Nonpharmacologic Interventions and Lifestyle Modifications Resulting in Prevention and Reduction of Osteoporosis

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Abstract

Osteoporosis is a preventable chronic disease. Identification of modifiable risk factors and education on nonpharmacological interventions and lifestyle modifications is an essential component to improve bone health and prevent osteoporosis. A case report was completed of a 72-year-old Caucasian female who presents to the clinic for a hospital follow up after a fall in which resulted in a right hip fracture. The results of her dual energy x-ray absorptiometry (DEXA) scan before her fall put her in the diagnosis category of having osteoporosis. She is also a current one pack a day smoker. A literature review was performed using online databases through the School of Medicine and Health Sciences website at the University of North Dakota to identify nonpharmacologic interventions such as healthy diet and nutrition recommendations; physical activity and exercise; and lifestyle modifications in which include smoking cessation, non-excessive use of alcohol and caffeine, maintaining a healthy body weight, and fall risk assessments. The literature review identified nonpharmacologic interventions in which promote bone health and prevent osteoporosis.
Background

“There is an estimated 9.9 million Americans diagnosed with osteoporosis and 43.1 million who have low bone density. An estimated 1.5 million osteoporosis related fractures occur in the United States annually, the majority occurring in women” (Yedavally- Yellayi, Ho, & Patalinghug, 2019). Osteoporosis is defined by the World Health Organization (WHO) as, “A skeletal disease characterized by low bone strength and increased risk of fracture” (Sabin & Sarter, 2014). The WHO also defines osteoporosis as a DEXA bone mineral density (BMD) T-score of -2.5 or below. Bone loss occurs when there is an imbalance between bone resorption and bone formation; bone breakdown is greater than replacement (Yedavally- Yellayi, et al., 2019). Characteristics of osteoporosis include decreased BMD, structural deterioration and porous bone in which create an increased risk for fractures. Osteoporosis is a progressive and asymptomatic disease in which is often times not diagnosed until after a fracture occurs. The most common locations for fractures to occur include: proximal femur (hip), distal forearm (wrist) and vertebrae (spine) (Bechtle, 2013; Kling, Clarke, & Sandhu, 2014; Lupsa & Insogna, 2015; Yedavally- Yellayi, et al., 2019). According to Yedavally- Yellayi, et al., (2019), it is recommended that all adults be assessed for risk factors for osteoporosis and screened according to guidelines so that osteoporosis can be prevented before long-term impacts occur.

In the United States, most expert group recommend BMD testing, using DEXA for women aged 65 years and older regardless of clinical risk factors. Recommendations on screening for women under the age of 65 and older men vary and are based on a variety of risk factors for bone loss and osteoporosis (Yedavally- Yellayi, et al., 2019). There are many modifiable and unmodifiable risk factors in which can lead to osteoporosis. Osteoporosis is a chronic disease in which can be prevented through early
screening of modifiable risk factors and implementation of lifestyle modifications that can improve bone health. Education and counseling on lifestyle modifications in prevention of osteoporosis is recommended to begin in childhood and continue as one ages. Lifestyle modifications that have been found to be successful in reducing the risk of osteoporosis include a balanced diet with adequate vitamin D, calcium, and protein intake; regular physical activity and reduction of a sedentary lifestyle; and healthy lifestyle choices such as smoking cessation, non-excessive consumption of alcohol and caffeine, maintaining a healthy body weight, and identifying environmental hazards through falls risk assessments (Kling, et al., 2014; Yedavally-Yellayi, et al., 2019).

Case Report

Chief Complaint and History of Present Illness

M.J. is a 72-year old Caucasian woman who presents to the clinic for a follow up after hospital discharge for a right hip fracture occurring six weeks ago as a result of a fall. Her fall was spontaneous as she states her “leg just gave out while walking”. She has no history of previous falls. She was hospitalized for three days during which she had an open reduction and internal fixation (ORIF) to her right hip. She reports no complications after her surgery, did not require blood transfusions after surgery, and feels that she is recovering well. She is back living at home and completed her physical therapy sessions. She is doing home exercises daily. She reports no current pain and when she does have slight discomfort, which usually occurs at night, Tylenol is taken in which relieves symptoms.

