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. Use the questions in Appendix D and record your answers on the examination form marked Post-Test. *(Found at the end of 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, found after the post-test.)* 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 online or return the MTGEC Participant Profile
   b. Turn in the Pre-Test, Post-Test, and Module Evaluation
   c. Obtain a score of 70% or better on the Post-Test

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Phone (406) 243-2339 & Fax (406) 243-4353
Pre-test: Screening for Osteoporosis in Older Adults

Record responses on examination form.

1. According to the National Osteoporosis Foundation, what percentage of postmenopausal women with osteoporosis have NOT been diagnosed?
   a) 25%
   b) 33%
   c) 50%
   d) 67%

2. 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) A person with primary osteoporosis developed osteoporosis as a consequence of growing older.

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

4. 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)

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

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

7. 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)

8. Of the following people, who would NOT be considered at increased risk for osteoporosis?
   a) Small framed person (weight < 127 lbs.)
   b) Women taking estrogen replacement
   c) Patient taking phenytoin (Dilantin®)
d) An alcoholic

9. 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.

10. 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

11. 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

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 CUBAClinical 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 (SEXA)
   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 transducers are closed.
### Participant Information

1. **Name:** _________________________________

2. **Mailing address:** _________________________________
   _________________________________
   _________________________________
   _________________________________

3. **Date exam completed** _________________________________

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

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Screening of Osteoporosis in Older Adults

Developed by Kim Madson, Pharm.D.

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University of Montana Missoula, MT

A Geriatric Health Screening Module from the

Montana Geriatric Workforce Enhancement Program

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

Montana Geriatric Education Center Website

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Montana Geriatric Education Center
Montana Geriatric Education Center (MTGEC)
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 text
- Visiting websites as directed in module
- Completion of the Post-Test with at least 70% accuracy
- Completion of the module evaluation

Contact Hours: 2.3, including 1.2 Rx Hours for Nurses

Montana Nurses Association (MNA)
The Montana Geriatric Education Center is an approved provider of continuing nursing education by the Montana Nurses Association, an accredited approver by the American Nurses Credentialing Center’s Commission on Accreditation.
MNA Continuing Nursing Education Expiration Date: 11/16/2017

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 $2,143,140 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 non-pharmacological interventions for osteoporosis.

**Module Purpose:**

The purpose of the module is to enable the learner to improve his/her knowledge and skill of 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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MTGEC Screening for Osteoporosis in Older Adults
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MNA CE expiration date: 11/16/2017
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. 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 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. (1)

1. Epidemiology
   a) Incidence
      • Approximately 80% of the patients with osteoporosis are women with the remaining 20% occurring in men. (2)
      • Nearly 20% of the postmenopausal white women in America have osteoporosis, but less than 33% of these women are diagnosed. Of those women diagnosed with osteoporosis, only about 14% receive treatment to prevent further bone loss. (3)
      • It is estimated that 40-50% of women and 25% of men over the age of 50 years old will experience an osteoporosis-related fracture. (4)
      • 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. (5,6)
      • The most devastating type of fracture is a hip fracture, accounting for nearly 300,000 hospitalizations each year. (5)
b) Morbidity & Mortality
   - Hip fractures are associated with 8.4-36% excess mortality within the first year of sustaining the injury.\(^ \text{(7)} \) Furthermore, those who survive a hip fracture have a 2.5 fold increase risk of a subsequent hip fracture.\(^ \text{(8)} \) Half of those who survive the fracture will not be able to function without assistance, requiring either home nursing care or admission to a long-term care facility.\(^ \text{(3,4)} \) Only 40% of those who experience a hip fracture will regain function at the same level as before the event.\(^ \text{(8)} \)

c) Cost
   - The economic burden of osteoporosis is substantial. In 2005, approximately $17 billion health care dollars were used to treat patients with osteoporosis-related fractures, with an average cost of treating a broken hip at nearly $40,000.\(^ \text{(3,8)} \)
   - 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.\(^ \text{(6,8)} \)

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)\(^ \text{(2,3,4,8)} \)

   **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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<tr>
<td>T-score</td>
<td>The normal expected BMD for a “young” adult of the same sex.</td>
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<tr>
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<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>
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</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” (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>
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WHO = World Health Organization; SD = standard deviation

a) Types of Osteoporosis: Primary and Secondary (9)

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. hypogonadism) 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 to 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. (9) 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 in early to mid-30’s for both men and women. Generally, men will gain a higher peak bone mass than women.\(^{(2)}\)

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.\(^{(9)}\) 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. But 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.\(^{(10,11)}\) Some of these factors will be discussed under osteoporosis risk factors.

