

Bone Health Improvement Protocol

Nathan K. Wool, M.D.¹, Shannon Wilson²,
Alexander C.M. Chong, MSAE, MSME^{1,2},
Bradley R. Dart, M.D.¹

¹University of Kansas School of Medicine-Wichita,
Department of Orthopaedics
²Via Christi Health, Wichita, KS

ABSTRACT

Introduction. Metabolic bone disease is a malady that causes significant morbidity and mortality to a patient who has sustained a fragility fracture. There is currently no protocol to prevent secondary fragility fracture at our institution. The objective of this study was to create an appropriate protocol for implementing clinical pathways for physicians to diagnose and treat osteoporosis and fragility fractures by educating patients.

Methods. A multidisciplinary team created an appropriate protocol that could be implemented in an inpatient setting. A thorough literature review was conducted to evaluate potential barriers and efficacious methods of protocol design.

Results. A bone health improvement protocol was developed. Any patient over the age of 50 who sustains a fracture from low energy trauma, such as a fall from standing or less, should be considered to place into this protocol. These patients received education on metabolic bone disease, a prescription for high dose vitamin D therapy, and laboratory testing to determine the etiology of their metabolic bone disease. Continuity of care of these patients with their primary care provider was provided for further management of their metabolic bone disease and evaluation of their disease after discharged from the hospital.

Conclusion. Comprehensive secondary prevention should consist of osteoporosis assessment and treatment together with a fall risk assessment. With this protocol, secondary fragility fractures potentially could be prevented. *KS J Med* 2017;10(3):62-66.

INTRODUCTION

Osteoporosis is a prevalent metabolic bone disease among the elderly. It is defined as a disorder with micro-architectural deterioration that impairs both bone structural properties and bone quality.¹ This is a significant public health issue that predisposes 50% of patients over age 50 to an increased risk for fragility fracture.¹⁻⁵ Fragility fractures, defined as bone fractures resulting from a low-energy trauma such as a fall from a standing height or less, are a consequence of low bone quality and density.^{6,7} These types of fractures are encountered most commonly in the hip, spine, distal radius, and proximal humerus. Hip fractures are the major cause of morbidity and mortality associated with osteoporosis and fragility fractures.¹ The risk of mortality for elders after a hip fracture due to low energy trauma is twice that of the general population. Osteoporosis

and fragility fractures pose enormous challenges for both the individual and society in terms of loss of independence, quality of life, and economic burden.^{8,9} These include long hospitalization, need for surgical treatment, increased disability, and partial or complete loss of the ability to perform activities of daily living independently.

El-Rabbany et al.¹⁰ found only 5 to 38% of patients with fragility fractures were being treated for osteoporosis at final follow-up. Identifying patients at risk and getting the proper evaluation and treatment are not universal. A disconnect exists between the realization that fragility fractures are the stigmata of osteoporosis and the engagement of the patient and physician team toward more universal diagnosis and treatment.

Orthopedic residency and curricula may not provide sufficient knowledge or training to allow osteoporosis management.¹¹ Edwards et al.¹² demonstrated a modest increase in certain aspects of bone health order pathways and treatment by using an electronic medical record order set. That intervention created with providers' input increased the follow-up and treatment of patients with osteoporosis. This, however, failed to increase diagnosis or treatment for osteoporosis at the time of hospitalization for a fragility fracture.

No protocol exists to prevent secondary fragility fracture at our institution. The objective of this study was to create an appropriate protocol for implementing clinical pathways for physicians to diagnose and treat osteoporosis and fragility fractures by educating patients.

METHODS

A multidisciplinary team, which consisted of physicians, nurse practitioners, physical therapists, nurse managers, and the orthopedic service line coordinator, was assembled to create an appropriate protocol that could be implemented at a level I trauma center about metabolic bone disease and fragility fractures. This team was tasked with vetting the protocol to ensure feasibility in implementation at a clinical level as well as ease of modification after implementation. A thorough literature review was conducted to evaluate efficacious methods of protocol design and potential barriers to implementation. The literature reviews also encompassed treatment goals for patients with osteoporosis and fragility fracture.

