Montana Geriatric Education Center

Instructions on Completing the Module

Screening for Osteoporosis in Older Adults

*The results of the assessments and evaluations are confidential, and the data is used to meet requirements of our federally funded grant.

Please make sure to turn in Pre-Test, Post-Test, and Module Evaluation.

1. **Before** reading the module, and without looking at it, complete the Pre-Test.
   Record your answers on the examination form marked **Pre-Test. (Found at the start of the module.)** Keep the completed answer form to turn in at the completion of the module.

2. Complete the module as outlined.

3. **After** reading the module and watching the videos, please complete the Post-Test.
   Record your answers on the examination form marked **Post-Test** (Appendix D). Keep the completed answer form to return with the pre-test at the completion of the module.

   Complete the **Module Evaluation** (Appendix E). Keep the completed module evaluation form to return with the pre-test and post-test at the completion of the module.

4. **To obtain credit for the module you must:**
   a. Complete the MTGEC Participant Profile at
      [https://health.umt.edu/ipharm/modules/default.php](https://health.umt.edu/ipharm/modules/default.php)
   b. Turn in the **Pre-Test, Post-Test, and Module Evaluation**
   c. Obtain a score of 70% or better on the Post-Test

**MTGEC/IPHARM**
Skaggs Building Room 318
University of Montana
32 Campus Drive
Missoula MT, 59812-1522
Email: IPHARM@umontana.edu
Phone (406) 243-2339 & Fax (406) 243-4353
Pre-test: Screening for Osteoporosis in Older Adults

Record responses on examination form.

1. Which of the following statements is NOT true about people with osteoporosis?
   a) Men have fewer osteoporosis-related fractures compared to women.
   b) Nearly one-third of patients who experience an osteoporosis-related hip fracture may die within one year of having the fracture.
   c) Black women have higher incidences of postmenopausal osteoporosis and fractures compared to white women.
   d) Approximately 10 million American adults have osteoporosis.

2. Secondary causes of osteoporosis include all of the following EXCEPT:
   a) Rheumatoid arthritis
   b) Glucocorticoid use
   c) Menopause
   d) Cigarette smoking

3. The earliest sign of osteoporosis in postmenopausal women may be:
   a) Low serum calcium level
   b) Chronic back pain
   c) A fractured wrist
   d) Hunched over back (Dowager’s hump)

4. Which of the following skeletal sites is the least common in osteoporosis-related fractures?
   a) Hip
   b) Collar bone
   c) Wrist
   d) Vertebrae

5. Which of the following exercises is NOT considered to be weight-bearing?
   a) Swimming
   b) Weight lifting
   c) Walking
   d) Aerobics

6. All of the following foods are a good dietary source of calcium EXCEPT:
   a) Fortified orange juice (6 ounces)
   b) Yogurt (8 ounces)
   c) Corn (1/2 cup)
   d) Fortified soy milk (8 ounces)

7. Of the following people, who would NOT be considered at increased risk for osteoporosis?
   a) Small framed person (weight < 127 lbs.)
   b) A 45 year old healthy male
   c) Patient taking phenytoin (Dilantin®)
   d) An alcoholic
8. Which of the following statements is TRUE regarding bone structure:
   a) Loss of cortical bone (more than trabecular bone) is primarily responsible for osteoporosis-related fractures.
   b) Peak bone mass is achieved for women in their early to mid-40’s.
   c) The process of building up and breaking down of bone is called resorption.
   d) Osteoblasts are cells which are responsible for the building up of bones.

9. Of the three major hormones involved in bone homeostasis, which one is primarily responsible for decreasing plasma calcium?
   a) Parathyroid hormone
   b) Calcitonin
   c) Vitamin D
   d) All of the above

10. Reducing a patient's risk for falling can decrease the risk of a fracture. Which of the following will decrease a patient’s risk for falls:
    a) Cataracts causing poor eye sight
    b) Initiating a new blood pressure medication
    c) Difficulty walking
    d) Adding hand rails in the bathroom

11. Which of the following statements is NOT true regarding the FRAX® tool?
    a) It is a validated on-line risk assessment calculator developed by the WHO.
    b) The DEXA T-score is an optional data point that can be entered to calculate the risk probability score.
    c) The FRAX score provides a 5-year risk percentage of major osteoporotic-related fractures.
    d) It is used for men and women between the ages of 40-90 years old.

12. If a 60 year old female patient’s T-score = -0.8 and their Z-score is +0.3, how would these results be best interpreted?
    a) This patient is at normal risk of a future fracture, and her bone density is less than that of someone her age, but better than a 30-year old female.
    b) This patient is at moderate risk of a future fracture, and her bone density is less than that of a 30-year old female, but slightly better than someone her age.
    c) This patient is at normal risk of a future fracture, and her bone density is less than that of a 30-year old female, but slightly better than someone her age.
    d) This patient is at moderate risk of a future fracture, and her bone density is less than that of someone her age, but better than a 30-year old female.

13. During a screening session with a CUBA Clinical device, a 75-year old woman, has a T-score of -1.8 & a Z-score of -1.3. She has a history of high blood pressure, heart disease, gastric reflux, and hypothyroidism for which she takes lisinopril, atorvastatin, lansoprazole, and levothyroxine. She states she tries to eat dairy products, but she has to watch her dietary fat intake. She does try to walk daily, but appears to be slightly overweight. This patient’s future risk of a fracture would be:*  
    a) Normal
    b) Moderate
    c) High
    d) Unknown
14. In addition to the above patient’s dietary calcium (estimated at 500mg daily), which calcium supplement would be the most beneficial?
   a) Caltrate® 600 + D. One tablet twice a day.
   b) Citracal® + D. One tablet three times a day.
   c) Tums® Ultra. One tablet twice a day.
   d) Viactiv® + D + K. One chew 5 times a day.

15. During a screening session, a 63-year old female, has a T-score of -3.1 and a Z-score of -1.9. She is a thin, frail looking patient, and states she doesn’t take any medications. This patient’s future risk of a fracture would be:
   a) Normal
   b) Moderate
   c) High
   d) Unknown

16. In the above patient, which of the following recommendations would be the most appropriate?
   a) Recommend to the patient that she continue what she is doing.
   b) Recommend to the patient that she continue what she is doing and recommend a dietary supplement.
   c) Recommend to the patient that she discuss the results of this screening with her primary care provider at her next scheduled appointment.
   d) Recommend to the patient that she be seen by her primary care provider at her earliest convenience to discuss the results of this screening and that further diagnostic testing may be needed.

17. According to the National Osteoporosis Foundation, screening for osteoporosis is recommended for:
   a) Adults who have a fracture after age 50.
   b) Any woman age 65 and older and men age 70 and older.
   c) Any younger postmenopausal women or men age 50-70 when there is concern based on their clinical risk factor profile.
   d) All of the above.

18. Which of the following bone mineral density tests does not use radiation as its method of detection?
   a) Quantitative computed tomography (QCT)
   b) Qualitative ultrasound (QUS)
   c) Single-energy X-ray absorptiometry (SXA)
   d) Dual-energy X-ray absorptiometry (DEXA)

19. Which of the following statements is FALSE regarding Qualitative Ultrasound (QUS)?
   a) QUS should not be used to diagnose osteopenia or osteoporosis.
   b) QUS provides information regarding the quantity of minerals in the patient’s bones.
   c) QUS uses broadband ultrasound (BUA) and speed of sound (SOS) to determine the structural complexity of a patient’s bones.
   d) The greatest usefulness of QUS is to help determine a patient’s future risk of a fracture.

20. When performing the QUS screening, which of the following will help to ensure an accurate result?
   a) The preferred foot to be used for testing is the dominant (usually the right) foot.
   b) It is acceptable to use a heel if it was broken at least 20 years prior to the current screening.
   c) It is possible to get an accurate test result with a person wearing nylon stockings or socks.
   d) The patient should be asked if they feel equal pressure on both sides of their heel when the membranes fill with water.
**PRE-TEST: Examination Form**

*Screening for Osteoporosis in Older Adults*

**Participant Information:**

1. Name: ______________________________________
2. Mailing address: ______________________________
   ______________________________________
   ______________________________________
   ______________________________________
3. Date exam completed _________________________

**Questions: (Please circle one response per question)**

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For credit, please return: MTGEC/IPHARM, Skaggs Building, Room 318, University of Montana, 32 Campus Dr., Missoula, MT 59812.
Montana Geriatric Education Center

Screening for Osteoporosis in Older Adults

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A 2-hour Geriatric Health Screening Module from the
Montana Geriatric Workforce Enhancement Program

A Consortium of: University of Montana,
Missoula Mountain Pacific Quality
Health, Helena RiverStone Health,
Billings
St. Vincent Healthcare, Billings

Montana Geriatric Education Center Website

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Screening for Osteoporosis in Older Adults
Disclosures

Montana Geriatric Workforce Enhancement Program Goals/Purpose
Improve health outcomes for older adults in rural Montana via increased knowledge of older adult care and treatment of health problems by health professionals.

Successful completion of this continuing education activity includes:
- Completion of the Pre-Test
- Reading of the text
- Visiting websites as directed in module
- Completion of the Post-Test with at least 70% accuracy
- Completion of the module evaluation

Contact Hours: 2

Conflicts of Interest
The planners and presenters of the CE activity have disclosed no relevant financial relationship with any commercial companies pertaining to this activity.

The Montana Geriatric Workforce Enhancement Program is supported by the Health Resources and Services Administration (HRSA) of the U.S. Department of Health and Human Services (HHS) under grant number U1QHP28733, Geriatric Workforce Enhancement Program (GWEP); the total award is $2,911,142 and supports the program 100%. This information or content and conclusions are those of the author and should not be construed as the official position or policy of, nor should any endorsements be inferred by HRSA, HHS or the U.S. Government.
Description of Module

Content

This module will discuss the impact of osteoporosis in the older adult population, discuss screening technology available for osteoporosis, and provide information on non-pharmacological interventions for osteoporosis.

Module Purpose

The purpose of the module is to enable the learner to improve his/her knowledge of and skill in screening and counseling for osteoporosis in older adults and apply it to the professional setting.

Learning Objectives

Specifically, the learner will be able to:

1. Identify risk factors for osteoporosis that indicate patients who should be screened.

2. Describe the technology behind quantitative ultrasound and how fracture risk is determined.

3. Formulate a care plan for a patient based on risk factors and the T- and Z-score results.

4. State the daily recommendations for calcium and Vitamin D, including a recommended supplement for each, along with the rationale for choosing one product over another.
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Screening for Osteoporosis in Older Adults

I. Osteoporosis as a Disease

A. Introduction
Osteoporosis is often referred to as a silent disease because it can painlessly progress until a fracture occurs. Fortunately, it is a preventable and treatable condition. However, in the U.S., osteoporosis is under-diagnosed and inadequately treated.\(^1\) Screening for low bone density can help to identify people at risk for developing fractures so that successful therapies can be initiated prior to the first typical symptom, a fracture.