c) **Bone composition**

Bone itself is composed of inorganic minerals (50-70%), mainly in the form of calcium phosphate (hydroxyapatite crystals \([\text{Ca}_{10}(\text{PO}_4)_6\text{OH}_2]\)), and an organic matrix (30-50%) made from collagen, proteins and cells (osteoclasts, osteoblasts and osteocytes).\(^{(11)}\) The skeleton contains 99% of the calcium and 85% of the phosphorus found in the body.\(^{(11)}\)

d) **Bone remodeling**

The process of remodeling occurs in 4 phases: resorption, reversal, formation and quiescence.\(^{(11)}\) 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.\(^{(12)}\)

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. This process takes about two to four weeks to complete. Once finished, the reversal phase starts with the maturation of osteoblasts that suppress further bone resorption.\(^{(11)}\)
Formation begins when osteoblasts manufacture and secrete an organic matrix (primarily collagen), called osteoid, which then begins to mineralize with calcium phosphate salts. This mineralization process is very slow and may take up to four months to complete.\(^{(12)}\) Once these phases are completed, a latent period begins, quiescence.\(^{(11)}\)

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.\(^{(11)}\)

**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).\(^{(11,12)}\) 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**
f) **Sites Affected by Osteoporosis**

As stated above, the overall skeleton is made up of 20% trabecular bone and 80% cortical bone. The hip bone (trochanter) is composed of 50% trabecular bone and 50% cortical bone whereas the vertebrae are made up of 66% trabecular bone and 34% cortical bone. The wrist (distal radius) is made up of 20% trabecular bone and 80% cortical bone.\(^{(4,6)}\)

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.\(^{(11,13)}\) Figure 2 demonstrates the percentage of fractures per year in the most common sites of osteoporotic fractures.

**Figure 2: Fractures Skeletal Site**\(^{(3)}\)

![Percentage of Fractures per Year](image)

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<td>Hip</td>
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<td>Other - hand, clavicle, humerus, tibia/fibula, distal femur</td>
<td>33%</td>
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<td>Wrist</td>
<td>19%</td>
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<tr>
<td>Pelvic</td>
<td>7%</td>
</tr>
<tr>
<td>Vertebral</td>
<td>27%</td>
</tr>
<tr>
<td>Pelvic</td>
<td>7%</td>
</tr>
</tbody>
</table>

\(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. 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.\textsuperscript{(11,12)} Table 3 summarises the hormonal actions on calcium homeostasis.

(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.\textsuperscript{(11,12)}

(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).\textsuperscript{(11,12)}

\textbf{Figure 3: Activation of Calcitriol (1,25-dihydroxyvitamin D3)\textsuperscript{(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{(11,13)}
Risk factors for vitamin D deficiency include: advanced age, malabsorption diseases (celiac, inflammatory bowel disease), renal disease, obesity, dark skin tone and situations where sun exposure is reduced, such as living above 35 degrees latitude in the winter (San Francisco; Springfield, MO; Washington DC).\(^{15}\) 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.\(^{12,13}\) 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 the sun’s angle is not as direct in the Northern Hemisphere. This leads to diminished sun ray 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.\(^{11,12}\)

**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.\(^{11}\)

<table>
<thead>
<tr>
<th>Table 3: Summary of Hormonal Actions on Calcium Homeostasis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tissue</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Gastrointestinal tract</td>
</tr>
<tr>
<td>Kidney</td>
</tr>
<tr>
<td>Bone</td>
</tr>
<tr>
<td>Effect on plasma ([\text{Ca}^{2+}])</td>
</tr>
</tbody>
</table>

\(\text{PTH} = \text{parathyroid hormone, Vitamin D} = 1, 25-\text{OH-Vitamin D}_3\)

**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 than women, and women undergo a rapid decrease in bone mass following menopause.\(^{(4)}\)

(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.\(^{(16,17)}\)

(3) **Race**
Bone densities tend to vary based on race and ethnicity (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.\(^{(17)}\)

Table 4: Prevalence Rates of Low Bone Mineral Density for Post-Menopausal Women of Different Racial/Ethnic Groups \(^{(18)}\)

<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.\(^{(19)}\)
(5) **Concurrent diseases**
A variety of medical conditions may increase the risk of osteoporosis such as cancer, insulin-dependent diabetes, chronic-obstructive pulmonary disease, hyperparathyroidism, hyperthyroidism, rheumatoid arthritis, organ transplantation, HIV/AIDS, lupus, heart failure, end-stage renal disease, multiple sclerosis and others.\(^{(3,4,8,9)}\)

(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\(^{(3,8,17)}\).