Past Medical History, Past Surgical History, Allergies, and Medications

M.J.’s past medical history includes chronic obstructive pulmonary disease (COPD), anemia, hypertension (HTN), hypercholesterolemia and smoking. She has no known medication
allergies. She has no past surgical history. Her current medications include fluticasone propionate and salmeterol 250/50 one puff twice daily (BID), losartan 50 milligrams (mg) daily, metoprolol 50 mg BID, paroxetine 20 mg daily, quetiapine 200 mg BID, Lipitor 20 mg daily, multivitamin daily, and iron sulfate 325 mg BID. A prednisone taper was completed the day before her visit in which was prescribed for a COPD flare up.

**Social and Family History**

M.J. lives alone but does have a daughter who frequently visits and helps her. She denies alcohol and drug use. She does smoke one pack of cigarettes a day for the past 45 years, she did try quitting 10 years ago by using patches. She has a family history of heart disease and HTN.

**Review of Systems**

M.J. has no recent weight loss or weight gain, denies fever or chills. She is sleeping well at night but does feel as though she is more fatigued and tired than usual. She denies any headache, hearing or vision changes, dizziness, lightheadedness, sore throat, congestion, or cold symptoms. She denies a cough, shortness of breath or wheezing. She denies heart palpitations, chest pressure, chest pain, or swelling to her lower extremities. She denies nausea, vomiting, diarrhea, heartburn, constipation, or appetite changes. She denies frequency, urgency, or hesitancy with urination. She does have discomfort to her right hip at night in which she takes a Tylenol for in which relieves her pain. Denies swelling, redness, or inflammation to joints or incision site. Incision to right hip in which she feels is heeling well. Denies numbness or tingling to extremities. Denies recent falls or feeling unsteady on her feet. She feels as though her moods have been good.

**Physical Exam**
M.J.’s vital signs during today’s visit include blood pressure (BP) 138/70 millimeters of mercury (mm Hg), pulse 70 beats per minute, respiratory rate 18 breaths per minute, and oxygen saturation 92 percent (%) on room air. Her laboratory results include white blood cells, platelet count, complete metabolic panel, and thyroid stimulating hormone all within normal ranges; hemoglobin 11.5 grams per deciliter (g/dL), hematocrit 34 %, mean corpuscular volume (MCV) 50 femtoliters per cell, and mean corpuscular hemoglobin concentration (MCHC) 30 g/dL. Her last (DEXA) scan resulted in a T-score of -2.6 and Z-score of 1.1. M.J. is a Caucasian female who appears in no acute distress. Her head is atraumatic and normocephalic. Her pupils are round, equal, and reactive to light. Her external ear canals have no signs of inflammation and bilateral tympanic membranes are pearly grey with no bulging or erythema. Her bilateral nasal turbinates have no inflammation. M.J.'s oral cavity is pink and moist with no lesions and posterior pharynx is pink with no exudate or tonsillar enlargement. There is no cervical lymphadenopathy palpated. Auscultation to heart reveals S1 and S2, no S3, no murmurs, and a regular rate and rhythm. There is no edema noted to her lower extremities. Palpation of bilateral radial, popliteal, and pedal pulses +2. Auscultation of lung sounds reveals clear lung fields bilateral, no adventitious lung sounds were heard, and there was equal rise and fall of her chest. M.J.’s abdomen is round, soft, and symmetric; bowel sounds are present in all quadrants and with no tenderness to palpation. No tenderness is noted to bilateral costovertebral angles. No muscle atrophy, weakness, instability or tenderness noted to her right hip. Full range of motion is noted to her right hip and M.J. had a steady gait without the use of assistive devices.