RESULTS

A bone health protocol was developed by the multidisciplinary team (Figure 1). This protocol was created to improve care for patients at risk for fragility fracture or post-fracture which focused on initiating and facilitating the screen and treatment of osteoporosis. It divided into several strategic steps: scenario, lab tests, patient education, vitamin D prescription, and primary care provider follow-up.

Scenario. Orthopedic surgeons, trauma surgeons, and emergency room (ER) providers often are the first clinicians to see the patients after a fragility fracture. A patient over the age of 50 who sustains a fracture to the appendicular skeleton caused by a low energy trauma event, such as a fall from standing height or less, should be placed into this protocol. The incidence and lifetime risk of any fracture doubles every decade after 50 years old.^{4,11,13-15} During the visit, a standard medical history also should be obtained, with particular attention paid to age, weight, personal and family history of fracture, physical inactivity, medication, alcohol, tobacco, and frailty.

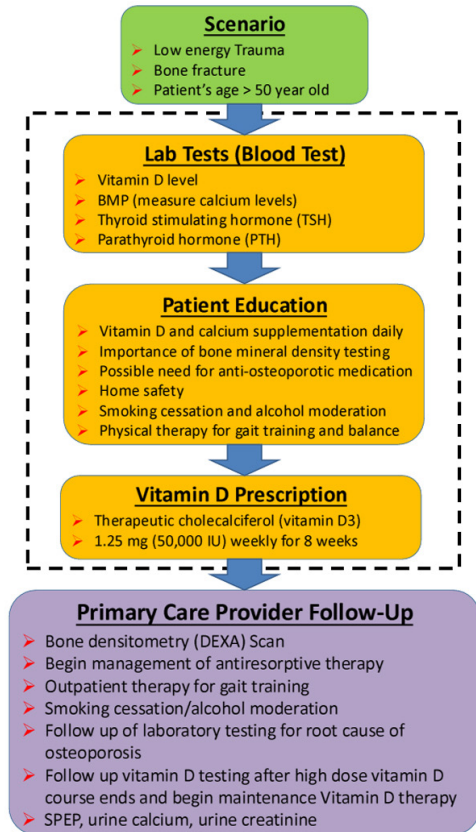


Figure 1. The bone health protocol with treatment goals to be provided before the patient leaves the hospital.

Laboratory Tests (Blood Test). Although bone strength cannot be determined directly *in vivo*, with increased age comes a marked reduction in bone mass and destruction of bone architecture, leading to a considerable decrease in bone strength.¹⁶⁻¹⁸ Basic laboratory tests, such as a complete blood count, serum chemistry profile, and urinalysis, are usually requested by the clinicians during a regular medical checkup to monitor patient health. Adding a basic metabolic profile, parathyroid hormone level, thyroid stimulating hormone, follicle-stimulating hormone level, luteinizing hormone level, and Vitamin D-25-hydroxy level to these tests would help in determining the etiology for metabolic bone disease. The results of these tests give clinicians insight into patient's status regarding common etiologies of metabolic bone disease, including decreased vitamin D levels, hyperparathyroidism, hyperthyroidism, renal osteodystrophy, and hypogonadism. These tests are among the most effective in determining etiology of metabolic bone disease based on literature.¹⁹

Patient Education. Patients with osteoporosis who have sustained a fracture have a very high risk of suffering a new fracture, often within one year of original fracture.^{14,20-28} Therefore, before discharging the patients from the hospital, nursing staff, and health-care providers must provide proper education to patients and their family members about metabolic bone disease. This includes acute management of the presenting fracture and prevention of secondary fragility fractures, the importance of vitamin D and calcium

supplementation, bone mineral density (BMD) testing, the possible need for anti-osteoporotic medications, home safety goals, smoking cessation and alcohol moderation, and physical therapy for gait training and balance. Patients who underwent balance training and education had better balance measures and fear of falling outcomes.²⁹⁻³¹ Smokers should be advised to quit, patients with alcoholism should be treated, and patients for whom risk factor analysis indicates a strong potential for osteoporosis should have an ultrasound of the heel as an initial screening tool every six months followed by a bone densitometry (DEXA) scan in those identified as having low bone density.³² This education will allow patients and their family members to be involved in the patient's bone health.