(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.\(^{(3,8)}\)

(8) **Nicotine products**

**Cigarettes**
Exposure to cigarette smoke (both active and passive) has detrimental effects on bone density.\(^{(8)}\) 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.\(^{(20, 21, 22,23)}\)

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.\(^{(20)}\) When comparing smokers to non-smokers, by the age of 80, the smokers’ bone density will be 6-10% lower than the non-smokers.\(^{(20)}\) This correlates to a doubling of the spinal fracture risk and a 50% increase in the risk of hip fracture.\(^{(20)}\)
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{(24)}

**Smokeless tobacco**

In 2009, the Montana Adult Tobacco Survey reported that 13\% of male Montanans use chewing tobacco, nearly double the national average.\textsuperscript{(25,26,27,28)} According to population based surveys, the racial subgroups that report the highest use of smokeless tobacco products are Native Americans and Alaska Natives.\textsuperscript{(25)}

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 study in women (2005) where the investigators determined that smokeless tobacco use increases age-related bone density loss.\textsuperscript{(30)}

(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{(8,31)}

(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), or inadequate diet are at greater risk of developing osteoporosis.\textsuperscript{(3,4,8)}

(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), 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.\(^{(8,32)}\)

(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.\(^{(11)}\) 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 3% per year and lasts about 7-10 years.\(^{(11)}\) After this point, the rate of loss resumes to the normal age-related decline, which is approximately 0.5% annually.\(^{(11)}\)

For many years, estrogen replacement was considered a first line therapy for the prevention and treatment of osteoporosis. In 2002, the landmark Women’s Health Initiative (WHI) trial was published. The results from 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 strokes and other thromboembolic events. Estrogen use alone was also associated with an increased risk of breast cancer. Currently, risks outweigh the benefits of estrogen ± progestins for a first line therapeutic option to prevent osteoporosis.\(^{(11,33,34,35)}\) The use of low-dose, short-term estrogen for vasomotor symptoms associated with menopause remains clinically appropriate.
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**: (3,4,8,36)

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. It was reported in 2009 that Montana had one of the highest mortality rates in the nation for falls across all age groups, 11 per 100,000 compared to 6 per 100,000 nationally. 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. (37)

For more information on screening for falls and fall risk reduction see the MTGEC module *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). (38) 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 developed could predict 74% of the patients who had a fracture within a one year period.\(^{(38)}\) 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® - Risk Factor Assessment Tool**

FRAX® is a computer-based, fracture prediction model created by the World Health Organization (WHO) that calculates the 10-year probability of a major osteoporotic fracture and hip fractures in men and women ages 40-90 years.\(^{(39)}\) 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, 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.\(^{(39,40)}\) The T-score or BMD from a DEXA can also be entered to help predict fracture risk.

The FRAX® tool can be used to periodically assess fracture risk and is recommended for use by the National Osteoporosis Foundation (NOF) for initiation of pharmacologic treatment. It is not recommended for patients already receiving osteoporosis medications, for whom treatment is clearly indicated, and for patients with low fracture risk (T-score greater than -1.0).\(^{(39)}\) The guideline recommends drug treatment if the 10-year probability for a major osteoporotic fracture is greater than 20% or if the probability for a hip fracture exceeds 3%.\(^{(40)}\)

This tool can be used in conjunction with quantitative ultrasound bone mineral density screening devices to more accurately determine the patient’s risk for fracture.
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.\(^{(1)}\) In addition, men experience 30% of the hip fractures, and are more likely to die within the year following the fracture.\(^{(9,42)}\)

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.\(^{(4,42)}\)

II. Osteoporosis Screening

A. Who should be screened?

In 2014, the National Osteoporosis Foundation (NOF) published updated recommendations for bone density testing\(^{(8)}\). 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\(^{(8)}\):

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.\(^{(43)}\) 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\(^{(43,44)}\)

<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.\(^{(43,44)}\)

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.\(^{(36)}\)

Although the technology may be different among screening devices, their ability to predict future fractures is similar and has been validated with multiple studies.\(^{(45-48)}\)

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

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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.\(^{(36,44)}\) 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.