**Assessment and Plan**

M.J.’s BP is found to be slightly elevated, it was recommended she start a BP monitoring log and bring her results to her next appointment. Based on M.J.’s laboratory results and feelings
of fatigue, she was recommended to increase her iron sulfate tablets from twice to three times daily. Due to M.J.’s age and recent hip fracture, education was provided on continuing her daily exercises and increasing her calcium, vitamin D, and protein in her diet to promote increased bone health and reduce her risk of future fractures. It was recommended that she follow up with a DEXA scan in three months based on her recent hip fracture and her last DEXA scan result placing her in the category of having osteoporosis as her T-score was -2.6. M.J. was also encouraged to stop smoking. She did have interest in quitting smoking, information was provided to her such as the North Dakota quits hotline number.

**Literature Search**

A literature search was completed using the School of Medicine and Health Sciences website at the University of North Dakota. A total of seven databases were used to search for literature articles pertinent to the case report. These data bases included: Cumulative Index to Nursing and Allied Health Literature (CINAHL), Clinical Key, Cochrane Library, PubMed, Science Direct, Scopus, and Wiley Online Library. Keywords searched included: *osteoporosis* AND *prevention* AND *nonpharmacologic* AND *lifestyle modification*. Limits placed in database included: articles not written in English, subjects not including humans, year range of 2013-2019, and full-text articles.

**Literature Review**

Osteoporosis is a preventable chronic disease that is often asymptomatic and referred to as a “silent disease”. Screening, education and encouragement in implementation of modifiable risk factors to promote bone health is suggested to start in childhood and continue as one ages to increase knowledge and prevention of osteoporosis. A healthy diet with adequate vitamin D and calcium supplementation decreases risk factors for osteoporosis. Physical activity and a
decreased sedentary lifestyle maintain bone strength and have been found to reduce falls and fracture risk. Lifestyle modifications such as smoking cessation, limited use of alcohol and caffeine, maintaining a healthy body weight, and environmental risk factor assessments, such as fall prevention screening, have also been found to decrease the risk of fractures and the development of osteoporosis (Bechtle, 2013; Yedavally- Yellayi, et al., 2019).

**Diet, Vitamins, and Nutrients**

A well-balanced nutrient-rich diet is vital for good bone health and prevention of osteoporosis. In order for the body to adequately build bone, maintain muscle mass, repair damaged tissue, and recover from injury, macronutrients such as amino acids and fatty acids, need to be available in plentiful amounts (Nachtigall, Nazem, Nachtigall, & Goldstein, 2013; Prah, Richards, Griggs, & Simpson, 2017). Adequate daily intake of calcium and vitamin D are recommended to prevent deficiencies which have been found to be related to osteoporosis, for good bone health, and to reduce the risk of fracture in the general population (Christianson & Shen, 2013; Cosman, Beur, LeBoff, Lewiecki, Tanner, Randall, & Lindsay, 2014; Prah, et al., 2017; Yedavally- Yellayi, et al., 2019). Calcium and vitamin D when taken together were found to be more effective in fracture reduction than when supplemented one without the other (Agostini, Zepa, Lucertini, Annibalini, Gervasi, Ferri Marini, Piccoli, Stocchi, Barbieri, & Sestili, 2018; Fares, 2018).

Calcium is an important mineral in bone health due to 99% of the body’s calcium being found in bone (Cosman, et al., 2014; Kling, et al., 2014; Webb, 2013). It is recommended that daily calcium requirements be obtained through diet and addition of calcium supplementation if adequate levels cannot be reached through diet alone. Daily recommendations for calcium vary according to age and gender and include: men age 50 to 70 consume 1000 mg/day and women
age 51 and older and men age 71 and older consume 1200 mg/day of calcium (Caple & Schub, 2018; Cosman, et al., 2014, Fares, 2018; Webb, 2013). Calcium is found to be important in bone mass, bone formation, bone quality, and bone remodeling. Inadequate calcium levels have been found to increase bone resorption and lower BMD. Research has shown there has been no benefit in increased bone health by consuming greater than the recommended amount of calcium and by consuming calcium in greater than recommended amounts, calcium has been found to increase the risk of developing kidney stones, cardiovascular disease and stroke (Caple & Schub, 2018; Christianson & Shen, 2013; Cosman, et al., 2014; Fares, 2018; Jones, Winzenberg, Callisaya, & Laslett, 2014; Kling, et al., 2014; Lupsa, 2015; Prah, et al., 2017).