B. Background
Osteoporosis is the most common bone disease and is a major public health concern. It affects a large number of Americans, both male and female, across all racial/ethnic backgrounds. Based on current prevalence rates and 2010 U.S. Census data, it is estimated approximately 10.2 million adults have osteoporosis and 43.3 million have low bone mass.\(^2\)

1. Epidemiology
   a) Incidence

- Approximately 80% of the patients with osteoporosis are women with the remaining 20% occurring in men.\(^2\)

- It is estimated that approximately 50% of white women and 20% of white men will experience an osteoporosis-related fracture in their lifetime.\(^1\)

- Each year approximately 2 million osteoporotic fractures occur in the United States leading to more than 500,000 hospitalizations, over 800,000 emergency room encounters, and more than 2.6 million physician office visits. It also leads to nearly 180,000 nursing home admissions.\(^1,3\)
• The most devastating type of fracture is a hip fracture, accounting for nearly 300,000 hospitalizations each year.\(^\text{(1)}\) The average age for experiencing a hip fracture is 80 years old.\(^\text{(4)}\)

b) Morbidity & mortality

• Hip fractures are associated with 12-37% excess mortality within the first year of sustaining the injury.\(^\text{(5-8)}\) Furthermore, those who survive a hip fracture have a 2.5 fold increase risk of a subsequent hip fracture.\(^\text{(9)}\) Half of those who survive the fracture will not be able to function without assistance and 20% will require either home nursing care or admission to a long-term care facility.\(^\text{(10)}\) Only 40% of those who experience a hip fracture will regain function at the same level as before the event.\(^\text{(1)}\)

c) Cost

• The economic burden of osteoporosis is substantial. In 2008, approximately $22 billion health care dollars were used to treat patients with osteoporosis-related fractures.\(^\text{(3)}\)

• In 2008, direct healthcare costs for the initial management and follow-up care in the first year post fracture were estimated to be $30,000 for hip, $11,300 for non-vertebral, and $8,380 for vertebral fractures.\(^\text{(11)}\)

• It has been estimated by 2025, due to the increasing cost of care and the number of aging adults, the cost of treating osteoporosis-related fractures could rise to $25.3 billion dollars annually.\(^\text{(3)}\)

2. Definition of osteoporosis

Osteoporosis occurs as a consequence of loss of bone mass and the decreased quality of the micro-architecture of bone, resulting in bone which is more susceptible to fracture. The World Health Organization (WHO) defines osteoporosis based on bone mineral density (BMD) measurement at the spine, hip or forearm by dual-energy x-ray absorptiometry (DXA or DEXA) (Tables 1 & 2).\(^\text{(12)}\)
### Table 1: T-score and Z-score: Terminology to Describe Bone Mineral Density (BMD)

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>T-score</td>
<td>The normal expected BMD for a healthy, “young” adult of the same sex</td>
</tr>
<tr>
<td></td>
<td>• Women’s reference age = 20-29 years old*</td>
</tr>
<tr>
<td></td>
<td>• Men’s reference age = 20-29 years old*</td>
</tr>
<tr>
<td>Z-score</td>
<td>The normal expected BMD for someone of the same age &amp; sex.</td>
</tr>
</tbody>
</table>

* Reference ages based on the normal achievement of maximal bone mass.

### Table 2: WHO Definitions for Osteoporosis using T-score Bone Mineral Density

<table>
<thead>
<tr>
<th>Classification</th>
<th>Bone Mineral Density Result</th>
</tr>
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<tbody>
<tr>
<td>Normal</td>
<td>BMD within 1 SD of a “young normal” adult (T-score at -1.0 and above)</td>
</tr>
<tr>
<td>Osteopenia</td>
<td>BMD is between 1 and 2.5 SD below that of a “young normal” adult (T-score between -1.0 and -2.5)</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>BMD is 2.5 SD or more below that of a “young normal” adult (T-score at or below -2.5)</td>
</tr>
</tbody>
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WHO = World Health Organization; SD = standard deviation

a) **Types of osteoporosis: Primary and secondary** (13)

Primary osteoporosis is not caused by other diseases or medication use. It is twice as likely to affect women compared to men over the age of 70 years old. The main contributing factors for primary osteoporosis include gonadal insufficiency in both men and women and age-related impairment of the bone remodeling process.

Secondary osteoporosis is bone loss from secondary factors such as other disease states (e.g., rheumatoid arthritis) or the use of medications which affect bone metabolism (e.g., glucocorticoids).

3. **Bone development and pathologic changes**

   a) **Skeletal function**

   The skeleton serves three main functions:
(1) Provides structural support for body movement and protection of vital organs.
(2) Contains the bone marrow essential for hematopoietic functions.
(3) Serves as a reservoir for minerals such as calcium, phosphorus, and carbonate which are involved in various physiological functions such as pH balance, neurotransmission, coagulation, and muscle contraction.

The functions of this organ system are very different and often compete with each other to meet the needs of the body. Maintaining biological function is essential to life; therefore, the structural purpose of the skeleton is secondary and ultimately expendable at the cost of bone architecture. [13] Although appearing to be a static entity, the skeleton is quite dynamic in its day-to-day functioning.

b) Bone growth
Bone growth and development from early childhood to adulthood is a process of modeling, replacing cartilage with bone, and the lengthening and thickening of bones. The peak amount of bone or bone mass usually occurs by the fourth decade of life for both men and women. Generally, men will gain a higher peak bone mass than women. [14]

Throughout life, a constant process of building bone and breaking it down occurs, which is referred to as remodeling. Early in life when bone remodeling processes are in balance, approximately 4% of bone is being built while 1% is being broken down. Although this is a slow process, within 7-10 years most of the skeleton will be replaced. [13] Before peak bone mass is achieved, the building of bone is greater than the break down (also called resorption), allowing for bones to increase in size. However, once peak bone mass is achieved, the building of bone slows and the resorption of bone gradually over time diminishes the skeletal reserves resulting in lower bone volume. Therefore, maximizing the amount of bone mass early in life is a significant predictor of bone health later in life. Factors which impact bone mass are genetic factors, dietary intake of calcium, sedentary lifestyle, chronic illnesses, low body weight, exposure to medications which affect bone remodeling, and hormonal influences. [15] Some of these factors will be discussed under osteoporosis risk factors.
c) Bone composition
Bone itself is composed of inorganic mineral, mainly in the form of calcium phosphate (hydroxyapatite crystals \([\text{Ca}_{10}(\text{PO}_4)_6\text{OH}_2]\)), and an organic matrix made from collagen, proteins, and cells (osteoclasts, osteoblasts and osteocytes).\(^{16,17}\) The skeleton contains 99% of the calcium and 85% of the phosphorus found in the body.\(^{16}\)

d) Bone remodeling
The process of remodeling occurs in 4 phases: resorption, reversal, formation and quiescence.\(^{18}\) Remodeling occurs within a group of cells called the bone modeling units (BMUs), which are comprised of cells which break down bone, called osteoclasts, and cells which build the bone, called osteoblasts.\(^{16,18}\)

The process begins with resorption. During this phase, osteoclasts secrete proteolytic enzymes and acids to dissolve the bony matrix to form a shallow indentation in the bone. Once finished, the reversal phase starts with the maturation of osteoblasts which suppress further bone resorption.\(^{16,18}\) Formation begins when osteoblasts manufacture and secrete an organic matrix (primarily collagen), called osteoid, which then begins to mineralize with calcium phosphate salts. Once these phases are completed, a latent period begins, called quiescence.\(^{16}\)

The activities of osteoclasts and osteoblasts are coupled to assist with the maintenance and integrity of the bone structure. In healthy, young to middle-aged adults, the rates of resorption and formation are normally equivalent, resulting in maintenance of bone mass. However, other factors, such as the normal aging process, menopause, certain medications and illnesses, can disrupt the equilibrium and bone loss can occur.\(^{18}\)

**Helpful Hint:**
“Clasts” = Cleave
“Blasts” = Build
e) **Bone structure**
Two types of bone are found in the adult skeleton: cortical (compact) and trabecular (spongy). Cortical bone comprises 80% of the skeleton, and consists of tight, compact concentric layers of bone. It is found on the external surfaces of bone and its main function is structural. Trabecular bone is found in the interior of large and flat bones, such as the pelvis, ribs, and vertebrae, and at the ends of long bones. Trabecular bone also contributes to structural support, especially in the vertebrae, but its highly vascular component allows it to respond to changes in metabolic needs (Figure 1). The appearance of the trabecular bone is like structural beams of a house, and the inner spaces or rooms are filled with bone marrow.

![Figure 1: Picture of Normal and Osteoporotic Trabecular Hip Bone](Image)

f) **Sites affected by osteoporosis**
The most common sites for fracture are the hip, vertebrae, and the wrist. These areas are more susceptible due to the high ratio of trabecular bone to cortical bone. Trabecular bone has a faster rate of remodeling and a less compact structure compared to cortical bone, therefore increasing the risk of bone loss and subsequent fracture. Figure 2 demonstrates the percentage of fractures per year in the most common skeletal sites.
g) Hormonal control of bone homeostasis

Ninety-nine percent of the body’s calcium is stored within the skeletal system leaving the remaining 1% available for cellular function.\(^{[6]}\) Three hormones, parathyroid hormone (PTH), vitamin D, and calcitonin, are involved in calcium homeostasis which is regulated through the kidney, the gastrointestinal tract, and the skeleton.\(^{[17,18]}\) Table 3 summarizes the hormonal actions on calcium homeostasis.