**Figure 5: Normal Distribution of 30-40 year old females**

![Normal Distribution of 30-40 year old females](image)
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.\(^{(45-47)}\)

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 which 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{(38)}

D. Quantitative Ultrasound (QUS): CUBAClinical Device\textsuperscript{(44)}

1. Equipment:
   - CUBAClinical measurement device by McCue Corporation (weighs 22 pounds)
   - Power cord
   - McCue data controller
   - 2 foot-positioning inserts
   - Quality assurance coupler
   - Ultrasound gel (salt free)

2. How it measures?
   The CUBAClinical device is an ultrasonic bone sonometry system. The system transmits sound waves from one transducer (the transmitter) to the other transducer (the receiver) and quantitatively measures the amount of sound passed through the calcaneous (heel bone). See Figure 8.

   \textbf{Figure 8: Depiction of ultrasound waves through heel bone}
3. **What it measures?**

The CUBAClinical 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 velocity of sound (VOS) 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 connectivity, 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 Quantitative Ultrasound (CUBAClinical)\(^{44}\)**

1. **Setting up the device**

   (1) Connect the cable between the data controller and the CUBAClinical device.

   (2) Connect the CUBAClinical, using the correct lead, to the main power supply.

   (3) Switch on the CUBAClinical (the mechanism will automatically open if it is not already in the open position).

   (4) Open the calf plate (the hinged lid over the footwell).
2. **Steps to calibrate device**

   It is recommended to check the CUBAClinical calibration at the beginning of each testing session to ensure the device is operating correctly. Checking the calibration is accomplished by using the manufacturer supplied quality assurance (QA) coupler.

   **Step 1: Activate the QA session on data controller.**

   Begin a session by activating the data controller to conduct a QA session and then follow the steps indicated.

   **Step 2: Add ultrasound gel to QA coupler.**

   First ensure the two sides (or faces) of the QA coupler are clean. Apply approximately a nickel-sized amount of ultrasound gel to each side of the coupler using the ultrasound bottle tip to spread the gel on the surface. DO NOT use your fingers to spread the gel and DO NOT apply gel to the transducers.

   **Step 3: Place QA coupler into CUBAClinical device.**

   The QA coupler should be placed in the device so that the sides of the coupler line up with the transducers.

   **Step 4: Press “continue” on the data controller,**

   The data controller will show a settling period followed by a measurement period. DO NOT disturb the CUBAClinical device during the QA process.
Step 5: Evaluate QA result.
At the completion of the QA measurement, a result will be displayed on the data controller. If the measurement is within the range specified on your supplied QA coupler, accept the result and the QA process is complete. If the measurement is outside the range specified on your supplier QA coupler, repeat the QA process. If the measurement result continues to be outside the acceptable range, do not use the device and contact the manufacturer.

3. Steps for completing a test on a client

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 located in the CUBAClinical 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 rest provided by the device, and the heel should be placed gently but firmly against the back wall of the footwell.

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 right handed person, is the preferred foot to be tested. The left foot has been used by 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 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: Place foot in device to determine which insert to use.
Anatomical foot inserts are supplied to ensure the proper alignment of the foot with the transducers. To select the correct insert, place the foot in the footwell and identify where the big toe crosses the reference line; read the insert needed.

- Insert A = foot size < 230 mm long.
- Insert B = foot size between 230 and 250 mm long.
- No insert is needed for a foot > 250 mm long.

Ask the patient to remove his or her foot from the footwell and place it on top of the device; place the recommended insert into the device.
Step 4: Cleansing of the foot.
While the foot is still on top of the device, gently cleanse the heel area with rubbing alcohol to remove any excess dirt, oils or lotions from this area.

Step 5: Application of ultrasound gel.
Ultrasound gel is used to ensure good contact is made on each side of the heel. A small, thin layer of gel should be placed on each side of the heel as well as on each transducer pad.

If the CUBAClinical is not able to get a valid reading, it is likely due to too little gel being applied, improper gel placement on the heel, or gel was removed as the foot was positioned. Excessive use of the gel should be avoided to decrease the possibility of equipment damage.

Step 6: Enter patient-specific data into data controller and begin measurement.
Enter the patient-specific data, i.e., sex, age and which foot is being used for test, into the handheld data controller. Prompts will appear on the controller for each entry needed.

Step 7: Place heel in footwell
Carefully place the foot into the footwell while avoiding contact between the heel and the transducers as this could result in the removal of ultrasound gel from either the heel or the transducers. Verify the heel is gently but firmly placed against the back of the footwell. Ideally, the heel should be centered between both transducers to ensure an accurate reading.

Once the foot position is verified and the calf of the leg is gently resting against the provided rest, strap the leg in using the Velcro straps on the calf rest.

