The rates of osteoporosis recognition and management after pelvic fractures at a large academic level-I trauma center and its 6 affiliated community hospitals were lower than expected considering the above-mentioned initiatives. More than 90% of patients with a pelvic fracture did not receive a DXA scan, and more than half of the patients (52.4%) received neither calcium and vitamin D supplementation nor treatment with FDA-approved anti-osteoporosis medications within the first year

TABLE II Refracture Counts at 2 Years After a Pelvic Fracture*

Fracture Type	Value†
Vertebral	155 (16.4%)
Hip	114 (12.0%)
Pelvic‡	58 (6.1%)
Radial or ulnar	52 (5.5%)
Humeral	44 (4.6%)
Ankle	15 (1.6%)
Femoral	24 (2.5%)
Patellar	4 (0.4%)

*This table shows the data on the incidence of new fractures within 2 years of an incident pelvic fracture by location; 466 fractures were observed in 388 of 947 patients. Categories were not mutually exclusive, as some individuals had >1 fracture. Fracture types that were not generally considered osteoporotic, such as carpal and rib fractures, were excluded. †The values are given as the number of patients who had an incident pelvic fracture, with the percentage in parentheses. ‡New pelvic fracture visits occurring within 90 days of the incident pelvic fracture were excluded as potentially relating to the original fracture rather than a new fracture.

after the fracture. These findings reflect a failure to recognize, diagnose, and treat osteoporosis in this population. Unfortunately, we believe that the low rates observed here are likely representative of many systems without an established FLS.

Per the World Health Organization's definition, the diagnosis of osteoporosis must be based on the results of a DXA scan. We found that, including both DXA scans within the 2 years before the fracture and those in the first year after the fracture, only 30 patients (3.2%) had scans useful for planning treatment. It is possible that clinicians believed that a DXA scan was not needed to make the diagnosis and this is why the DXA rates are so low. Unfortunately, even if the diagnosis was empirically made, appropriate treatment did not follow. The DXA scanning rate in this population suggests that 98% of patients presenting with a pelvic fracture did not receive an appropriate diagnosis of or a workup for osteoporosis.

During the study period, 662 patients (70.0%) with a pelvic fracture did not receive calcium and vitamin D supplementation. Vitamin D deficiency is quite prevalent in the United States[8]; ensuring adequate calcium and vitamin D intake through dietary modification and/or supplementation is often one of the first steps in osteoporosis management. We interpret the data on calcium and vitamin D supplementation with caution; these supplements may be omitted from patients' medication lists. Although calcium and vitamin D supplementation has a role in osteoporosis treatment in vitamin-D-deficient individuals, the low rate of supplementation observed in this group suggests that even the most conservative osteoporosis management measures are frequently missed in this population.

When treatment was broadly defined to include calcium and vitamin D supplementation or pharmacotherapy with an FDA-approved medication, 497 patients (52.5%) with an incident pelvic fracture were never treated. However, because calcium and vitamin D supplementation is only effective in individuals who are deficient in these nutrients, we believe that the best indicator of efficacious treatment is the rate of prescription of anti-osteoporosis agents. When only FDA-approved medications for osteoporosis were counted, 637 patients (67.3%) with a pelvic fracture never received treatment, and only 4.4% initiated treatment in the year following the pelvic fracture.

The trend in the treatment rate among treatment-naïve patients indicates that clinicians did not successfully correct the care gap after a fracture due to osteoporosis. Unfortunately, we believe that these results are representative of a majority of sophisticated health systems in the United States. This is discouraging, considering the increased public focus on bone health after a fracture during this time[9-12]. In the latter half of the President's National Bone and Joint Decade in the United States[12], several awareness campaigns were aimed specifically at improving recognition after a fracture and the management of osteoporosis[10-12]. Teriparatide, which was approved during this period, was shown in 2011 to accelerate healing and to improve functional outcomes in this specific fracture in the setting of osteoporosis[13]. However, our data did not demonstrate a corresponding improvement in treatment rates after a fracture. This trend has been noted in the literature and has been attributed to concerns over side effects of bisphosphonate therapy, such as atypical femoral fractures or osteonecrosis of the jaw[14,15]. However, the 41.0% rate of new fractures within 2 years in this undertreated population demonstrates the importance of promptly beginning osteoporosis treatment after fractures to limit subsequent fracture risk. Systematic interventions, such as FLS implementation, have been shown to improve the rate of treatment after a fracture and to reduce the risk of a future fracture[16,17].

These results are limited by the nature of the database utilized. The ICD-9 coding utilized did not allow the granular evaluation of specific pelvic fracture patterns or a robust assessment of high-energy compared with low-energy injuries.

Our data included providers from only a single healthcare system. Given that the study population is that of an academic medical center plus 6 affiliated community hospitals, we believe that this is a representative cross-section of health care in the United States. Additionally, given the nature of the system, we were not able to assess the loss to follow-up. This could conceivably have overestimated the number of patients who could have received treatment but did not. Out of concern for the possibility of incomplete data capture, the results of this study were discussed with local endocrinology, internal medicine, and family medicine practitioners, who concluded that these results accurately reflected local practice patterns. Anecdotal explanations include "not having time" to evaluate patients for osteoporosis or treat them, even after fractures. A formal survey of these providers is planned but has not yet been completed. Based on these data, global trends, and anecdotal evidence suggested above, an FLS was implemented in 2017. The preliminary results of implementation are encouraging, and further formal study is indicated.