Dietary calcium sources include: diary foods, leafy green vegetables, and fortified foods and beverages (Hernandez, 2017; Prah, et al., 2017; Webb, 2013).

Vitamin D is needed for bone health, intestinal absorption of calcium, and regulation of phosphorus (Agostini, et al., 2018; Cosman, et al., 2014). Decreased levels of vitamin D have been found to be associated with increased bone turnover, bone loss, loss of muscle mass and strength, increased falls, and increased risk and poorer outcomes for fractures. Daily recommendations of vitamin D vary throughout ages of life. For adults ages 50 and older, the recommended daily vitamin D intake is 800-1000 international units (IU). There are few foods containing vitamin D, some include: fatty fish, egg yolks, and fortified foods and drinks. Supplementation is found to be the most practical method of reaching recommended daily vitamin D levels due to the limited dietary sources it is found in. Sunlight through ultraviolet B exposure is also a source of vitamin D (Agostini, et al., 2018; Cosman, et al., 2014; Christianson & Shen, 2013; Prah, et al., 2017). Greater than recommended daily amounts of vitamin D have
been found to increase the risk of hypercalciuria and hypercalcemia (Jones, et al., 2014; Kling, et al., 2014; Prah, et al., 2017).

Research studies on protein and bone health are conflicting. In past studies, increased dietary protein intake was thought to cause a loss of bone mass by causing calcium excretion and increase bone resorption. Studies are now showing improved bone density and lower fracture risks with increased dietary protein intakes, although, this has only been found to be beneficial when calcium levels were elevated (Lupsa & Insogna, 2015; Webb, 2013). Vitamins and minerals such as vitamin B12, omega-3 fatty acid, zinc, soy isoflavones, and dehydroepiandrosterone sulfate (DHEAS), are now being researched on the effects they have on bone health as they have been found to improve BMD (Christianson & Shen, 2013; Webb, 2013).

Physical Activity and Exercise

Physical activity, exercise, and reduction of a sedentary lifestyle promote bone health and prevent the onset of osteoporosis by increasing bone mass, increasing BMD, stimulating osteoblasts for new bone formation, preventing bone loss, strengthening bones, and reducing the risk of fractures and falls through balance and coordination. Weight-bearing exercises, non-weight bearing exercises, resistance training and aerobic exercises improve muscle strength and coordination and increase BMD. Each exercise program has been found to target different skeletal and muscular areas in the body, making multicomponent exercise programs the most effective in preventing the loss of BMD and reducing the risk of falls and the incidence of fractures. Weight-bearing exercises, in which can be high or low impact, have been found to increase bone density, increase bone strength, increase muscle mass, and stimulate bone growth. Non-weight bearing exercises have been found to have the greatest effective on BMD in the
femur neck. Combination exercise programs are found to be most effective in the spine. High intensity resistance training, aerobics, and weight-bearing activities were found to increase BMD in the lumbar spine and femoral neck. Exercise programs need to be individualized and age appropriate in order to be safe and effective. Weight-bearing and resistance training exercises have been found to be of most benefit in prevention of osteoporosis and have the greatest effects on BMD (Agostini, 2018; Christianson & Shen, 2013; Fares, 2018; Kling, et al., 2014; Lupsa & Insogna, 2015; Nachtigall, et al., 2013; Van Pelt, 2018; Prah, 2017). There have been varying results as to the amount and frequency of exercise needed for improvements in bone health. A minimum of three to five times a week for a minimum of thirty minutes of weight-bearing aerobic exercise and one to two times a week resistance training exercise programs has shown to have a positive impact on bone density, bone strength, and increased muscle mass (Agostini, 2018; Lupsa & Insogna, 2015; Nachtigall, et al., 2013).