Step 8: Close transducers on heel.
The transducers should be closed by using the handheld controller. The controller instructs the person administering the test to “apply gel” and as soon as the “continue” button is pushed, the transducers will close automatically. Once they have been closed, the patient must remain still and not talk while the device is measuring (approximately 30-60 seconds) to ensure an accurate result.
The patient should feel equal, gentle pressure on both sides of the heel bone. If equal pressure is not felt, the test should be stopped, the foot realigned, extra ultrasound gel applied if needed, and the test started again.

At the completion of the test, the transducers will automatically retract to the open position and the patient can easily remove his or her foot. Remaining ultrasound gel should be removed from the patient's foot and the transducers. Additionally, the footwell and insert plates 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 this occurs, reapply ultrasound gel to the heel and the transducers and repeat the test. If an error message continues, see the section on Sources of Error for clarification.

F. Interpretation of Results

Interpretation of CUBA Clinical T- and Z-scores requires the incorporation of risk factors to assist with clinical recommendations. But to aid with initial decision making, the following decision tree (Figure 10) may be of assistance.
Figure 10: Suggestions for Therapeutic Recommendations (44)

G. Sources of Error (44)

1. Equipment
   - Infrequent use of QA coupler
   - Not properly maintained (not kept clean)

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 transducers to heel
   - Lack of ultrasound gel on either heel area or transducers
**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. However, implementation of bone density testing has been successfully accomplished in community pharmacy settings.\(^{(49,50,51)}\)

   Medicare does cover bone density (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:\(^{(8,49,52)}\)

   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 \(\geq 5\text{mg/d of prednisone or an equivalent dose for } \geq 3\text{ months}\)

   d) Individuals with primary hyperparathyroidism

   e) Individuals being monitored to assess the response 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 implemented 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\(^{(3,4,8)}\)

   a) Avoid the use of tobacco products.

   b) Moderate alcohol intake (no more than 2 standard size drinks per 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.

   e) Follow a low-sodium diet (less than 2.4 grams of salt per day).

2. Increased dietary calcium\(^{(3,4,8)}\)

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. Table 6 provides a tool to estimate a patient’s dietary calcium intake, Table 7 demonstrates 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\(^{(8)}\)

<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>
<tr>
<td>Estimated sum total of daily calcium</td>
<td>=</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 7: Estimated Calcium Content of Common Foods \(^{(8,53)}\)

<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><strong>Dairy</strong></td>
<td></td>
<td></td>
<td><strong>Yogurt</strong></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></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><strong>Cheese</strong></td>
<td></td>
<td></td>
<td><strong>Vegetables, bean &amp; nuts</strong></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 \(^{(3,53)}\)

<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.\(^{(54)}\) 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:

- **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.\textsuperscript{(54,55)}

\textbf{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

\textbf{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 foot wear

\textbf{c) Suggestions to help minimize a patient’s risk for falling}\textsuperscript{(3,4,4,54,55,56)}
(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 a 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 – 1,200mg\(^6,9,52\) 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.\(^8,51,57\)

   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.\(^8\)

   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 bulletin 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.\(^58\)
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.\(^{(57)}\)

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 mineral bone density.

b) Vitamin D

The National Osteoporosis Foundation recommends an intake of 400-800 IU of vitamin D\(_3\) for adults under 50 and 800-1,000 IU for adults over 50.\(^{(1,8,15,59)}\) 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 good for bone health.\(^{(8,58)}\) For most adults the upper limit 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.\(^{(8,60,61)}\)

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
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.\(^{(58)}\)

**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>Generic</td>
<td>Brand</td>
</tr>
<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>Generic</td>
<td>Brand</td>
</tr>
<tr>
<td>Cimetidine</td>
<td>Tagamet(^{®})</td>
</tr>
<tr>
<td>Famotidine</td>
<td>Pepcid(^{®})</td>
</tr>
<tr>
<td>Nizatidine</td>
<td>Avid(^{®})</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.\(^{(60)}\)

**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 will require vitamin D supplementation.\(^{(3,8,60,61)}\) 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 cutpoints for sufficient 25-hydroxyvitamin D concentrations according to the Institute of Medicine.\(^{(2,62)}\) Currently, there is some
variability in guidelines regarding optimal serum 25 hydroxyvitamin D serum concentrations for bone health. The Institute of Medicine recommends > 20ng/ml as a normal value for 25(OH) vitamin D to maintain bone health. While several other organizations recommend 25(OH) vitamin D concentration 30-60 ng/mL. (62,63)

Table 10: Serum 25-Hydroxyvitamin D [25(OH)D] Concentrations and Health (2,62)

<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</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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 in combination 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, then 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 health care professionals can aid in product clarification and selection for patients (see Table 11). (3,59)