Vitamin D Prescription. Vitamin D is essential for normal calcium metabolism and maintenance of bone density, and the risk of deficiency increases with age.³³⁻³⁶ The prevalence of vitamin D deficiency in 2010 in the U.S. was 41.6% with deficiency rates around 49% in patients age 55 to 64 years.³⁷ Due to the high levels of vitamin D deficiency among elderly individuals and the delay in test results, which may take up to five days due to the specialized nature of the test and scarcity of laboratories that perform it, there is a benefit to start therapeutic cholecalciferol (vitamin D3) prophylactically before discharge from the hospital. Supplementation with vitamin D reduced bone loss and the incidence of non-vertebral fractures in men and women aged ≥ 65 years.³⁸ Patients should be prescribed vitamin D supplementation (vitamin D3) for eight weeks at a dose of 1.25 mg or 50,000 international units (IU) once a week which is supported by previous studies.³⁹⁻⁴¹ With this high dose of vitamin D supplementation (50,000 IU) cholecalciferol restored serum 25-hydroxy vitamin D (25(OH)D) levels to sufficient levels (i.e., above vitamin D deficiency level of 50 nmol/L)^{42,43} among migrants and non-migrants, especially for those with lower baseline serum 25(OH)D.

Primary Care Provider Follow-up. The ultimate goal in treating fragility fracture patients with osteoporosis is not only acute management of the presenting fracture, but also the prevention of subsequent fractures.^{7,44-47} The primary care providers are the crucial members that need to provide continuity of care with these patients on their metabolic bone disease management and further evaluation of their disease after the patient is discharged from the hospital. A DEXA scan should be scheduled to measure and evaluate BMD. The results of the DEXA scan can be used to gauge the severity of bone loss, predict future fracture risk, make treatment decisions, and monitor changes in BMD related to age, medical conditions, or therapeutic intervention. The provider should discuss initiation of antiresorptive therapy, outpatient physical therapy for gait training, smoking cessation, and alcohol intake moderation. By evaluating the initial routine laboratory test results, the primary care providers should make the decision on continuing therapeutic cholecalciferol (vitamin D3) treatment and, if necessary, order further testing, such as serum protein electrophoresis, 24-hour urine calcium, and 24-hour urine creatinine, to delineate the etiology of the metabolic bone disease.

DISCUSSION

The goal of this bone health improvement protocol was to ensure that patients with osteoporosis and fragility fractures receive quality care for their bone health in both the inpatient and outpatient settings. About 10 million Americans over the age of 50 have osteoporosis and that number will increase to 14 million by 2020.¹⁵ These patients are high risk and should be monitored closely for osteoporosis in the setting of any fracture. There is a large gap between what has been learned and what is applied by patients and health care providers. The biggest problem is a lack of awareness of bone disease among both the public and health care professionals.³²

Patients who have had a fragility fracture have hypovitaminosis D 73% of the time.⁴⁸ This is in line with current levels in the United States and Canada in a population without fracture. A prospective randomized trial in 2009 demonstrated a trend toward a decrease in fracture incidence in patients who took daily vitamin D and calcium supplementation.⁴⁹ High dose vitamin D3 ($\geq 300,000$ IU) is efficacious in treating low levels of vitamin D and restoring the level to a normal limit.³⁹ Kearns et al.⁵⁰, however, concluded that a high dose of vitamin D3 ($\geq 600,000$ IU) at one time will have adverse effects which could cause hypercalcemia or hypercalciuria.