**Table 3: Summary of Hormonal Actions on Calcium Homeostasis**

<table>
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<tr>
<th>Tissue</th>
<th>PTH</th>
<th>Vitamin D</th>
<th>Calcitonin</th>
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<tbody>
<tr>
<td>Gastrointestinal tract</td>
<td>No direct effect</td>
<td>↑Ca(^{2+}) absorption</td>
<td>No direct effect</td>
</tr>
<tr>
<td>Kidney</td>
<td>↑Ca(^{2+}) retention</td>
<td>↑Ca(^{2+}) retention</td>
<td>↓Ca(^{2+}) retention</td>
</tr>
<tr>
<td></td>
<td>↑ Vitamin D synthesis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bone</td>
<td>↑ bone resorption</td>
<td>↑ bone resorption</td>
<td>↓ bone resorption</td>
</tr>
<tr>
<td>Effect on plasma [Ca(^{2+})]</td>
<td>↑ [Ca(^{2+})]</td>
<td>↑ [Ca(^{2+})]</td>
<td>↓ [Ca(^{2+})]</td>
</tr>
</tbody>
</table>

*PTH = parathyroid hormone, Vitamin D = 1, 25-diOH-Vitamin D\(_3\)*
(1) **Parathyroid hormone (PTH)**

PTH is a polypeptide hormone synthesized in the parathyroid gland. PTH release is correlated with the levels of circulating plasma calcium. Low calcium concentrations stimulate PTH production which directly leads to calcium reabsorption from the bone. PTH also increases renal reabsorption of calcium. These actions result in increased serum calcium levels. Likewise, elevated calcium levels inhibit the synthesis of PTH, allowing the circulating calcium to be utilized for bone formation.\(^{(17,18)}\)

(2) **Vitamin D**

The active form of vitamin D is calcitriol (1,25-dihydroxyvitamin D3). The two primary sources of vitamin D are the diet and when the skin is exposed to the sunlight. The conversion of vitamin D to its active form occurs as a two-step hydroxylation process, with the first step in the liver and the second step in the kidney (see Figure 3).\(^{(17,18)}\)

**Figure 3: Activation of Calcitriol (1,25-dihydroxvitamin D3)**\(^{(14)}\)
Once the active form is synthesized, its primary effect is to increase calcium absorption in the small intestine, increase calcium reabsorption in the kidney, and stimulate osteoclasts to release calcium from the bone.\textsuperscript{16-18}

Risk factors for vitamin D deficiency include advanced age, malabsorption disorders (celiac, inflammatory bowel disease, gastric bypass surgery), renal disease, obesity, dark skin tone, and situations where sun exposure is reduced.\textsuperscript{15, 16} In the older adult population, the skin’s ability to synthesize vitamin D is not as efficient as it once was, which can lead to a deficiency.\textsuperscript{16,17} In addition, people living in nursing care facilities may have less time outdoors in sunlight. During winter months, not only do people tend to spend less time outdoors, but also the sun’s angle is not as direct in the Northern Hemisphere. This leads to diminished sunray dermal activation due to decreased penetration of the ultraviolet (UV) light through the ozone layer of the atmosphere. The use of sunscreen products can also decrease UV exposure and can lead to less vitamin D synthesis.\textsuperscript{16-18}

(3) Calcitonin
Calcitonin is a polypeptide hormone secreted from the parafollicular cells of the thyroid. When high levels of calcium are perfused in the thyroid, calcitonin is secreted to decrease calcium levels. It exerts its action by directly inhibiting osteoclasts in the bone, as well as increasing renal excretion of calcium in the urine.\textsuperscript{17}

4. Risk factors
Risk factors for osteoporosis can be categorized as those which affect bone structure and those which increase the risk for fracture.

a) Factors which affect bone structure

(1) Gender
Both men and women experience age-related decreases in bone mass, but women are twice as likely as men to incur an osteoporosis-related fracture. Factors which may help explain this result are that men tend to achieve higher bone density, experience fewer falls, and have a shorter lifespan, compared to women.
Additionally, women undergo a rapid decrease in bone mass following menopause.\(^{(19,20)}\)

(2) **Increasing age**
Bone loss is a normal process of aging primarily due to loss of osteoblast activity and an increase in adipocytes in the bone marrow, which leads to crowding out of bone formation sites.\(^{(21,22)}\)

(3) **Race**
Rates of low bone mass and osteoporosis vary among different racial and ethnic groups. (Table 4). Caucasian women account for 75% of all hip fractures. African-American women are thought to achieve a higher peak bone mass and have a slower rate of bone loss after menopause\(^{(22,23)}\)

<table>
<thead>
<tr>
<th>Ethnic/Racial Group</th>
<th>Osteopenia</th>
<th>Osteoporosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian</td>
<td>50%</td>
<td>10%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>47%</td>
<td>10%</td>
</tr>
<tr>
<td>Native American</td>
<td>45%</td>
<td>12%</td>
</tr>
<tr>
<td>Caucasian</td>
<td>40%</td>
<td>7%</td>
</tr>
<tr>
<td>African-American</td>
<td>28%</td>
<td>4%</td>
</tr>
</tbody>
</table>

(4) **History of low-trauma fracture**
A prior low-trauma fracture, especially one which occurred after age forty, is a strong predictor of future fractures. In fact, women who have experienced a low-trauma fracture in their 40’s are twice as likely to experience future fractures.\(^{(12,24,25)}\)

(5) **Concurrent diseases**
A variety of medical conditions may increase the risk of osteoporosis such as cancer, insulin-dependent diabetes, chronic-obstructive pulmonary disease, hyperpara-
thyroidism, hyperthyroidism, rheumatoid arthritis, organ transplantation, HIV/AIDS, lupus, heart failure, end-stage renal disease, multiple sclerosis and others.\(^{(12,13,25)}\)

(6) **Decreased physical activity or sedentary lifestyle**
Physical exercise is essential for strengthening bones and maintaining bone health. Exercise also aids in improving balance and strength which may diminish the risk for falling. Patients who do not get adequate exercise, whether by choice, lack of physical mobility or illness, have been shown to be at increased risk of fracture.\(^{(12,25)}\)

(7) **Low body mass**
Low body mass may indicate low bone density, which may predispose a patient to osteoporosis. Women who weigh less than 127 pounds have been found to be at greater risk of osteoporosis-related fractures compared to women who weigh more.\(^{(12,25)}\)

(8) **Nicotine products**
**Cigarettes**
Exposure to cigarette smoke (both active and passive) has detrimental effects on bone density.\(^{(12,25)}\) It has been well documented that smoking reduces peak bone mass, increases the rate of bone loss by inhibiting osteoblast activity, and reduces circulating estrogen levels.\(^{(26-30)}\)

Due to the negative effects cigarettes have on bone health, smokers have a much higher risk of developing osteoporosis and related fractures. Additionally, it is a dose-response relationship. Those who smoke more heavily have lower bone density and increased fracture risk.\(^{(26)}\) When comparing smokers to non-smokers, by the age of 80, the smokers’ bone density will be 6-10% lower than the non-smokers.\(^{(26)}\) This correlates to a doubling of the spinal fracture risk and a 50% increase in the risk of hip fracture.\(^{(26)}\)

Not only does smoking have direct effects on bone density, smokers generally have other risk factors for osteoporosis. They tend to be thinner, may drink more alcohol, have poorer nutrition, and female smokers may have earlier menopause due to lower
estrogen levels. Many will be less active which could lead to decreased muscle strength predisposing them to falls.\textsuperscript{31}

**Smokeless tobacco**

In 2009, the Montana Adult Tobacco Survey reported that 13\% of male Montanans used chewing tobacco, nearly double the national average.\textsuperscript{31-35} According to population based surveys, the racial subgroups that report the highest use of smokeless tobacco products are Native Americans and Alaska Natives.\textsuperscript{31}

Currently, the evidence is limited showing the relationship between smokeless tobacco and systemic bone density loss in humans. According to literature reports, the use of chewing tobacco will cause bone loss in the oral cavity. However, only nicotine studies in animals and one small study with human subjects have shown negative effects on bone density. In one of the few cross sectional studies in women, the investigators determined that smokeless tobacco use increases age-related bone density loss.\textsuperscript{36}

**Electronic cigarettes**

Currently, there is no long-term safety data on e-cigarette use. It is unclear if this method of nicotine delivery has a lower risk for bone loss compared to cigarettes or smokeless tobacco. Cessation of all forms of nicotine use should be encouraged to reduce risk of negative long-term health effects.

**9) Excessive alcohol consumption**

The ingestion of 3 alcoholic drinks per day or greater than 7 alcoholic drinks per week is associated with an increased risk of osteoporosis and higher risk of falls.\textsuperscript{12,37}

**10) Inadequate nutrition**

Proper nutrition is essential to the development of optimal peak bone mass. The intake of appropriate calcium and vitamin D is particularly important. Patients with a history of eating disorders (e.g., anorexia nervosa), malabsorption disorders (e.g., celiac sprue, inflammatory bowel disease, gastrectomy or gastric bypass surgery), or inadequate diet are at greater risk of developing osteoporosis.\textsuperscript{12,25}
(11) Use of resorptive medications

Some medications increase bone resorption leading to increased bone loss and subsequent risk of osteoporosis. The main groups of medications primarily involved are systemic glucocorticoids (e.g., prednisone and hydrocortisone), older anti-seizure medications (e.g., phenytoin and phenobarbital), depot medroxyprogesterone for contraception, and loop diuretics (e.g., furosemide). Other less common medications involved are methotrexate (usually for chronic use as an immunosuppressant for diseases such as rheumatoid arthritis), antiretroviral medications for HIV, long-term total parenteral nutrition, lithium, and supra-therapeutic doses of thyroid hormone.\(^{12,38}\)

(12) Estrogen exposure

Estrogen plays an important role in the development of healthy bones. When levels are decreased, the rate of bone resorption exceeds that of bone formation, especially in trabecular bone.\(^{18}\) Therefore, women who start menstruating at a later age, have infrequent menstrual cycles, experience premature menopause (earlier than 45 years of age) or who have their ovaries removed (without estrogen replacement) are at increased risk of developing osteoporosis.

Following menopause, an increased rate of bone loss occurs at approximately 2% per year and lasts about 7-10 years.\(^{18}\) After this point, the rate of loss resumes at the normal age-related decline, which is approximately 0.5% annually.\(^{18}\)

For many years, estrogen replacement was considered a first line therapy for the prevention and treatment of osteoporosis. In 2002, the results of the landmark Women’s Health Initiative (WHI) trial were published. This primary prevention trial showed estrogen replacement alone or hormone replacement therapy (HRT) can increase bone mass and decrease fracture rates, but also increased the risks of thromboembolic events and some forms of cancer.\(^{39,40}\) Currently, risks outweigh the benefits of estrogen alone or with progestin for a firstline therapeutic option to prevent osteoporosis.\(^{12,18,25}\) The use of low-dose, short-term estrogen for vasomotor
symptoms associated with menopause remains clinically appropriate. Once estrogen therapy is discontinued bone loss is fairly rapid and the benefit is lost.\textsuperscript{(18)}

b) Factors which increase the risk of falls
A high percentage of osteoporosis-related fractures occur secondary to falls. Therefore, it is important to assess fall risk and address modifiable risk factors.