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 USP (United States Pharmacopeia) 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.\(^{67}\) 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**\(^{(8,59)}\)

<table>
<thead>
<tr>
<th>Product</th>
<th>Tablet mg</th>
<th>Elemental mg/Tablet</th>
<th>Vitamin D3 Content/Tablet</th>
<th>Bottle Size</th>
<th>Suggested Retail Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caltrate(^{8}) 600+D</td>
<td>1500 mg</td>
<td>600 mg</td>
<td>800 IU</td>
<td>60</td>
<td>$8.99</td>
</tr>
<tr>
<td>Os-Cal(^{8})+D</td>
<td>1250 mg</td>
<td>500 mg</td>
<td>600 IU</td>
<td>60</td>
<td>8.99</td>
</tr>
<tr>
<td>Tums(^{8})</td>
<td>500 mg</td>
<td>200 mg</td>
<td>-</td>
<td>150</td>
<td>$7.99</td>
</tr>
<tr>
<td>Tums(^{8}) EX</td>
<td>750 mg</td>
<td>300 mg</td>
<td>-</td>
<td>96</td>
<td>$7.99</td>
</tr>
<tr>
<td>Tums(^{8}) Ultra</td>
<td>1000 mg</td>
<td>400 mg</td>
<td>-</td>
<td>108</td>
<td>$4.99</td>
</tr>
<tr>
<td>Viactiv(^{8})+D+K</td>
<td>1250 mg</td>
<td>500 mg</td>
<td>500 IU</td>
<td>72</td>
<td>$8.99</td>
</tr>
<tr>
<td>Calcium liquid softgel (Nature Made)</td>
<td>1500 mg</td>
<td>600 mg</td>
<td>400 IU</td>
<td>100</td>
<td>$15.99</td>
</tr>
<tr>
<td>Coral calcium (GNC)</td>
<td>500 mg</td>
<td>200 mg</td>
<td>100 IU</td>
<td>180</td>
<td>$27.99</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product</th>
<th>Tablet mg</th>
<th>Elemental mg/Tablet</th>
<th>Vitamin D3 Content/Tablet</th>
<th>Bottle Size</th>
<th>Suggested Retail Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citracal-D(^{8})</td>
<td>1190 mg</td>
<td>250 mg</td>
<td>200 IU</td>
<td>150</td>
<td>$14.49</td>
</tr>
<tr>
<td>Citracal Gummies+D(^{8})</td>
<td>1190 mg</td>
<td>250 mg</td>
<td>250 IU</td>
<td>60</td>
<td>$13.99</td>
</tr>
<tr>
<td>Calcium Citrate Plus (GNC)</td>
<td>952 mg</td>
<td>200 mg</td>
<td>200 IU</td>
<td>180</td>
<td>$13.99</td>
</tr>
</tbody>
</table>

* = based on recommended daily calcium dose of 1000 mg to 1200 mg per day.
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.\(^{63,67}\) 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.(64,68)

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.

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. (3)

5. **Potential drug-drug interactions with calcium products** (69)
   Calcium products have the potential to interact with other medications.

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

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 (69)

<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>Alendronate + Vitamin D3 (Fosamax Plus D®)</td>
<td>70mg alendronate/ 5600 IU Vitamin D3 po weekly</td>
<td>$1,842.24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Risedronate (Actonel®)</td>
<td>5 mg po daily or 35 mg po weekly 150 mg po weekly</td>
<td>Weekly 35mg Brand $2,873.04 Monthly generic $2,800.68</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ibandronate (Boniva®)</td>
<td>2.5mg po daily or 150mg po monthly 3 mg IV every 3 months</td>
<td>Monthly generic $4,994.16 IV $2,020.80(drug only)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zoledronic Acid (Reclast®)</td>
<td>5mg IV infusion annually</td>
<td>$1,004.42(drug only)</td>
</tr>
<tr>
<td>Estrogen replacement</td>
<td>Decreases menopausal bone loss</td>
<td>Various products</td>
<td>Oral</td>
<td>Varies based on product</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Transdermal (patch)</td>
<td>Varies based on products</td>
</tr>
<tr>
<td>Estrogen Agonist/Antagonist</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 $2,563.2</td>
</tr>
<tr>
<td>(EAA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estrogen Agonist/Antagonist</td>
<td>Estrogenic effects on bone</td>
<td>Bazedoxifene and Conjugated Equine Estrogen (Duavee®)</td>
<td>20mg BZA and 0.25mg CEE daily</td>
<td>$1,603,56</td>
</tr>
<tr>
<td>and Estrogen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcitomin</td>
<td>Inhibits bone resorption</td>
<td>Calcitonin (Miacalcin®)</td>
<td>200 units nasally daily</td>
<td>Generic - $1422.48</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Calcitonin (Fortical®)</td>
<td>200 units nasally daily</td>
<td>$1,234.68</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>$22,248</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RANK-L Inhibitor</td>
<td>Binds to RANK-L, inhibiting osteoclast formation</td>
<td>Denosumab (Prolia®)</td>
<td>60mg subQ every 6 months</td>
<td>$2,115.72</td>
</tr>
</tbody>
</table>