Exercise programs enhancing muscle strength and muscle mass have been found to play a part in osteoporosis prevention due to the fact that muscles support bones. Exercises that increase muscle strength and mass have been found to increase bone mass. Muscle strengthening exercises work against resistance and slow bone loss. Swimming and cycling have been found to be least effective in increasing bone density and bone strength but have been found to be effective in strengthening muscles (Agostini, 2018; Baron, 2016; Lupsa & Insogna, 2015; “Osteoporosis”, 2018; Nachtigall, et al., 2013; Pelt, 2018).

Alternative and complimentary therapies are being studied for their positive effects on BMD. Mind-body therapies that are non-weight bearing with no resistance such as yoga, Tai Chi, and qigong have been shown to have positive effects on bone health by slowing bone resorption, increasing bone density, and reducing fractures. Traditional Chinese Medicine (TCM)
has been found to be beneficial in preventing osteoporosis. Pulsed electromagnetic field therapy (PEMF) has been found to increase bone density, muscle strength, and balance. Whole body vibration (WBV) training has been found to have beneficial effects on balance and motility in which reduce the risk of falls (Baron, 2016; Christianson & Shen, 2013; Fares, 2018).

**Education and Lifestyle Modifications**

Education should be provided to patients focusing on lifestyle modifications in which promote bone health, maximize BMD, and prevent osteoporosis. Prevention provides the foundation to decreasing the risk of BMD loss and development of osteoporosis. Lifestyle modifications including alcohol intake in moderate recommended amounts, smoking cessation, maintaining a healthy body weight, and assessing for risks of falls can be educated to all patients, especially those over the age of 50, to decrease the risk of osteoporosis (Bechtle, 2013; Cosman, et al., 2014; “Osteoporosis”, 2018”; Nachtigall, et al., 2013).

Alcohol use should be limited to non-excessive, recommended amounts. Consuming alcohol in moderation has been found to have no negative effects on bone health. It has been found that alcohol consumption in moderation may be associated with slightly increased BMD and lowered risk of fractures in postmenopausal women. Alcohol intake greater than recommended amounts, that is more than two drinks a day for women and more than three drinks a day for men, has been found to have negative effects on bone health and also can increase one’s risk for falls. Heavy alcohol use has been found to reduce BMD, bone formation, and lower serum bone formation markers causing a reduction to the bone remodeling process (Cosman, et al., 2014, Kling, et al., 2014; Lupsa & Insogna, 2015; Nachtigall, et al., 2013; Prah, et al., 2017). Excessive amounts of caffeine intake, which is greater than 330 mg per day, has been found to, “directly affect osteoclast differentiation and increase the release of intracellular
calcium in osteoclasts while increasing elimination of calcium through diuresis. Large amounts of caffeine have been found to increase oxidative stress which negatively impacts cell viability of osteoblasts” (Prah, et al., 2017). Alcohol and caffeine consumption are not recommended as they interfere with calcium absorption (Cosman, et al., 2014, Kling, et al., 2014; Lupsa & Insogna, 2015; Nachtigall, et al., 2013; Prah, et al., 2017).

Tobacco use is not only harmful to overall health but also to bone health. Smoking cessation should be strongly encouraged by health care providers to prevent osteoporosis. Cigarette smoking has a negative impact on bone metabolism and also causes a reduction in BMD. Cigarette smoking has been found to effect calcium and vitamin D absorption and effect osteoblasts (Cosman, et al., 2014; Fares, 2018; Lupsa & Insogna, 2015; Nachtigall, et al., 2013; Prah, et al., 2017). According to Fares (2018),

Smoking has been found to be a risk factor for low BMD and increased risk of fracture. Biological effects of smoking on bone have been suggested such as smoking leading to a decrease in intestinal calcium absorption and increased metabolism or decreased production of oestrogen, which may indirectly have an effect on bone health. Smoking has may contribute to impaired physical balance and increase risk of falls.