Risk Factors for Falls\textsuperscript{(12,25,41)}

1. Orthostatic hypotension
2. Medical conditions (arrhythmias, anxiety, vitamin D deficiency)
3. Frailty/poor health
4. Poor vision
5. Impaired hearing
6. Cognitive impairment
7. Sedation caused by medications (benzodiazepines, tricyclic antidepressants, and antihistamines)
8. Dizziness or vertigo
9. Environmental factors (low lighting, lack of assistive devices in the bathroom, throw rugs)
10. Neuromuscular changes (poor balance, weak muscles, gait impairment)

Montanans are not immune to fall-related injuries. From 2007 to 2016, a significant increase in death from falls was reported in residents aged ≥65. In 2007, the age-adjusted rate of death from falls among people ≥65 in Montana was 60 per 100,000 and grew to 85 per 100,000 in 2017. As Montana’s population continues to age, injuries from falls are expected to increase, which will continue to contribute to premature deaths for older adults in Montana.\textsuperscript{(42)}

For more information on screening for falls and fall risk reduction, see the MTGEC module \textit{Fall Prevention for Community Dwelling Older Adults}.

c) Importance of risk factor identification
The importance of identifying patient risk factors for osteoporosis was demonstrated with a one-year, observational study in over 57,000 white, female patients who had a diagnosis of osteopenia (T-score between -1.0 and -2.5).\textsuperscript{(43)} The women taking medications for the prevention or treatment of osteoporosis, including bisphosphonates, calcitonin or raloxifene, were excluded from the study. Those taking estrogen replacement therapy were not. At the baseline visit, a bone density test was performed and the patients were
asked to complete a survey assessing 32 potential risk factors. One year later, they were contacted regarding any fractures incurred within the last year. Two percent of the women had osteoporosis-related fractures including 196 hip, 319 rib, 126 vertebral and 535 wrist or forearm fractures. The results of the one-year study were entered into a classification and regression tree analysis to develop an algorithm to be used as a tool to predict future fractures. The four risk factors with the strongest prediction of a one-year risk of fracture were: (1) history of a previous fracture as an adult, (2) a T-score ≤-1.8, (3) self-reported health status of fair/poor, and (4) self-reported poor mobility. Based on these four factors alone, the algorithm that was developed could predict 74% of the patients who had a fracture within a one year period.[43] Therefore, identifying risk factors is an important aspect of osteoporosis screening and should be utilized in conjunction with bone structural measurements to help determine patient-specific recommendations.

**FRAX® - Fracture Risk Assessment Tool**

FRAX® is a validated, computer-based, fracture prediction model created by the World Health Organization (WHO) used to calculate the 10-year probability of a major osteoporotic fracture and hip fractures in men and women ages 40-90 years old.[44] A major osteoporotic fracture is defined as a spine, hip, forearm or humerus fracture. The estimated fracture risk is obtained by entering patient data including age, sex, body mass index, current smoking status, alcoholic drinks per day, previous fracture, parent hip fracture, medication use, and presence of rheumatoid arthritis and other causes of secondary osteoporosis into the online tool. A score is calculated and a 10-year fracture risk percentage is determined.[44,45] The T-score or BMD from a DEXA can also be entered to help predict fracture risk, but this data point is optional. This tool can be utilized in conjunction with quantitative ultrasound bone mineral density screening devices to more accurately determine the patient’s risk for fracture.

The FRAX® tool can be used to provide further guidance for interventions. United States Preventative Services Task Force (USPSTF) currently recommends a DEXA scan if the major osteoporosis-related fracture probability score is ≥ 9.3%, however, the panel suggests considering other factors such as additional risk factors and patient preference to guide
clinical decision making. The National Osteoporosis Foundation (NOF) recommends providers to consider medication therapy if the 10-year probability for a major osteoporotic fracture is ≥20% or if the hip fracture probability is ≥3%.

**Figure 4: Image of FRAX® tool**

5. **Osteoporosis in males**

While the majority of patients with osteoporosis are women, men should not be excluded from this discussion. A lower incidence of osteoporosis in men occurs for several reasons; however, the disease continues to be under-diagnosed and under-treated in this subgroup. In addition, men experience 30-40% of the osteoporosis related fractures, and are more likely to die within the year following the fracture.

Primary or age-related osteoporosis accounts for roughly 60% of the osteoporosis cases in men, but the remaining 40% is related to secondary causes, such as low testosterone levels, alcoholism, and oral corticosteroid use.
II. Osteoporosis Screening

A. NOF Screening Recommendations
In 2014, the National Osteoporosis Foundation (NOF) published updated recommendations for bone density testing\(^1\). It should be noted that screening individuals who fall outside these recommendations is appropriate, if warranted, but current evidence does not support population screening outside of these parameters.

Indications for BMD Testing\(^1\):  
1. Women age 65 and older and men age 70 and older, regardless of clinical risk factors.  
2. Younger post-menopausal women, women in the menopausal transition and men over 50 with clinical risk factors for fracture.  
3. Adults who have had a fracture after age 50.  
4. Adults with a condition (e.g., rheumatoid arthritis) or who are taking a medication (e.g., prednisone ≥5mg/day or equivalent glucocorticoid dose for ≥ 3 months) associated with low bone mass or bone loss.  
5. In those taking medications for osteoporosis, BMD testing 1-2 years after initiation and every two years thereafter. More frequent testing may be indicated in certain clinical situations, while longer intervals between testing may be appropriate in those without major risk factors and initial T-scores which are normal to slightly low (osteopenia).

B. Screening Technologies
The strength of bone is determined by bone density, bone elasticity, and its microarchitecture, particularly the architecture of trabecular bone. The gold standard test for assessing bone density is the dual-energy X-ray absorptiometry (DXA or DEXA), which utilizes X-rays to penetrate bone to determine the density; the denser the bone, the more X-rays are absorbed\(^48\). Other technologies are available for osteoporosis detection, but may not be suitable for mass screenings due to relatively high cost and low portability. Table 5 summarizes the technologies available.
Table 5: Comparison of Bone Mineral Density Devices\textsuperscript{48,49}

<table>
<thead>
<tr>
<th>Technology</th>
<th>Detection Method</th>
<th>Sites tested</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Dual-energy X-ray absorptiometry (DEXA) | X-ray radiation  | Total body, spine, proximal femur, forearm, heel, & finger | • Gold standard for diagnosis  
• Expensive  
• Need skilled technician |
| Single-energy X-ray absorptiometry (SEXA) | X-ray radiation  | Forearm, finger, & heel                           | • Only on peripheral sites  
• Less expensive than DEXA  
• Good for screening |
| Quantitative computed tomography (QCT) | Radiation        | Spine & forearm                                   | • Can be used to diagnose  
• Expensive  
• Need skilled technician |
| Radiographic absorptiometry      | X-ray radiation  | Fingers                                           | • Expensive  
• Need skilled technician  
• Good for screening |
| Qualitative ultrasound (QUS)     | Sound waves      | Heel, tibia, & patella                            | • Portable device  
• Inexpensive  
• Good for screening |

While bone mineral content is an indicator for bone strength, it tells little about the quality of the bone. Quantitative ultrasound technology (QUS) uses sound waves to reveal the structural integrity of the bone by measuring the broadband ultrasound attenuation (BUA) and the speed of sound (SOS) through bone. Simply put, the more structurally complex the bone, the more sound waves will be blocked resulting in a higher BUA. In a similar fashion, structurally complex bone conducts sound faster than weakened bone, displaying a higher SOS. Therefore, structurally complex (or normal) bone has a higher BUA and SOS compared to weakened, osteoporotic bone. BUA and SOS are then used to estimate a patient’s bone mineral density\textsuperscript{48,49}

The greatest utility of screening devices is not their ability to measure bone mineral density, but rather that the results can estimate the risk of future fractures. Since different tests utilize different technologies as well as different test sites (i.e., heel, hip, forearm, etc.), the raw data or results can NOT be used interchangeably between devices\textsuperscript{61}. Although the technology may be different among screening devices, their ability to predict future fractures is similar and has been validated with multiple studies\textsuperscript{50-53}. 
C. Interpreting Results

In order to understand the topic of fracture risk, one must first understand how bone density tests are reported: T-score and Z-score. Recall from statistics that a normal population should have a Gaussian distribution, which has a bell-shaped curve. Bone mineral content follows a Gaussian distribution and, therefore, can be represented in terms of the number of standard deviations (SD) from the normal. The number of standard deviations approximates a certain percentage of the population: 1 SD = 68%, 2 SD = 95%, and 3 SD = 99.7%. Because the loss of bone density is the concern, the left side or the negative side of the bell curve is the focus of osteoporosis-related discussions. The T-score value is the number of SDs away from mean bone density for normal young women or men at peak bone mass which occurs in early adulthood. The Z-score is the number of SDs above or below the mean of someone of equal age and gender to the person being tested. Figure 5 demonstrates the normal distribution of bone mineral density in women ages 30-40 years old; Figure 6 demonstrates the age-related shift of the normal distribution of bone density, thus the basis for the Z-score determination.\textsuperscript{41,49} Therefore, it is possible for a 60-year old woman to have a T-score of -2.4 and a Z-score of -1.0.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{normal_distribution.png}
\caption{Normal Distribution of 30-40 year old females}
\end{figure}
An inverse relationship exists between bone density and fracture risk; the lower the bone density, the higher the future fracture risk. A similar relationship exists between heel ultrasound and hip fracture. For every SD decrease in BUA, there is approximately a 2-fold increase in risk of fracture at the hip. This 2-fold increase in fracture risk can be predicted by either DEXA or QUS.\textsuperscript{[50-53]}

One final distinction needs to be made among the screening technologies; QUS devices are for screening and not intended as a diagnostic test for osteoporosis. DEXA is the only technology that can be used to diagnose osteoporosis. QUS is a portable, validated tool to assess fracture risk, which can be used to screen patients and then make recommendations for lifestyle
modifications, calcium and Vitamin D intake, or a referral for follow-up care with their primary health care provider.\textsuperscript{41}

\section*{D. GE Achilles Bone Ultrasonometer}

\subsection*{1. Equipment}

- Achilles measurement device by GE Corporation (weighs 25.4 pounds)
- Power cord
- Foot-positioning insert
- Quality assurance phantom
- Rubbing alcohol (70\% ethanol)
2. How it measures?

The Achilles device is an ultrasonic bone sonometry system. The Achilles EXPII converts the soundwaves to electrical signals and measures the speed of sound (SOS) and the attenuation of the soundwaves (broadband ultrasound attenuation – BUA), and combines them to determine the Stiffness Index. See Figure 8.
3. What does it measure?
The Achilles device measures broadband ultrasound attenuation (BUA) by measuring the attenuation of ultrasound waves in decibels (dB) at a particular frequency in megahertz (MHz). The typical range of BUA in the normal population ranges from 20-125 dB/MHz. The device also measures speed of sound (SOS) which is used in the quality assurance of the machine.

The more structurally ‘dense’ bones are, the more the sound wave will be blocked through the bone. Thus normal bone results in a higher attenuation, or higher BUA measurement, than osteoporotic bone. Bone which has a high degree of conductivity, such as normal bone, allows for sound waves to move quickly through the bone. Conversely, as bone becomes more osteoporotic, the speed of the sound wave will slow down and a lower BUA will be measured.\(^{(44)}\)

E. How to Use the GE Achilles Bone Ultrasonometer

1. Setting up the device
   (1) Connect the cable between the Achilles device and the main power supply.
   (2) Switch on the Achilles.
   (3) Open the calf plate (the hinged lid over the footwell).
2. **Steps to calibrate device**

The Achilles device must be calibrated once every 7 days using the QA phantom. The device will cue the operator when it is switched on as to the need for QA.

**Step 1: Device notifies when QA measurement required.**
Begin a session by following the on-screen instructions and using the QA phantom and rubbing alcohol. Briefly, the operator will spray both sides of the phantom and both membranes on the device with rubbing alcohol and then select next on the screen.

**Step 2: Press “continue” on the screen.**
The membranes will fill with water and there will be a countdown on the screen. Do not disturb the Achilles device during the QA process.