Summary for Patient Counseling

Each counseling session should include a discussion of 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 to 1200 mg of elemental calcium and 400-800 IU of Vitamin D daily. Individuals age 70 and older should try to reach at least 800 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.

D. Frequently Encountered Scenarios from Osteoporosis Screening

Example 1: Elderly 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. 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: Elderly 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 patients. 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: Elderly 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 doses greater than 1000mcg of flunisolide are used, significant bone loss can occur. The patient should be assessed and recommendations made based on her risk factors and T- & Z-Score.

**Example 4:** *Elderly 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 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 CUBAClinical 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 event

The MTGEC/IPHARM program provides wellness screening to people throughout Montana that 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 the CUBAclincal Device**

**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.
V. USEFUL WEBSITES

Specific to Osteoporosis

a) National Osteoporosis Foundation
b) Physician’s Guide to Prevention and Treatment of Osteoporosis
c) WHO Fracture Assessment Tool
d) National Institutes of Health: Osteoporosis and Related Diseases, National Resource Center
e) The Bone Thief from The National Institute on Aging
f) International Osteoporosis Foundation
g) Osteoporosis and Bone Physiology, University of Washington
h) Calcium calculator (by the IOF)
h) 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

1. 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:10.0002/jbmr.2269) (epub ahead of print)

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69. Lexi-Comp (Lexi-Interact) [computer program]. Lexi-comp; 2010.
Appendix A: Bone Measurements Tests

There are a couple of ways to look at the health of your bones. One way is by measuring the density of your bones (or mineral content) and another way is to look at the strength of your bones (elasticity or structure). The test you are having done today looks at the strength of the bone by using sound waves (or ultrasound). This is a similar tool to that used on pregnant women to look at the unborn child in the womb. More sound waves will be absorbed in bone which is stronger compared to bone which is weaker. The amount of sound absorbed in your heel bone can be used to determine your risk of developing a fracture in the future. This test does NOT diagnose you with osteoporosis, but rather it is used as a screening tool to determine if you should be doing something different for the health of your bones.

Understanding Your Bone Measurements

The results from your test are reported in terms of two different scores.

- The **T-Score** compares your bones to a young adult (30-year old female or male) which is the time when bones reach their maximum amount of bone mass.
- The **Z-Score** compares your bones to someone of the same age and sex as you.

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<th>Your T-Score</th>
<th>Your Z-Score</th>
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<td>+ 1.0</td>
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<td>0</td>
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<td>- 1.0</td>
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<td>- 2.0</td>
<td>Moderate Risk</td>
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<td>- 3.0</td>
<td>High Risk</td>
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<td>- 4.0</td>
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</tbody>
</table>
Risk Factor Assessment (check all that apply)

**Modifiable**
- Inadequate dietary calcium and Vitamin D
- Current cigarette smoking
- Lack of physical activity
- Alcohol use greater than 2 drinks per day

**Non-modifiable**
- Caucasian or Asian ancestry
- Female
- Age over 60 years old
- Menopause or Early menopause
- Family history of osteoporosis
- Personal history of fracture after age 45
- Small-boned & thin (weigh less than 127 pounds)

**Secondary causes of osteoporosis**
Certain medications decrease bone mass. Do you take (past or present)…?
- Steroids (e.g., prednisone) for asthma, lupus, rheumatoid arthritis, multiple sclerosis, or another condition.
- Anti-seizure medications (e.g., phenytoin or phenobarbital)
- Aluminum-containing antacids (excessive use)
- Methotrexate (for cancer, rheumatoid arthritis, or lupus)
- Progestin used alone (e.g. Depo-Provera) and not used with estrogen products

Certain diseases may cause bone loss. Do you have (past or present)…?
- Hyperthyroidism (high thyroid hormone)
- Low sex hormone production (due to over-exercise, anorexia, early menopause, or in males, a low testosterone level)
- Cushing’s Disease (overactive adrenal gland)
- Spinal cord injury with paralysis
- Long-term or chronic diseases of your kidneys, liver, lungs, or digestive tract.