Osteoporosis is thought to be caused by factors including age-related impairment of bone formation, decreased calcium and vitamin D intake, decreased physical activity, and estrogen's positive effects on calcium balance in the intestines, kidneys, and bone.⁵¹ Providing patients with the adequate information to take control of their osteoporosis is crucial to the success of this protocol. Patient education, such as the benefit of smoking cessation, should be emphasized, especially in the setting of fracture. Tobacco has been shown to hinder fracture healing and alcohol consumption of three or more units per day will have consequential effects on bone health, leading to lower BMD when compared with more moderate drinking.⁶ Education on avoidance of preventable falls also has a major impact on reducing further fragility fractures as patients with osteoporosis often experience muscle weakness, postural deformity, and poor balance.⁵² Patients who undergo tailored exercises and intervention have a decrease in fall rate in the community.⁵³ These measures should assist in decreasing the rate of recurrent fragility fracture.

Elderly patients presenting with fragility fractures should be offered assessment with this protocol by orthopedic and/or trauma surgeon teams, as they have a unique opportunity to diagnose, arrange follow-up, and ensure the patient is started on the appropriate therapy. The orthopedic and trauma surgeons should communicate clearly with the primary care physicians the need to explore and address the relevant causes.

Genetics and nutrition contribute to the rapid phase of bone loss in postmenopausal women and the slow phase of bone loss in aging women and men.³² These factors appear to be largely the result of estrogen deficiency. Estrogen is a hormone that is important throughout life to support bone development and main-

tenance in both men and women. Drugs, such as antiresorptives, that prevent bone breakdown have been effective in reducing the risk of future fractures. These drugs not only slow any further deterioration of the skeleton, but also allow for some repair and restoration of bone mass and strength. However, they cannot completely restore mechanical integrity because of the absence of an anabolic effect.

There are several possible barriers to implementation of this protocol in the current healthcare setting. The most notable is provider education. Healthcare providers of fragility fracture patients will need to be well educated on the protocol for it to be effective. These healthcare providers include orthopedic physicians, emergency room physicians, emergency room physician extenders, orthopedic mid-level providers, primary care providers, resident physicians, and nurses. After adequate education, the protocol implementation could be subjected to improvements that would incorporate potential patients into all aspects of the protocol. Another potential barrier was identified through a survey of physicians which was cost of the workup necessary for osteoporosis.⁵⁴ Communication between orthopedic surgeons and primary care physicians also has been identified as a barrier that needs to be addressed.⁵⁵ Increasing awareness of the responsibility and the opportunity providers have to make a substantial impact on this clinical problem would prevent secondary fragility fractures and decrease the morbidity and mortality of patients with underlying metabolic bone disease. Other potential barriers include cost of therapy, patient reluctance, time and cost of diagnosing osteoporosis, special patient populations (e.g., uninsured or underinsured, minorities) gender differences, lack of access to BMD testing, and a lack of time to address secondary prevention.⁵⁶⁻⁵⁷

Comprehensive secondary prevention should consist of osteoporosis assessment and treatment together with a fall risk assessment. With this protocol, secondary fragility fractures could be prevented.

ACKNOWLEDGEMENT

We would like to acknowledge and thank the bone health team members: Judy Dusek, Lauren Duerr, and Linda Waters.