**Step 3: Evaluate QA result.**
The device will indicate whether or not the QA measurement was successful on the screen and will automatically print the result. In the case of a “fail” result, rerun the phantom and confirm that there are no leaks in the membranes and that sufficient alcohol was used. Repeat until it passes.

3. **Steps for completing a test on a patient**

**Step 1: Patient must be comfortably seated in a stable chair.**
The patient must be seated in a fixed chair (no wheels) and positioned such that the patient can comfortably sit back in the chair with the foot correctly aligned in the Achilles footwell. Correct foot and leg alignment is imperative to achieving an accurate result. Proper positioning of the leg and foot consists of the leg resting comfortably on the calf support provided by the device, and the heel should be placed gently but firmly against the back wall of the footwell. In addition, the first two toes should straddle the ridge as indicated in the diagram on the footwell of the device.

**Step 2: Ask patient to remove shoe and sock from the non-dominant foot.**
The non-dominant foot, which is typically the left foot in a righthanded person, is the preferred foot to be tested. The left foot has been used in the majority of clinical trials. If the patient prefers the right foot, that is acceptable. If the patient has broken or severely injured one of the heel bones in the past year or has a metal rod or plate in the heel, the
other foot should be used. Similarly, patients who have abrasions, open sores on the skin of the foot, or edema, should use the other foot without such problems.

Step 3: Determine if foot insert is needed.
An anatomical foot insert is supplied to ensure the proper alignment of the foot with the transducers. To determine if the foot insert (foot shim) is needed, ask the patient about shoe size; if they are less than a size 6, then the shim is required.

- No shim is needed for a foot greater than a size 6.

Ask the patient to remove his or her foot from the footwell and place it on top of the device; place the foot shim into the device, if needed.

Step 4: Enter patient-specific data into the Achilles device and begin measurement.
Enter the patient-specific data, i.e., sex, age and which foot is being used for testing, into the device. Prompts will appear on the touchscreen for each entry needed.

Step 5: Application of rubbing alcohol.
Rubbing alcohol (70% ethanol) is used to ensure good contact is made on each side of the heel. Two to three sprays, creating a thin layer of alcohol should be placed on each side of the heel as well as on each membrane of the device. Proceed quickly to the measurement before the alcohol dries.

Step 6: Position heel in footwell.
Carefully place the foot into the footwell. Verify the heel is gently but firmly placed against the back of the footwell. Ideally, the heel should be centered between both membranes to ensure an accurate reading. Click continue on the data entry screen.

Step 7: Device fills membranes with warm water on both sides of the heel.
After entering patient data and selecting the continue arrow, the membranes will fill with water automatically. Once they have been filled, the patient must remain still and not talk while the device is measuring (approximately 10 seconds) to ensure an accurate result.
The patient should feel equal, gentle pressure around the heel bone.
At the completion of the test, the membranes will automatically empty and the patient can easily remove his or her foot. Remaining alcohol can be removed from the patient’s foot using tissues. Additionally, the footwell should be cleansed with rubbing alcohol in preparation for the next patient.

An error message displayed at the end of the test indicates a failure of the device to read the ultrasound results. If the Achilles is not able to get a valid reading, it is likely due to too little alcohol being applied, air bubbles under the membrane, or the patient moved during the reading. If this occurs, reapply alcohol to the heel and the membranes and repeat the test. If an error message continues, see the section on Sources of Error for the possible cause.

F. Interpretation of Results

Interpretation of Achilles T- and Z-scores requires the incorporation of risk factors to assist with clinical recommendations. The following decision tree (Figure 10) may be of assistance in initial decision making.
G. Sources of Error

1. Equipment
   - Infrequent use of QA phantom
   - Not properly maintained (not kept clean, water changed, membrane replaced)

2. Operator
   - Not properly trained

3. Patient
   - Moving/talking during test
   - Unusually thickened heel bone; not uncommon in big-boned people, particularly in men.
   - Edema of the feet

4. Procedural
   - Improper alignment of the heel
   - Lack of sufficient rubbing alcohol on either the heel area or the membranes
H. Screening in the Community

1. Financial Implications

Currently, clinical pharmacists may be able to charge for services incident to the screening process by performing the screening assessment in a physician’s office. The implementation of bone density testing has been successfully accomplished in community pharmacy settings; however, insurance doesn’t typically cover services provided.\textsuperscript{(55-57)}

Medicare does cover DEXA scan (CPT Code 76977) testing every two years with a primary health care provider order in patients 65 years or older, including but not limited to:\textsuperscript{(12,55,58)}

a) Estrogen deficient women at clinical risk of osteoporosis

b) Individuals with abnormalities on x-ray including findings suggestive of osteoporosis, osteopenia, and/or vertebral fractures

c) Individuals receiving, or planning to receive, long-term glucocorticoid (steroid) therapy $\geq$ 5mg/d of prednisone or an equivalent dose for $\geq$3 months

d) Individuals with primary hyperparathyroidism

e) Individuals being monitored to assess the response to or efficacy of an approved osteoporosis drug therapy

III. Interventions to Prevent or Treat Osteoporosis

A healthy lifestyle to promote optimum bone health should be pursued at all ages. A plan that consists of healthy lifestyle habits, good nutrition, the recommended calcium and vitamin D intake, regular exercise, and that addresses safety issues to prevent falls, will reduce the risk of osteoporosis and fractures. For more information on nutrition in osteoporosis, see the MTGEC module Nutrition Concerns of Older Adults.
A. Non-pharmacologic Interventions

1. Lifestyle modifications
   
   a) Avoid the use of nicotine products.

   b) Moderate alcohol intake (no more than 2 standard size drinks in a day or 7 drinks per week).

   c) Regular weight-bearing and muscle strengthening exercise. Examples of weight bearing exercises include walking, running, stair climbing, dancing, and tennis. Swimming is an example of nonweight-bearing form of exercise. Muscle strengthening exercises include weight lifting or the use of resistance bands.

   d) Limit the use of caffeine and soft drinks.\(^{(12,25)}\)

2. Increased dietary calcium

The average American diet for men and women over 50 years of age consists of about 600-700 mg of elemental calcium, of which approximately 75-80% is supplied from dairy sources.\(^{(3,4,8)}\) Table 6 provides a tool to estimate a patient’s dietary calcium intake. Table 7 lists the calcium content of common foods and Table 8 contains the estimated calcium content of some calcium-fortified foods. A more sophisticated calcium calculator can be used to more accurately determine calcium intake.

Table 6: Simplified Calculation of Daily Dietary Calcium \(^{(12)}\)

<table>
<thead>
<tr>
<th>Food</th>
<th># of servings</th>
<th>Calcium amount per serving</th>
<th>Total Calcium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk (8 oz)</td>
<td></td>
<td>X 300mg</td>
<td>=</td>
</tr>
<tr>
<td>Yogurt, plain lowfat (8 oz)</td>
<td></td>
<td>X 400 mg</td>
<td>=</td>
</tr>
<tr>
<td>Cheese (1 oz)</td>
<td></td>
<td>X 200 mg</td>
<td>=</td>
</tr>
<tr>
<td>Non-dairy calcium sources</td>
<td></td>
<td></td>
<td>= 250 mg</td>
</tr>
</tbody>
</table>

Estimated sum total of daily calcium \(\rightarrow\) =
Table 7: Estimated Calcium Content of Common Foods\(^{(12,58)}\)

<table>
<thead>
<tr>
<th>Food</th>
<th>Serving Size</th>
<th>Calcium (mg) per serving</th>
<th>Food</th>
<th>Serving Size</th>
<th>Calcium per serving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td></td>
<td></td>
<td>Yogurt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk</td>
<td>1 cup (8 oz)</td>
<td>300</td>
<td>Low-fat fruit</td>
<td>1 cup</td>
<td>350</td>
</tr>
<tr>
<td>Milk, powdered</td>
<td>1 teaspoon</td>
<td>50</td>
<td>Fish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ice cream</td>
<td>½ cup</td>
<td>100</td>
<td>Sardines</td>
<td>3 oz</td>
<td>370</td>
</tr>
<tr>
<td>Egg</td>
<td>1 egg</td>
<td>55</td>
<td>Salmon</td>
<td>3 oz</td>
<td>200</td>
</tr>
<tr>
<td>Cheese</td>
<td></td>
<td></td>
<td>Vegetables, bean &amp; nuts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>American</td>
<td>1 oz</td>
<td>175</td>
<td>Almonds</td>
<td>¼ cup</td>
<td>100</td>
</tr>
<tr>
<td>Cheddar</td>
<td>1 oz</td>
<td>200</td>
<td>Beans, kidney</td>
<td>1 cup</td>
<td>50</td>
</tr>
<tr>
<td>Cottage</td>
<td>½ cup</td>
<td>80</td>
<td>Beans, baked</td>
<td>1 cup</td>
<td>130</td>
</tr>
<tr>
<td>Cream</td>
<td>2 tablespoons</td>
<td>30</td>
<td>Broccoli</td>
<td>1 cup</td>
<td>160</td>
</tr>
<tr>
<td>Mozzarella</td>
<td>1 oz</td>
<td>210</td>
<td>Tofu</td>
<td>4 oz</td>
<td>150</td>
</tr>
</tbody>
</table>

Table 8: Estimated Calcium Content of Fortified Foods\(^{(25,59)}\)

<table>
<thead>
<tr>
<th>Food</th>
<th>Serving Size</th>
<th>Calcium (mg) per serving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soy beverage</td>
<td>1 cup (8 oz)</td>
<td>80-500</td>
</tr>
<tr>
<td>Orange juice</td>
<td>6 oz</td>
<td>378</td>
</tr>
<tr>
<td>Ready-to-eat cereal</td>
<td>1 cup</td>
<td>100-1,000</td>
</tr>
</tbody>
</table>

### 3. Fall prevention

Ninety-five percent of hip fractures are related to falls and roughly 55% of fractures in older adults occur at home.\(^{(60)}\) Therefore, it is important to identify patients at risk and to make recommendations to prevent falls from occurring.

**Questions useful to assess a patient’s risk of falls include:**

- *Have you had any recent falls? What caused the fall? Was it an issue of balance, dizziness, tripping over a rug or shoes?*

- *Is it difficult for the patient to get in and out of the chair used for the bone density test? Did they seem unsteady or need assistance?*

- *Does the patient live alone? What might they do if they did fall and should need help?*
Falls are caused by intrinsic (personal) and extrinsic (environmental) factors, or a combination of both.\(^{60,61}\)

a) **Intrinsic Factors**

(1) Difficulties with gait & balance

(2) Visual problems

(3) Decreased muscle strength

(4) Co-existing disease states (e.g., hypotension, arrhythmias, and epilepsy)

(5) High risk medications

   (a) Central nervous system drugs: benzodiazepines, antipsychotics, antidepressants, and anticonvulsants

   (b) Antihypertensive drugs which can lead to hypotension

b) **Extrinsic Factors**

(1) Tripping over loose rugs or clutter

(2) No stair railings

(3) Poor lighting

(4) No handrails in bathrooms and tubs

(5) Introduction to a new or foreign environment

(6) Slippery conditions

(7) Poorly fitting or inappropriate footwear

c) **Suggestions to help minimize a patient’s risk for falling**\(^{25,60-62}\)

(1) Exercise to improve balance and strength. Exercise is beneficial for a patient with osteoporosis as it helps strengthen the bones as well as improve balance which may decrease the risk of a fall.