**Limitations of this test**
1. If the heel was previously broken or injured, the test may not give an accurate result.
2. In some people, the foot may not rest properly in the device and a measurement may be impossible.
3. Persons who run long distances or engage in activities where they are constantly compressing the heel bone may have results that do not reflect the other bones in their body.
4. The prediction of your risk of a future fracture may not be accurate if you change your exercise or food patterns.
5. This device predicts future risk of a fracture that most closely estimates risk of fracture in the spine and may not accurately reflect risk of fracture at other sites.
Appendix B: Summary of Topics for Patient Counseling

When to refer to a physician:
- 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 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 52 million Americans.
- Osteoporosis is the cause of 2 million fractures per year.
- It is estimated that 80% of those with osteoporosis are women and 20% are men.
- 50% of women and 26% 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 use

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 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.

Tips on Calcium and Vitamin D Supplements

Exercise. 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-bearing 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 your bones as well as for your heart and lungs. Smokers also may absorb less calcium from their diets.

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.

Osteoporosis & YOU

Phone: (406) 243-2339 Fax: (406) 243-4563 Email: IPHARM@montana.edu

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:

<table>
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<th>Food</th>
<th>Calcium Content (mg)</th>
</tr>
</thead>
<tbody>
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<td>Milk, skim (1 cup)</td>
<td>302</td>
</tr>
<tr>
<td>Cheese, cheddar (1 oz)</td>
<td>211</td>
</tr>
<tr>
<td>Cheese, american (1 oz)</td>
<td>150</td>
</tr>
<tr>
<td>Cheese, cottage (1 oz)</td>
<td>156</td>
</tr>
<tr>
<td>Yogurt, low fat (8 oz)</td>
<td>340-416</td>
</tr>
<tr>
<td>Ice cream (8 oz)</td>
<td>200</td>
</tr>
<tr>
<td>Broccoli (1 cup)</td>
<td>100-130</td>
</tr>
<tr>
<td>Tofu (4 oz)</td>
<td>100-130</td>
</tr>
<tr>
<td>Kale, raw (1 cup)</td>
<td>90</td>
</tr>
<tr>
<td>Fortified orange juice (8 oz)</td>
<td>3000</td>
</tr>
<tr>
<td>Fortified cereal (1 cup)</td>
<td>100-1000</td>
</tr>
</tbody>
</table>

Calculating calcium intake from food:

Step 1: Add daily intake of calcium from dairy sources
Step 2: Add intake from fortified sources and juices
Step 3: Add 250mg for non-dairy sources

Total daily dietary calcium intake

*Some people may need more vitamin D. Talk to your healthcare provider.
Appendix D: Post-test: Screening for Osteoporosis in Older Adults

Record responses on examination form.

1. According to the National Osteoporosis Foundation, what percentage of postmenopausal women with osteoporosis have NOT been diagnosed?
   a) 25%
   b) 33%
   c) 50%
   d) 67%

2. 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) A person with primary osteoporosis developed osteoporosis as a consequence of growing older.

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

4. 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)

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

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

7. 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)
8. Of the following people, who would **NOT** be considered at increased risk for osteoporosis?
   a) Small framed person (weight < 127 lbs.)
   b) Women taking estrogen replacement
   c) Patient taking phenytoin (Dilantin®)
   d) An alcoholic

9. 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.

10. 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

11. 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

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 CUBAClinical 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 (SEXA)
   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 transducers are closed.
## POST-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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Missoula MT, 59812-1522
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### APPENDIX E: Evaluation: Screening for Osteoporosis

Please indicate your major

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<th>Strongly Disagree</th>
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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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<td>0</td>
</tr>
<tr>
<td>Case Studies</td>
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</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Use</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Don't Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide new information to patients/clients</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>Adjust practices with geriatric patients/clients</td>
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<td>0</td>
</tr>
<tr>
<td>New program development or program enhancement</td>
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<td>0</td>
</tr>
<tr>
<td>Provide new information to family, friends, coworkers</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Train staff or provider</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>Other implementation*</td>
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<td>0</td>
</tr>
</tbody>
</table>
4. How do you plan to implement the information from this module to strengthen your practice, employment or personal goals? (check any that apply)

|          | 0 | O | O | O | O | O | O |

* 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)

|          | <1 hour | 1-2 hours | 2-3 hours | 3-4 hours | 4-5 hours | >5 hours |

|          | 0 | O | O | O | O | O |

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

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

8. Please offer ideas or suggestions for new modules.

For credit, please return this completed page to:

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