REFERENCES

- 1 Gregory PC, Lam D, Howell P. Osteoporosis treatment following hip fracture: How rates vary by service. *South Med J* 2010; 103(10):977-981. PMID: 20818315.
- 2 Cummings SR, Melton LJ. Epidemiology and outcomes of osteoporotic fractures. *Lancet* 2002; 359(9319):1761-1767. PMID: 12049882.
- 3 Iqbal MM. Osteoporosis: Epidemiology, diagnosis, and treatment. *South Med J* 2000; 93(1):2-18. PMID: 10653058.
- 4 Kanis JA, Johnell O, Oden A, et al. Long-term risk of osteoporotic fracture in Malmö. *Osteoporos Int* 2000; 11(8):669-674. PMID: 11095169.
- 5 Klotzbuecher CM, Ross PD, Landsman PB, Abbott TA 3rd, 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(4):721-739. PMID: 10780864.
- 6 Rebolledo BJ, Unnanuntana A, Lane JM. A comprehensive approach to fragility fractures. *J Orthop Trauma* 2011; 25(9):566-573. PMID: 21654529.
- 7 Bouxsein ML, Kaufman J, Tosi L, Cummings S, Lane J, Johnell O. Recommendations for optimal care of the fragility fracture patient to reduce the risk of future fracture. *J Am Acad Orthop Surg* 2004; 12(6):385-395. PMID: 15615504.
- 8 Papaioannou A, Morin S, Cheung AM, et al. 2010 clinical practice guidelines for the diagnosis and management of osteoporosis in Canada: Summary. *CMAJ* 2010; 182(17):1864-1873. PMID: 20940232.
- 9 Pasco JA, Henry MJ, Korn S, Nicholson GC, Kotowicz MA. Morphometric vertebral fractures of the lower thoracic and lumbar spine, physical function and quality of life in men. *Osteoporos Int* 2009; 20(5):787-792. PMID: 18802658.
- 10 El-Rabbany M, Rosenwasser M, Bhandari M. Managing the burden of osteoporosis: Is there a standard of care? *J Orthop Trauma* 2011; 25(Suppl 2):S44-46. PMID: 21566473.
- 11 Sorbi R, Aghamirsalim MR. Knowledge of orthopaedic surgeons in managing patients with fragility fracture. *Int Orthop* 2012; 36(6):1275-1279. PMID: 22281934.
- 12 Edwards BJ, Bunta AD, Anderson J, et al. Development of an electronic medical record based intervention to improve medical care of osteoporosis. *Osteoporos Int* 2012; 23(10):2489-2498. PMID: 22273834.
- 13 Tian FM, Zhang L, Zhao HY, Liang CY, Zhang N, Song HP. An increase in the incidence of hip fractures in Tangshan, China. *Osteoporos Int* 2014; 25(4):1321-1325. PMID: 24562838.
- 14 Chiu HC, Chen CH, Ho ML, Liu HW, Wu SF, Chang JK. Longitudinal changes in bone mineral density of healthy elderly men in southern Taiwan. *J Formos Med Assoc* 2008; 107(8):653-658. PMID: 18678549.
- 15 Friedland SM, Mendelson DA. Epidemiology of fragility fractures. *Clin Geriatr Med* 2014; 30(2):175-181. PMID: 24721358.
- 16 Greenspan SL, Maitland LA, Myers ER, Krasnow MB, Kido TH. Femoral bone loss progresses with age: A longitudinal study in women over age 65. *J Bone Miner Res* 1994; 9(12):1959-1965. PMID: 7872062.
- 17 Kaptoge S, Dalzell N, Loveridge N, Beck TJ, Khaw KT, Reeve J. Effects of gender, anthropometric variables, and aging on the evolution of hip strength in men and women aged over 65. *Bone* 2003; 32(5):561-570. PMID: 12753873.
- 18 Warming L, Hassager C, Christiansen C. Changes in bone mineral density with age in men and women: A longitudinal study. *Osteoporos Int* 2002; 13(2):105-112. PMID: 11905520.
- 19 Crandall C. Laboratory workup for osteoporosis. Which tests are most cost-effective? *Postgrad Med* 2003; 114(3):35-38, 41-44. PMID: 14503399.
- 20 Johnell O, Kanis JA, Odén A, et al. Fracture risk following an osteoporotic fracture. *Osteoporos Int* 2004; 15(3):175-179. PMID: 14691617.
- 21 Minicuci N, Maggi S, Noale M, Trabucchi M, Spolaore P, Crepaldi G; VELCA Group. Predicting mortality in older patients. The VELCA Study. *Aging Clin Exp Res* 2003; 15(4):328-335. PMID: 14661825.
- 22 Qin L, Au SK, Leung PC, et al. Baseline BMD and bone loss at distal radius measured by peripheral quantitative computed tomography in peri- and postmenopausal Hong Kong Chinese women. *Osteoporos Int* 2002; 13(12):962-970. PMID: 12459939.
- 23 Karlsson MK, Obrant KJ, Nilsson BE, Johnell O. Changes in bone mineral, lean body mass and fat content as measured by dual energy X-ray absorptiometry: A longitudinal study. *Calcif Tissue Int* 2000; 66(2):97-99. PMID: 10652954.
- 24 Melton LJ 3rd, Khosla S, Atkinson EJ, O'Connor MK, Ofallon WM, Riggs BL. Cross-sectional versus longitudinal evaluation of bone loss in men and women. *Osteoporos Int* 2000; 11(7):592-599. PMID: 11069193.