(2) Use non-skid rugs and mats on floors as well as in bath tubs, and anchor rugs down to the floor.

(3) Minimize clutter, especially in high traffic areas.

(4) Install handrails in stairways, hallways, and bathrooms.
(5) Improve lighting in hallways, stairways and entrances.

(6) Encourage patients to wear low-heeled shoes with non-skid surfaces, including use of gait stabilizing devices such as the Yaktrax Walker® to prevent falls on slippery outdoor surfaces.

(7) Encourage the patient to have his or her medication profile reviewed by a pharmacist or other health care provider to identify medications or combinations of medications which may increase the risk of falling.

(8) Recommend padded hip protectors for patients at high-risk for falling.

**B. Pharmacologic Therapy (Nonprescription)**

1. **Recommended daily dose of calcium & Vitamin D**

   a) **Calcium**
   
   The general consensus for the recommended daily intake of elemental calcium in the older adult population is 1,000mg – 1,200 mg\(^{12,13,59}\) Supplemental doses greater than 1,500 mg are generally not recommended because of the increased potential for adverse effects such as constipation, hypercalcemia, hypercalciuria and subsequent kidney stones.\(^{12,64}\)

   According to the 2014 NOF recommendations on calcium supplementation, all individuals should be counseled regarding adequate calcium intake to reduce fracture risk. If dietary consumption is inadequate to meet recommended daily requirements, the NOF recommends the use of calcium supplementation\(^{12}\)

   Although adequate calcium and vitamin D intake are important factors in bone health, recently calcium supplementation has become somewhat controversial due to concerns of increased risk of cardiovascular events and lack of evidence to support use for primary fracture reduction in people with normal bone mineral density.

   In 2013, the U.S. Preventative Services Task Force published a recommendation statement regarding calcium and vitamin D supplementation to prevent fractures in adults, which stated there is a lack of evidence to support the use of calcium supplementation in home dwelling adults with normal bone density and vitamin D serum concentrations for primary fracture prevention.\(^{64}\)
Additionally, new data from observational studies suggest a slight increased risk of cardiovascular events (including MI and stroke) seen in adults taking calcium supplements. Dietary intake of calcium has not been associated with the same risk. Study data from Bolland et al, has shown for every 1,000 women taking calcium supplementation for 5 years, there will be 26 fewer fractures, but 10 more strokes, 14 more myocardial infarctions, and 13 more deaths.\(^{64}\)

At this time, based on available evidence and potential for increased CV risk, adequate dietary intake should be recommended for all people to build and maintain healthy bones. If dietary intake is insufficient, calcium supplementation can be recommended for those with low bone mineral density and/or vitamin D deficiency.

b) **Vitamin D**

The NOF recommends an intake of 400-800 IU of vitamin D\(_3\) for adults under 50 and 800-1,000 IU for adults over 50.\(^{1,12}\) Vitamin D can be found in the diet through the following sources: some saltwater fish, fish oils, egg yolks, liver, cheese, and fortified milk and cereals. To achieve adequate intake, supplements may be necessary because few foods contain vitamin D naturally. When dietary supplementation is required, vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol) are both appropriate forms for bone health.\(^{12}\) For most adults the upper limit for Vitamin D intake is 4000 IU per day, above which the risk of toxicity increases. Recommendations at screening events should not exceed 2000 IU per day unless serum vitamin D serum concentrations are being monitored.\(^{12,65,66}\) Supplemental doses of Vitamin D can be attained in combination products with calcium.

2. **Factors which affect calcium absorption**

a) **Salt form**

Calcium carbonate is an insoluble salt, which requires an acidic gastric environment for proper dissolution (breakdown) for absorption. Through the normal aging process, a decrease in the amount of gastric acid production occurs, raising the pH within the stomach. Therefore, older adults benefit from taking their calcium carbonate
supplement at meal times when their acid production is usually at its highest. Calcium citrate supplements can be taken without regard to meals as the citrate salt does not require stomach acid for dissolution.

Similarly, patients who take medications which significantly decrease gastric acidity, such as proton pump inhibitors or H-2 receptor blockers (see Table 9), should be advised to use the calcium citrate products as the citrate salt does not require an acidic environment to dissolve effectively.

Table 9: Common Proton Pump Inhibitors and H-2 Receptor Blockers

<table>
<thead>
<tr>
<th>Proton Pump Inhibitors</th>
<th>Brand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esomeprazole</td>
<td>Nexium*</td>
</tr>
<tr>
<td>Lansoprazole</td>
<td>Prevacid*</td>
</tr>
<tr>
<td>Omeprazole</td>
<td>Prilosec*</td>
</tr>
<tr>
<td>Pantoprazole</td>
<td>Protonix*</td>
</tr>
<tr>
<td>Rabeprazole</td>
<td>Aciphex*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>H-2 Receptor Blockers</th>
<th>Brand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cimetidine</td>
<td>Tagamet*</td>
</tr>
<tr>
<td>Famotidine</td>
<td>Pepcid*</td>
</tr>
<tr>
<td>Nizatidine</td>
<td>Aixid*</td>
</tr>
<tr>
<td>Ranitidine</td>
<td>Zantac*</td>
</tr>
</tbody>
</table>

b) **Amount given (maximum absorbable dose)**

The maximum absorbable one-time dose of calcium, from diet or supplements, is approximately 500-600mg. Therefore, it is recommended to divide the daily dose into at least 2 smaller doses so that no more than 500-600mg of elemental calcium are ingested at one time.

c) **Vitamin D**

As mentioned in previous sections, vitamin D is essential to intestinal absorption of calcium, although it does not need to be taken at the same time. Patients with diets deficient in vitamin D or with minimal exposure to sunlight may require vitamin D supplementation. When measuring serum concentrations of vitamin D, it is
recommended that the 25-hydroxyvitamin D level be used due to its long half-life (15 days) and direct relationship to dietary and supplemental intake as well as cutaneous synthesis. Table 10 outlines cutoffpoints for sufficient 25-hydroxyvitamin D concentrations according to the Institute of Medicine.\(^{66}\) Currently, there is some variability in guidelines regarding optimal serum 25-hydroxyvitamin D serum concentrations for bone health and a consensus has not been reached. The Institute of Medicine recommends greater than 20ng/ml as a normal value for 25(OH) vitamin D to maintain bone health.\(^{65,66}\) Several other organizations recommend 25(OH) vitamin D concentrations of 30-60 ng/mL.\(^{25,67}\)

**Table 10: Serum 25-Hydroxyvitamin D [25(OH)D] Concentrations and Health (IOM)\(^{66}\)**

<table>
<thead>
<tr>
<th>ng/mL</th>
<th>(nmol/L)</th>
<th>Health Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;12</td>
<td>(&lt;30)</td>
<td>Associated with risk of Vitamin D deficiency</td>
</tr>
<tr>
<td>12-20</td>
<td>(30-50)</td>
<td>Generally considered inadequate for bone health</td>
</tr>
<tr>
<td>≥20</td>
<td>(&gt;50)</td>
<td>Generally considered adequate for bone health</td>
</tr>
<tr>
<td>&gt;50</td>
<td>(&gt;125)</td>
<td>Reason for concern and potential side effects Particularly with &gt;150nmol/L (&gt;60 ng/mL)</td>
</tr>
</tbody>
</table>

3. **Comparison of common supplement preparations**

There are numerous calcium supplements on the market including single ingredient products or combinations with other vitamins and minerals. The labeling of these products can cause confusion regarding the content of elemental calcium. To determine the daily regimen of tablets, find the amount of elemental calcium contained in the product and use that number to calculate the dosage. The calcium content will be listed on the labeling as a calcium salt (e.g., calcium carbonate, calcium citrate, calcium lactate, etc.) or as calcium alone. If calcium is listed as the salt, e.g., calcium carbonate 500mg, this product contains 500mg of the calcium salt. Since 40% of calcium carbonate is elemental calcium, this product contains 200mg of elemental calcium. If calcium is listed alone on the label, e.g., calcium 250mg, this refers to the amount of elemental calcium contained in the product. Pharmacists and other healthcare professionals can aid in product clarification and selection for patients (see Table 11).
Purity is an issue to consider when choosing a calcium supplement. Products prepared from unrefined oyster shell, bone meal or dolomite can contain lead, mercury or other toxic metals. By choosing a product made from other calcium sources or those that contain “purified” or the United States Pharmacopeia (USP) symbol in the labeling can help to avoid problems with impurities.

Additionally, some manufacturers claim their calcium products, namely coral calcium, have superior absorption compared to other calcium formulations. Since companies manufacturing nutritional products are not required to support their claims with clinical trials, it is difficult to disprove these claims to patients. Unfortunately, these products are usually more expensive and there is no strong data to show coral calcium products are better than other calcium products. In June 2003, the Federal Trade Commission filed charges against two coral calcium manufacturers for making false claims regarding their products. The Food and Drug Administration sent letters to 18 marketing firms warning about the false claims made to consumers. *(69)* Many coral calcium products are still available and are promoted to be a more ‘bioavailable’ form of calcium, which remains to be substantiated.

### Table 11: Common Preparations of Calcium Products *(70)*

<table>
<thead>
<tr>
<th>Product</th>
<th>Tablet mg</th>
<th>Elemental Ca mg/Tablet</th>
<th>Vitamin D3 Content/Tablet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caltrate® 600+D</td>
<td>1500 mg</td>
<td>600 mg</td>
<td>800 IU</td>
</tr>
<tr>
<td>Os-Cal®+D</td>
<td>1250 mg</td>
<td>500 mg</td>
<td>200 IU</td>
</tr>
<tr>
<td>Tums®</td>
<td>500 mg</td>
<td>200 mg</td>
<td>-</td>
</tr>
<tr>
<td>Tums® EX</td>
<td>750 mg</td>
<td>300 mg</td>
<td>-</td>
</tr>
<tr>
<td>Tums® Ultra</td>
<td>1000 mg</td>
<td>400 mg</td>
<td>-</td>
</tr>
<tr>
<td>Viactiv®+D+K</td>
<td>1250 mg</td>
<td>500 mg</td>
<td>500 IU</td>
</tr>
<tr>
<td>Calcium liquid softgel (Nature Made)</td>
<td>1500 mg</td>
<td>600 mg</td>
<td>400 IU</td>
</tr>
<tr>
<td>Coral calcium (GNC)</td>
<td>500 mg</td>
<td>200 mg</td>
<td>100 IU</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product</th>
<th>Tablet mg</th>
<th>Elemental Ca mg/Tablet</th>
<th>Vitamin D3 Content/Tablet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citracal Maximum®</td>
<td>1190 mg</td>
<td>315 mg</td>
<td>250 IU</td>
</tr>
<tr>
<td>Citracal Gummies®</td>
<td>1190 mg</td>
<td>250 mg</td>
<td>500 IU</td>
</tr>
<tr>
<td>Calcium Citrate Plus (GNC)</td>
<td>952 mg</td>
<td>200 mg</td>
<td>200 IU</td>
</tr>
</tbody>
</table>

IU – international units
Manufacturers may add other vitamins and minerals to calcium supplement formulations. The addition of these vitamins or minerals such as potassium, magnesium, or vitamins B, C, E or K has not been proven to improve bone density. These products may be more expensive and patients may need to consume more tablets for an equivalent dose of elemental calcium.