If smoking was started at a younger age when bone growth was rapid, it could be associated with an increased risk of poor bone health in later years of life (Cosman, et al., 2014; Fares, 2018; Lupsa & Insogna, 2015; Nachtigall, et al., 2013; Prah, et al., 2017).

Maintaining a healthy weight and body mass index (BMI) is important for good bone health. Fragility fractures are more likely to result in those with a low BMI. A BMI less than 21 kilograms divided by the square of height in meters or less than 127 pounds can result in low
BMD and increased risk of fracture in older women. The risk factor for fracture increases as BMI decreases (Bechtle, 2013; Christianson & Shen, 2013).

A fall risk assessment is an important factor in the reduction of osteoporosis related fractures due to falls. Internal environments including patient’s strength, stability, and mental status should be evaluated along with and external environments in which include a home safety assessment identifying potential safety risks that could lead to falls. Vision and hearing screenings and medication reviews to identify those that may increase fall risk or bone loss are also suggested interventions to decrease fall risk (Bechtle, 2013; Cosman, et al., 2014; Fares, 2018; Kling, et al., 2014; Lupsa & Insogna, 2015; “Osteoporosis”, 2018).

Early identification of individual risk factors and education on lifestyle modifications are important in the prevention of osteoporosis and bone health improvement. Individualized patient-focused goal-setting, routine screening, and assessment should be used by primary providers and health care professionals to increase bone health (Prah, et al., 2017). Morfeld, Vennedey, Muller, Pieper, and Stock (2016) performed a systematic review to evaluate the effect of patient education on osteoporosis prevention and treatment results. The results were unclear whether patient education was beneficial or had an impact on osteoporosis management, indicating more effective education and prevention of osteoporosis is needed. Sabin and Sarter (2014) and Ryan, Schlidt, and Ryan (2013), recommended primary care providers approach osteoporosis in a health-based model to prevent it, rather than educating on osteoporosis in a disease-based model when a patient is already diagnosed with the chronic disease. Sabin and Sarter (2014), stated that there are many missed opportunities by health care providers to educate and promote information on bone health. Further education programs are needed in order to improve awareness of bone health and prevent osteoporosis (Mackey & Whitaker, 2015; Pelt, 2018).
Learning Points

▪ Osteoporosis caused by modifiable risk factors is a preventable chronic disease. Lifelong education should be provided to emphasize the importance of good bone health by identification of lifestyle modifications such as a healthy diet, regular physical activity and exercise, smoking cessation, maintaining a healthy body weight, limiting the consumption alcohol and caffeine to non-excessive amounts, and assessing for risk factors for falls.

▪ Healthy diet and nutrition with intake of daily recommended amounts of calcium, vitamin D, and protein are beneficial for bone health and prevention of osteoporosis. Daily recommendations for calcium vary according to age and gender and include: men age 50 to 70 consume 1000 mg/day and women age 51 and older and men age 71 and older consume 1200 mg/day of calcium. The recommended daily vitamin D intake for adults ages 50 and older, is 800-1000 IU.

▪ Regular weight-bearing exercises, non-weight bearing exercises, resistance training and aerobic exercises have been found to improve muscle strength and coordination, increase BMD, increase bone mass, stimulate osteoblasts for new bone formation, prevent bone loss, strengthen bones, and reduce the risk of falls and fractures.

▪ Lifestyle modifications such as maintaining a healthy body weight, smoking cessation, and avoidance of excessive intake of alcohol and caffeine should be educated in promotion of bone health and prevention of osteoporosis. Risk for falls assessments should also be performed to prevent osteoporosis related fractures.
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