- 25 Johnell O. The socioeconomic burden of fractures: Today and in the 21st century. *Am J Med* 1997; 103(2A):20S-25S; discussion 25S-26S. PMID: 9302894.
- 26 Papadimitropoulos EA, Coyte PC, Josse RG, Greenwood CE. Current and projected rates of hip fracture in Canada. *CMAJ* 1997; 157(10):1357-1363. PMID: 9371065.
- 27 Jones G, Nguyen T, Sambrook P, Kelly PJ, Eisman JA. Progressive loss of bone in the femoral neck in elderly people: Longitudinal findings from the Dubbo osteoporosis epidemiology study. *BMJ* 1994; 309(6956):691-695. PMID: 7950520.
- 28 Keene GS, Parker MJ, Pryor GA. Mortality and morbidity after hip fractures. *BMJ* 1993; 307(6914):1248-1250. PMID: 8166806.
- 29 Olsen CF, Bergland A. The effect of exercise and education on fear of falling in elderly women with osteoporosis and a history of vertebral fracture: Results of a randomized controlled trial. *Osteoporos Int* 2014; 25(8):2017-2025. PMID: 24807628.
- 30 Bonner FJ Jr, Sinaki M, Grabois M, et al. Health professional's guide to rehabilitation of the patient with osteoporosis. *Osteoporos Int* 2003; 14(Suppl 2):S1-22. PMID: 12759719.
- 31 Gillespie LD, Gillespie WJ, Robertson MC, Lamb SE, Cumming RG, Rowe BH. Interventions for preventing falls in elderly people. *Cochrane Database Syst Rev* 2001; (3):CD000340. Update in: *Cochrane Database Syst Rev* 2003; (4):CD000340. PMID: 11686957.
- 32 US Department of Health and Human Services. Bone Health and Osteoporosis: A Report of the Surgeon General. Rockville, MD: U.S. Department of Health and Human Services, Office of the Surgeon General, 2004.
- 33 van der Wielen RP, Löwik MR, van den Berg H, et al. Serum vitamin D concentrations among elderly people in Europe. *Lancet* 1995; 346(8969):207-210. PMID: 7616799.
- 34 Yoshida T, Stern PH. How vitamin D works on bone. *Endocrinol Metab Clin North Am* 2012; 41(3):557-569. PMID: 22877429.
- 35 Lips P, van Schoor NM. The effect of vitamin D on bone and osteoporosis. *Best Pract Res Clin Endocrinol Metab* 2011; 25(4):585-591. PMID: 21872800.
- 36 Sai AJ, Walters RW, Fang X, Gallagher JC. Relationship between vitamin D, parathyroid hormone, and bone health. *J Clin Endocrinol Metab* 2011; 96(3):E436-446. PMID: 21159838.
- 37 Forrest KY, Stuhldreher WL. Prevalence and correlates of vitamin D deficiency in US adults. *Nutr Res* 2011; 31(1):48-54. PMID: 21310306.
- 38 Dawson-Hughes B, Harris SS, Krall EA, Dallal GE. Effect of calcium and vitamin D supplementation on bone density in men and women 65 years of age or older. *N Engl J Med* 1997; 337(10):670-676. PMID: 9278463.
- 39 Gowda U, Ruwanpathirana T, Fong DP, Kaur A, Renzaho AM. Efficacy of high dose Vitamin D supplementation in improving serum 25(OH)D among migrant and non migrant population: A retrospective study. *BMC Health Serv Res* 2016; 16(1):579. PMID: 27737675.
- 40 Holick MF. Vitamin D deficiency. *N Engl J Med* 2007; 357(3):266-281. PMID: 17634462.
- 41 Malabanan A, Veronikis IE, Holick MF. Redefining vitamin D insufficiency. *Lancet* 1998; 351(9105):805-806. PMID: 9519960.
- 42 Atkins D, Best D, Briss PA, et al. Grading quality of evidence and strength of recommendations. *BMJ* 2004; 328(7454):1490. PMID: 15205295.
- 43 Holick MF, Binkley NC, Bischoff-Ferrari HA, et al. Evaluation, treatment, and prevention of vitamin D deficiency: An Endocrine Society clinical practice guideline. *J Clin Endocrinol Metab* 2011; 96(7):1911-1930. PMID: 21646368.
- 44 Harrington JT, Lease J. Osteoporosis disease management for fragility fracture patients: New understandings based on three years' experience with an osteoporosis care service. *Arthritis Rheum* 2007; 57(8):1502-1506. PMID: 18050169.
- 45 Harrington JT, Barash HL, Day S, Lease J. Redesigning the care of fragility fracture patients to improve osteoporosis management: A health care improvement project. *Arthritis Rheum* 2005; 53(2):198-204. PMID: 15818644.
- 46 McLellan AR, Gallacher SJ, Fraser M, McQuillan C. The fracture liaison service: Success of a program for the evaluation and management of patients with osteoporotic fracture. *Osteoporos Int* 2003; 14(12):1028-1034. PMID: 14600804.
- 47 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(6):450-455. PMID: 12107657.