Vitamin K plays a role in bone mineralization and deficiencies have been associated with lower bone mineral density and higher fracture risk. However, data to support routine supplementation of vitamin K to improve bone health is lacking at this time. One popular calcium supplement, Viactiv, contains 80mcg of vitamin K per two chews. This is roughly equivalent to the vitamin K content of a ½ cup of raw spinach and may lower the INR value for patients taking warfarin. If a patient takes a supplement containing vitamin K, such as calcium or a multivitamin, the general rule of thumb is to report it to the provider monitoring the INR and to consistently take the supplement to avoid fluctuations in the INR.

4. Adverse effects from calcium products
The main side effects with calcium supplementation are bloating, flatulence and constipation. Gastrointestinal intolerances are most prominent with the calcium carbonate. There are several ways to alleviate these common effects:

1. Switching to calcium citrate products may help
2. Increasing dietary intake of fiber and fluids
3. Titrating calcium doses slowly

The risk of hypercalcemia or hypercalciuria is uncommon at doses recommended for osteoporosis.

5. Potential drug-drug interactions with calcium products
Calcium products have the potential to interact with other medications.

a) Calcium salts may decrease the absorption of certain medications and administration should be separated according to instructions for each individual drug:
   - Fluoroquinolone antibiotics (e.g., ciprofloxacin, levofloxacin, gatifloxacin)
   - Tetracycline antibiotics (including doxycycline)
   - Thyroid hormones (e.g., levothyroxine)
   - Bisphosphonates (e.g., alendronate, ibandronate, and risedronate)
• Iron supplements
• Phenytoin
• Fluoride

b) A drug-drug interaction specific to calcium citrate is its ability to increase aluminum absorption from oral products such as aluminum hydroxide (e.g., Alternagel® or Amphojel®). Calcium citrate products should be separated by 2 hours from aluminum hydroxide, and these two products should be avoided in patients with renal disease to decrease the risk of aluminum toxicity.

6. Summary for patient counseling
Each counseling session should include a discussion of current medications, brief medical history, and family history of osteoporosis as well as calcium and vitamin D intake. This is followed by an explanation of the screening results and the graph of the T-score. All patients, regardless of the test results, should be encouraged to reach at least 1000-1200 mg of elemental calcium and 400-800 IU of vitamin D daily. Individuals age 50 and older should try to reach at least 800-1,000 IUs per day of vitamin D.

After a decision by the counselor regarding the patient’s current baseline dietary consumption of calcium and vitamin D, the counselor can suggest an appropriate daily regimen of the supplements. Specific sources of supplemental calcium should be discussed and modified for the individual patient based on age, preferences, and medical conditions. Calcium may cause constipation in some individuals at the doses recommended. Therefore, discussion on ways to mediate or reduce constipation should be offered. Appendix B provides a summary of topics to be discussed with patients.

C. Pharmacologic Therapy (Prescription)
Pharmacological therapy is often warranted in patients with osteopenia or osteoporosis to further prevent bone loss and reduce the risk of future fracture. These therapeutic options will not be discussed in detail, as it is beyond the scope of this educational module. Table 12 briefly describes the types of agents utilized in the treatment of osteoporosis.
### Table 12: Prescription Treatments of Osteoporosis (6.70)

<table>
<thead>
<tr>
<th>Drug Class</th>
<th>Mechanism of Action</th>
<th>Generic (Brand) Name</th>
<th>Dose, Route, Frequency</th>
<th>Annual Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bisphosphonates</td>
<td>Inhibits bone resorption</td>
<td>Alendronate (Fosamax®)</td>
<td>10 mg po daily or 70 mg po weekly</td>
<td>Weekly generic - $980</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Risedronate (Actonel®)</td>
<td>5 mg po daily or 35 mg po weekly, 150 mg po monthly</td>
<td>Weekly 35mg generic - $2,980 Monthly generic - $2,800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ibandronate (Boniva®)</td>
<td>2.5 mg po daily or 150 mg po monthly, 3 mg IV every 3 months</td>
<td>Monthly generic - $1,670 IV generic - $2,020 (drug only)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zoledronic Acid (Reclast®)</td>
<td>5 mg IV infusion annually</td>
<td>IV generic - $420 (drug only)</td>
</tr>
<tr>
<td>Estrogen replacement</td>
<td>Decreases menopausal bone loss</td>
<td>Various products</td>
<td>Oral Transdermal (patch)</td>
<td>Varies based on products</td>
</tr>
<tr>
<td>Estrogen Agonist/Antagonist (EAA)</td>
<td>Acts like estrogen on the bone to decrease bone loss</td>
<td>Raloxifene (Evista®)</td>
<td>60 mg po daily</td>
<td>Generic - $2,500</td>
</tr>
<tr>
<td>Estrogen Agonist/Antagonist and Estrogen</td>
<td>Estrogenic effects on bone</td>
<td>Bazedoxifene and Conjugated Equine Estrogen (Duavee®)</td>
<td>20 mg BZA and 0.25 mg CEE daily</td>
<td>$1,600</td>
</tr>
<tr>
<td>Calcitonin</td>
<td>Inhibits bone resorption</td>
<td>Calcitonin (Miacalcin®, Fortical®)</td>
<td>200 units nasally daily</td>
<td>Generic - $1,415</td>
</tr>
<tr>
<td>Parathyroid hormone analog</td>
<td>Stimulates osteoblasts, increases calcium absorption, &amp; increases renal reabsorption</td>
<td>Teriparatide (Forteo®)</td>
<td>20 mcg subQ daily</td>
<td>$47,400</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abaloparatide (Tymlos®)</td>
<td>80 mcg subQ daily</td>
<td>$24,780</td>
</tr>
<tr>
<td>RANK-L Inhibitor</td>
<td>Binds to RANK-L, inhibiting osteoclast formation</td>
<td>Denosumab (Prolia®)</td>
<td>60 mg subQ every 6 months</td>
<td>$2,850</td>
</tr>
</tbody>
</table>

### D. Frequently Encountered Scenarios from Osteoporosis Screening

**Example 1:** *Older woman with a history of two broken wrists and lactose intolerance.*

Patients with lactose intolerance can either use calcium and Vitamin D supplements or try dairy products which are produced for people with lactose intolerance.
intolerance. Also, there are non-dairy foods which are fortified with calcium (See Table 8). Consider an agent to help with digestion of dairy products (Lactaid).

**Example 2:** *Older man with a history of a heart attack whose doctor has prescribed a stool softener to avoid straining on the commode.*

Adding calcium supplements may be constipating and this can complicate pre-existing medical problems, e.g., cardiac diagnoses. Suggest that if calcium supplements are initiated that they should be initiated at a lower dose and titrated slowly to avoid constipating complications. Additionally, increasing fiber in the diet and water intake may help relieve constipation symptoms.

**Example 3:** *Older woman with asthma who uses Advair® and wants to know if she needs more calcium to offset the bone mineral loss caused by her inhaler.*

Bone loss rarely occurs with low to medium dose inhaled glucocorticoids. However, when high doses are used, some bone loss can occur. The patient should be assessed and recommendations made based on her risk factors and T- & Z-Scores.

**Example 4:** *Older woman who takes calcium supplements (500mg elemental twice daily) plus exercises and eats well. She takes Prevacid™ for gastroesophageal reflux disease (GERD) and wants to know if she can take Tums® (calcium carbonate) with orange juice rather than pay more for Citracal®.*

Calcium carbonate requires an acidic environment for absorption and gastric acid-suppressing medications such as proton pump inhibitors or histamine type-2 blockers (See Table 9) can prevent adequate absorption of calcium products such Tums. In this situation, switching to a generic calcium citrate product would be preferred, as these products do not require an acidic environment for absorption, but they may still be more expensive. Taking calcium carbonate with orange juice or cola will probably not increase absorption and may exacerbate the patient’s GERD symptoms.
**Example 5:** A 55-year old woman had a previous T-Score of -1.8 done 10 years earlier by ultrasound and wants to know if her bone density has improved.

Comparing results between different devices should not be done. Each device may have different methods used to determine bone density, and while they may report the results similarly using T- & Z-Scores, the results cannot be interchanged. Inform the patient that testing with the GE Achilles device is a method to determine the future risk of a fracture, and more definitive testing would have to be conducted using other technologies.

**IV. Videos of IPHARM Screening Events**

The MTGEC/IPHARM program provides wellness screening to people throughout Montana who might otherwise be unable to access service. Additionally, the program provides patient care experience to students in their last professional year in the study of pharmacy, physical therapy, nursing and other health care fields.

The following videos illustrate a typical screening for bone density. The first video shows how to set up and calibrate the screening device. The second video is a sample of a typical patient consulting session. Watching the videos is a component of the contact hours for this module and should be completed at this time.

**Setting up and Screening with the GE Achilles**

**Counseling the Patient**

- Please note that the guidelines for counseling the patient include referring to a healthcare provider if the result is a t-score that is < -2.0. The video shows a patient with a -2.5 T-score but the health care professional does not specifically recommend that the patient see her primary care provider about the results, although she should have done so.
V. Useful Websites

Specific to Osteoporosis

National Osteoporosis Foundation

Clinical Guide to Prevention and Treatment of Osteoporosis

National Institutes of Health: Osteoporosis and Related Diseases, National Resource Center

The Bone Thief, The National Institute on Aging

International Osteoporosis Foundation

Osteoporosis and Bone Physiology, University of Washington

Calcium calculator (by the IOF)

FRAX- WHO Fracture Risk Assessment Tool

Information on Aging or Older Adults

The Merck Manual of Geriatrics

The Merck Manual on Health and Aging

National Institute on Aging

Montana Senior and Long Term Care

Center for Medicare & Medicaid Services: Your Guide to Medicare's Preventive Services
VI. References

2. Wright NC, Looker AC, Saag KG. The recent prevalence of osteoporosis and low bone mass in the United States based on bone mineral density at the femoral neck or lumbar spine. *J Bone Miner Res* 2014; (doi:10.1007/jbmr.2269)


70. Lexi-Comp (Lexi-Interact) [computer program]. Lexi-comp; 2018.

Appendix A: Bone Density Screening-Patient Counseling

**Bone Density Test**

This is a screening test designed to determine the density of your bone by measuring the attenuation (absorption) of sound waves by the bones in your heel. The instrument sends ultrasound waves through your heel and measures the amplitude (loudness) of the sound waves that come through the bone. The amplitude of the sound waves depends on the density and continuity of the bone. The test provides you with a printout of the BUA (Broadband Ultrasound Attenuation) and translates this number into two scores, the T-score and the Z-score.