In conclusion, this large cohort study demonstrated a persistent care gap in osteoporosis after a pelvic fracture in a large academic tertiary care institution without a secondary fracture prevention program. A low percentage of patients were appropriately diagnosed and treated, and, unfortunately, 41.0% experienced another fracture within 2 years. The treatment rates among previously untreated patients did not improve over time. This study demonstrated the opportunity that geriatric pelvic fractures present to improve bone health by increasing the osteoporosis diagnosis and treatment rates. These data further underscored the need for the implementation of a dedicated FLS. ■

Christian T. Smith, MS[1]
David W. Barton, MD[1]
Amit S. Piple, BS[1]
Jonathan J. Carmouche, MD[1]

[1]Department of Orthopaedic Surgery (J.J.C.), Virginia Tech Carilion School of Medicine (C.T.S., D.W.B., and A.S.P.), Roanoke, Virginia

Email address for C.T. Smith: ctsmith2@carilionclinic.org

ORCID iD for C.T. Smith: 0000-0001-8888-5824
ORCID iD for D.W. Barton: 0000-0002-1792-4942
ORCID iD for A.S. Piple: 0000-0001-7810-3075
ORCID iD for J.J. Carmouche: 0000-0002-3473-5203

References

1. Lippuner K, Johansson H, Kanis JA, Rizzoli R. Remaining lifetime and absolute 10-year probabilities of osteoporotic fracture in Swiss men and women. Osteoporos Int. 2009 Jul;20(7):1131-40. Epub 2008 Oct 31.

2. Burge R, Dawson-Hughes B, Solomon DH, Wong JB, King A, Tosteson A. Incidence and economic burden of osteoporosis-related fractures in the United States, 2005-2025. J Bone Miner Res. 2007 Mar;22(3):465-75.

3. Morris RO, Sonibare A, Green DJ, Masud T. Closed pelvic fractures: characteristics and outcomes in older patients admitted to medical and geriatric wards. Postgrad Med J. 2000 Oct;76(900):646-50.

4. Pogrund H, Rigal WM, Makin M, Robin G, Menczel J, Steinberg R. Determination of osteoporosis in patients with fractured femoral neck using the Singh index: a Jerusalem study. Clin Orthop Relat Res. 1981 May;156:189-95.

5. Kannus P, Parkkari J, Niemi S, Sievänen H. Low-trauma pelvic fractures in elderly Finns in 1970-2013. Calcif Tissue Int. 2015 Dec;97(6):577-80. Epub 2015 Aug 29.

6. Miki RA, Oetgen ME, Kirk J, Insogna KL, Lindskog DM. Orthopaedic management improves the rate of early osteoporosis treatment after hip fracture. A randomized clinical trial. J Bone Joint Surg Am. 2008 Nov;90(11):2346-53.

7. Barton DW, Behrend CJ, Carmouche JJ. Rates of osteoporosis screening and treatment following vertebral fracture. Spine J. 2019 Mar;19(3):411-7. Epub 2018 Aug 22.

8. Forrest KY, Stuhldreher WL. Prevalence and correlates of vitamin D deficiency in US adults. Nutr Res. 2011 Jan;31(1):48-54.

9. U.S. Department of Health and Human Services, Office of the Surgeon General. Bone health and osteoporosis: a report of the Surgeon General. Office of the Surgeon General; 2004.

10. 2 million 2 many. Accessed 2018 Feb 27. http://www.2million2many.org/

11. American Orthopaedic Association. Own the Bone. Accessed 2018 Feb 27. http://www.ownthebone.org/

12. Eisman JA, Bogoch ER, Dell R, Harrington JT, McKinney RE Jr, McLellan A, Mitchell PJ, Silverman S, Singleton R, Siris E; ASBMR Task Force on Secondary Fracture Prevention. Making the first fracture the last fracture: ASBMR task force report on secondary fracture prevention. J Bone Miner Res. 2012 Oct;27(10):2039-46. Epub 2012 Jul 26.

13. Peichl P, Holzer LA, Maier R, Holzer G. Parathyroid hormone 1-84 accelerates fracture-healing in pubic bones of elderly osteoporotic women. J Bone Joint Surg Am. 2011 Sep 7;93(17):1583-7.

14. Khosla S, Shane E. A crisis in the treatment of osteoporosis. J Bone Miner Res. 2016 Aug;31(8):1485-7. Epub 2016 Jun 28.

15. Roux C, Briot K. Osteoporosis in 2017: addressing the crisis in the treatment of osteoporosis. Nat Rev Rheumatol. 2018 Feb;14(2):67-8. Epub 2018 Jan 11.

16. Huntjens KM, van Geel TC, Geusens PP, Winkens B, Willems P, van den Bergh J, Brink PR, van Helden S. Impact of guideline implementation by a fracture nurse on subsequent fractures and mortality in patients presenting with non-vertebral fractures. Injury. 2011 Sep;42(Suppl 4):S39-43.

17. Huntjens KM, van Geel TA, van den Bergh JP, van Helden S, Willems P, Winkens B, Eisman JA, Geusens PP, Brink PR. Fracture liaison service: impact on subsequent nonvertebral fracture incidence and mortality. J Bone Joint Surg Am. 2014 Feb 19;96(4):e29.