- ⁴⁸ Sprague S, Petrisor B, Scott T, et al. What is the role of vitamin D supplementation in acute fracture patients? A systematic review and meta-analysis of the prevalence of hypovitaminosis D and supplementation efficacy. *J Orthop Trauma* 2016; 30(2):53-63. PMID: 26429406.
- ⁴⁹ Salovaara K, Tuppurainen M, Kärkkäinen M, et al. Effect of vitamin D(3) and calcium on fracture risk in 65- to 71-year-old women: A population-based 3-year randomized, controlled trial-the OSTPRE-FPS. *J Bone Miner Res* 2010; 25(7):1487-1495. PMID: 20200964.
- ⁵⁰ Kearns MD, Alvarez JA, Tangpricha V. Large, single-dose, oral vitamin D supplementation in adult populations: A systematic review. *Endocr Pract* 2014; 20(4):341-351. PMID: 24246341.
- ⁵¹ Riggs BL, Khosla S, Melton LJ 3rd. Sex steroids and the construction and conservation of the adult skeleton. *Endocr Rev* 2002; 23(3):279-302. PMID: 12050121.
- ⁵² Hsu WL, Chen CY, Tsauo JY, Yang RS. Balance control in elderly people with osteoporosis. *J Formos Med Assoc* 2014; 113(6):334-339. PMID: 24650494.
- ⁵³ Stubbs B, Brefka S, Denking MD. What works to prevent falls in community-dwelling older adults? Umbrella review of meta-analyses of randomized controlled trials. *Phys Ther* 2015; 95(8):1095-1110. PMID: 25655877.
- ⁵⁴ Simonelli C, Killeen K, Mehle S, Swanson L. Barriers to osteoporosis identification and treatment among primary care physicians and orthopedic surgeons. *Mayo Clin Proc* 2002; 77(4):334-338. PMID: 11936928.
- ⁵⁵ Switzer JA, Jaglal S, Bogoch ER. Overcoming barriers to osteoporosis care in vulnerable elderly patients with hip fractures. *J Orthop Trauma* 2009; 23(6):454-459. PMID: 19550234.
- ⁵⁶ 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(10):767-778. PMID: 15258724.
- ⁵⁷ Sheehan J, Mohamed F, Reilly M, Perry IJ. Secondary prevention following fractured neck of femur: A survey of orthopaedic surgeons practice. *Ir Med J* 2000; 93(4):105-107. PMID: 11037567.

Keywords: metabolic bone disease, bone fractures, osteoporosis, secondary prevention.