**Interpreting your results from the GE Achilles**

The T-score is a comparison of your bone density to the maximum expected bone density of a person your sex. Women and men reach peak bone density at about age 30. A T-score greater than -1 (i.e., a number such as -0.7) is considered normal. Numbers less than -1 (such as -1.5) may indicate a bone density that should be discussed with your primary care provider.

The Z-score compares your bone density to others of your same age and sex.

There are two percent expected values in the patient results. The % Young Adult shows the % of measurement that is expected for a person at their peak bone density (approximately 30 yrs old); this is similar to the T-score. The % Age Matched shows the % of measurement that is expected for a person of the same age and sex; this is similar to the Z-score.

The BUA (broadband ultrasound attenuation) is the actual ultrasound reading in decibels/megahertz.

Remember, a SINGLE result (whether normal or abnormal) is not enough information on which to base treatment decisions.

**Patient Variables that can affect the results:**

- In some cases, a foot may not properly rest in the device and a measurement may not be possible.
- Talking or moving during a test can affect or prevent results from being obtained.
- Women and men under the age of about 30 may not have reached their maximum bone density and, therefore, numbers reflecting low bone density may not accurately predict a future fracture risk.
Limitations:
- If a heel was injured or broken, this can affect the results.
- Persons who run long distances or engage in jobs where they are constantly compressing the heel bone may have results that do not reflect the other bones in their body.
- The use of current bone density to predict future bone density may not properly indicate your future bone density, especially if you change your exercise, smoking, or calcium intake.
- The device predicts future risk of fracture that most closely estimates risk of fracture in the hip and may not accurately reflect risk of fracture at other sites.
- The device calculates a broadband sound attenuation that may be affected by bone density and other bone characteristics such as bone elasticity and, therefore, the device should only be used for screening, not for therapeutic monitoring.

**RISK FACTOR ASSESSMENT**

Non-modifiable risk factors:
- Caucasian or Asian ancestry
- Female
- Family history of fractures or stooped posture OR personal history of a fracture as an adult.
- Early menopause before the age of 45 (natural or surgical)
- Small-boned, thin frame (body weight less than 127 pounds)
- Over 60 years of age

Modifiable risk factors:
- Menopause without hormone therapy
- Inadequate calcium and Vitamin D
- Tobacco use
- Lack of weight-bearing exercise or physical inactivity
- Alcohol use beyond 2 drinks/ounces per day

Secondary causes of low bone mineral density:
- Medications: glucocorticoids (inhaled or taken orally like prednisone or “steroids”), certain anticonvulsants (anti-seizure medications), certain anti-cancer medications
- Excess use of thyroid hormone
- Inadequate function of the gonads (hypogonadism)
- Excessive parathyroid hormone (hyperparathyroidism)
- Overactive adrenal gland (Cushing’s disease)
- Low sex hormone levels - may be caused by over-exercise, eating disorders or decreased production of testosterone in men
- Chronic kidney, liver, lung or gastrointestinal disorders
- Systemic lupus or rheumatoid arthritis
- Spinal cord injury with paralysis

Note that many other diseases may result in decreased ability to absorb calcium or change the way your body utilizes calcium and re-builds your bones. If you have questions, please ask the screening personnel or your healthcare provider.

UNIVERSITY OF MONTANA

IPHARM
406-243-2339
ipharm@umontana.edu
Appendix B: Summary of Topics for Patient Counseling

When to refer to a physician or primary care provider:
- T-score < -2.0 or significant risk factors are identified

When to refer for follow-up at next physician visit
- T-score between -1.0 and -2.0

Calcium & Vitamin D:
- Recommend appropriate daily intake of elemental calcium.
- Maximum absorbable amount of elemental calcium is 500-600mg at one time. Therefore, patients should split up their doses.
- Patient with low gastric acidity should take calcium citrate products.
- Recommend appropriate daily intake of Vitamin D according to IOM guidelines.

Weight bearing exercises:
- Increases mobility, bone and muscle strength, and balance.

Lifestyle modifications:
- Quit smoking
- Decrease alcohol consumption to 2 or less drinks/day or 7 or less drinks/week.

Decrease risk for falls:
- Intrinsic factors: Poor eyesight, medications, coexisting disease states, etc,
- Extrinsic factors: Decrease clutter, add handrails in hallways, stairs and bathrooms, increase lighting in dark areas, and secure loose rugs to the floor.
APPENDIX C: IPHARM BROCHURE: Osteoporosis & You

**Talk with Your Health Care Providers**

Certain medications and chronic medical conditions can increase your risk for osteoporosis. Also, some medications can interact with calcium supplements reducing the absorption. Review your medical history and medication list with your health care provider and pharmacist to discuss any potential problems.

If you need to be treated for low bone density, there are several prescription options available. Review calcium and Vitamin D supplements, bone density screening and treatment options with your health care provider.

**Why Should You Be Concerned?**

Osteoporosis is a disease in which bones become weak, increasing the risk for breaks (fractures). If not detected and/or left untreated, osteoporosis can progress painlessly until a bone breaks. The keys to preventing and treating osteoporosis include screening for bone density, lowering risk factors through a healthy lifestyle and sometimes taking medications.

**Facts and Figures**

Osteoporosis and low bone density is a common health problem for over 54 million Americans.

Osteoporosis is the cause of many fractures every year.

It is estimated that 80% of those with osteoporosis are women and 29% are men.

50% of women and 25% of men over the age 50 will have a fracture related to osteoporosis.

Osteoporosis can occur at any age.

Women can lose up to 20% of their bone density in the first 5-7 years after menopause.

**Symptoms**

Osteoporosis is often called the “silent disease” because bone loss occurs without symptoms. People may not know that they have osteoporosis until their bones become so weak that a sudden strain, bump or fall causes a hip fracture, a vertebra to collapse or other bones to break.

**Are You at Risk?**

**Risk factors for osteoporosis**

- Females have a higher risk
- Advanced age
- Low body weight and body mass index
- Ethnicity: Caucasian and Asian
- Family or personal history of osteoporosis or fractures as an adult
- Diet low in calcium and vitamin D
- Certain medications
- Some chronic diseases
- Anorexia or bulimia
- An inactive lifestyle
- Low sex hormones
- Cigarette smoking
- Excessive alcohol

**What Can I Do For My Bones?**

**Calcium is the mineral needed to build new bone.** An inadequate supply of calcium over the lifetime is thought to play a significant role in the development of osteoporosis. The average U.S. diet provides about 500-700 mg of calcium per day. Depending on your dietary calcium intake, you may need to take a calcium supplement to meet requirements.

Vitamin D helps the body absorb calcium. Our skin makes vitamin D when it is exposed to sunlight. While some people are able to obtain enough naturally, studies show that the production decreases in the elderly, in people who are housebound, and during the winter months. Some people with low levels of vitamin D are more likely to break bones when they fall.

**Dietary Calcium.** Good sources of calcium include dairy products, such as milk, yogurt, cheese and ice cream; dark green leafy vegetables, such as broccoli, collard greens, and bok choy; tofu; and foods fortified with calcium, such as orange juice, soy milk, cereals and breads.

Calcium content of common foods:
- Milk, skim (1 cup): 302 mg
- Cheese, cheddar (1 oz): 111 mg
- Cheese, American (1 oz): 150 mg
- Cheese, cottage (1 cup): 156 mg
- Yogurt, low-fat (8 oz): 345-415 mg
- Ice cream (8 oz): 200 mg
- Fortified almond milk (1 cup): 200-400 mg
- Fortified soy milk (1 cup): 300 mg
- Fortified orange juice (8 oz): 300 mg
- Fortified cereal (1 cup): 100-150 mg
- Lactose free yogurt (8 oz): 25 mg
- Tofu (4 oz): 106 mg
- Broccoli (1 cup): 100-136 mg
- Kale, raw (1 cup): 90 mg
- Pinto beans, cooked (1 cup): 75 mg
- Almonds, dried (1 oz): 80 mg
- Kiwi, raw (1 cup): 60 mg

**Calcium Recommendations**

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<td>Age 50 &amp; younger</td>
<td>1000mg daily</td>
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**Vitamin D Recommendations**

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<td>Under age 50</td>
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<td>600-1000 IU daily</td>
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**Tips on Calcium and Vitamin D Supplements**

Calcium carbonate is the most common and inexpensive form of calcium. It requires acid in the stomach for the best absorption and must be taken after meals.

Calcium citrate is considered the most absorbable form of calcium, it may be a better choice for people taking medications to reduce stomach acid.

High doses of calcium are not well absorbed. It is recommended to take doses of 500 - 600mg or less divided throughout the day.

Look for products that have USP on the label. Calcium from oyster shell, bone meal or dolomite sources without the USP symbol may contain toxic impurities.

Vitamin D, ergocalciferol and D3, (cholecalciol) are both good sources of vitamin D. Vitamin D is the most common form of vitamin D found over the counter. People who do not get enough vitamin D should consider taking a supplement.

Fall prevention. Fall-proof your house by wearing non-slip footwear, removing rugs that are not secured, keep areas well lighted, add safety bars and non-skid surfaces to tubs and showers.

Excessive use. Like muscle, bone becomes stronger with exercise. The best exercise for your bones is weight-bearing exercise that forces you to work against gravity. This includes walking, hiking, jogging, stair-climbing, weight training, tennis, and dancing. Muscle strengthening exercise can improve agility and balance, which may reduce the risk of falls.

Alcohol. Regular consumption of 2 to 3 ounces a day of alcohol may be damaging to the skeleton, even in young women and men.

Smoking. Smoking is bad for your bones as well as for your heart and lungs. Smokers also may absorb less calcium from their diets.
POST-TEST: Examination Form

Screening for Osteoporosis in Older Adults

Participant Information:

1. Name: ______________________________________

2. Mailing address: ________________________________
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3. Date exam completed ________________________

Questions: (Please circle one response per question)

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### Evaluation:  *Screening for Osteoporosis in Older Adults*

Please indicate your major:

1. Based on the module description and stated objectives, this module met my expectations of the content it would deliver.

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2. How effective were the following in helping you understand the material?

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3. I learned something I can use in my practice/employment or personal setting.

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4. How do you plan to implement the information from this module to strengthen your practice, employment or personal goals? (check any that apply)

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<th>Adjust practices with geriatric patients/clients</th>
<th>New program development or program enhancement</th>
<th>Provide new information to family/friends/co-workers</th>
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* Describe 'other' implementation plan here:

5. How long did it take you to complete the module? (including pre-test, module review, post-test and evaluation)

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6. The test questions were relevant to the module content.

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7. Please provide suggestions to improve the online learning experience to meet your needs.

8. Please offer ideas or suggestions for new modules.

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