



## Montana Geriatric Education Center

### Instructions on Completing the Module

## Screening for Osteoporosis in Older Persons

*\*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 in the syllabus.
3. **After** reading the module, please complete the Post-Test.  
Use the questions in Appendix C and record your answers on the examination form marked Post-Test. (*Found at the end of Appendix E.*) Keep the completed answer form to turn in with the pre-test at the completion of the module.

Complete the Module Evaluation. (*Found after the post-test.*) Keep the completed module evaluation form to turn in with the pre-test and post-test at the completion of the module.

4. **To obtain credit for the module you must:**
  - a. Complete and turn in 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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# Pre-test: *Screening for Osteoporosis in Older Persons*

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) About 10-20% of patients who experience an osteoporosis-related hip fracture will 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 Type II 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 not commonly seen in osteoporosis-related fractures?
  - a) Hip
  - b) Pelvis
  - 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:
- Loss of cortical bone (more than trabecular bone) is primarily responsible for osteoporosis-related fractures.
  - Peak bone mass is achieved for women in their early to mid-40's.
  - The process of building up and breaking down of bone is called resorption.
  - 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?
- Parathyroid hormone
  - Calcitonin
  - Vitamin 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:
- Cataracts causing poor eye sight
  - Initiating a new blood pressure medication
  - Difficulty walking
  - 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?
- 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.
  - 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.
  - 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.
  - 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:
- Normal
  - Moderate
  - High
  - Unknown
14. In addition to the above patient's dietary calcium (estimated at 500mg daily), which calcium supplement would be the most beneficial?
- Caltrate<sup>®</sup> 600 + D. One tablet twice a day.
  - CitraCal<sup>®</sup> + D. One tablet three times a day.
  - Tums<sup>®</sup> Ultra. One tablet twice a day.
  - Viactiv<sup>®</sup> + 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:
- Normal
  - Moderate
  - High
  - Unknown

16. In the above patient, which of the following recommendations would be the **most** appropriate?
- Recommend to the patient that she continue what she is doing.
  - Recommend to the patient that she continue what she is doing and recommend a dietary supplement.
  - Recommend to the patient that she discuss the results of this screening with her primary care provider at her next scheduled appointment.
  - 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:
- Adults who have a fracture after age 50.
  - Any woman age 65 and older and men age 70 and older.
  - Any younger postmenopausal women or men age 50-70 when there is concern based on their clinical risk factor profile.
  - All of the above.
18. Which of the following bone mineral density tests does not use radiation as its method of detection?
- Quantitative computed tomography (QCT)
  - Qualitative ultrasound (QUS)
  - Single-energy X-ray absorptiometry (SEXA)
  - Dual-energy X-ray absorptiometry (DEXA)
19. Which of the following statements is FALSE regarding Qualitative Ultrasound (QUS)?
- QUS should not be used to diagnose osteopenia or osteoporosis.
  - QUS provides information regarding the quantity of minerals in the patient's bones.
  - QUS uses broadband ultrasound (BUA) and speed of sound (SOS) to determine the structural complexity of a patient's bones.
  - 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?
- The preferred foot to be used for testing is the dominant (usually the right) foot.
  - It is acceptable to use a heel if it was broken at least 20 years prior to the current screening.
  - It is possible to get an accurate test result with a person wearing nylon stockings or socks.
  - The patient should be asked if they feel equal pressure on both sides of their heel when the transducers are closed.

# PRE-TEST: Examination Form

## Screening for Osteoporosis in Older Persons

### Participant Information

1. Name: \_\_\_\_\_
2. Mailing address: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
3. Date exam completed \_\_\_\_\_

Questions: (Please circle one response per question)

1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D

For credit, please return this completed page to:

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## Montana Geriatric Education Center

# Screening of Osteoporosis in Older Persons

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A 2-hour module from the  
**Montana Geriatric Education Center**

A Consortium of:  
The University of Montana, Missoula  
St Vincent Hospital  
Montana Tech

<http://mtgec.montana.edu>

February 2012  
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**Description of module:**

A 2-hour module will discuss the impact of osteoporosis in the elderly population, discuss screening technology available for osteoporosis, and provide non-pharmacological interventions for osteoporosis.

**Learning objectives:**

1. Describe the impact osteoporosis has on elderly patients & the health care system.
2. List the definitions for osteoporosis.
3. Identify risk factors for osteoporosis and patients who should be screened for osteoporosis
4. Describe the technology behind quantitative ultrasound and how fracture risk is determined.
5. Formulate a care plan for a patient based on risk factors and their T- and Z-score results.
6. State the daily recommendations for calcium and Vitamin D and recommend a supplement for each stating the rationale for choosing one product over another.

**MONTANA GERIATRIC EDUCATION CENTER**  
**Required Disclosures to Participants**

**Goal/Purpose**

Improve health outcomes for older adults in rural Montana via increased knowledge of geriatric care and treatment of health problems by health professionals.

**Successful Completion of this Continuing Education Activity:**

- Completion of Participant Profile
- Completion of Pre-Test
- Reading of Text
- Completion of Post-Test with at least 70% accuracy
- Completion of module evaluation

**Contact Hours: 2**

**MT Nurses Association Continuing Education expiration date: February 15, 2012**

**Conflicts of Interest**

A conflict of interest occurs when an individual has an opportunity to affect educational content about health-care products or services of a commercial company with which she/he has a financial relationship.

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

**Commercial Company Support**

There is no Commercial Company Support for this CE activity

**Noncommercial Sponsor Support**

This CE activity is supported 100% by a federally funded grant from the Health Resources and Services Administration (HRSA) Grant Number UB4HP19056 for \$2,136,009 (07/01/2010 – 06/30/2015).

**Non-Endorsement of Products**

Approved provider status does not imply that there is real or implied endorsement by MTGEC, ANCC, or MNA of any product, service, or company referred to in this activity nor of any company subsidizing costs related to the activity.

**Off-label Product Use**

This CE activity does not include any unannounced information about off-label use of a product for a purpose other than that for which it was approved by the Food and Drug Administration (FDA).

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# 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 data from the National Health and Nutrition Examination Survey III (NHANES III), the National Osteoporosis Foundation (NOF) has estimated that more than 10 million Americans have osteoporosis and 33.6 million have low bone density of the hip. <sup>(2)</sup>

### 1. Epidemiology

#### a) Incidence

- Approximately 80% of the patients with osteoporosis are women <sup>(51)</sup>
- 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. <sup>(4)</sup>
- 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. <sup>(5)</sup>
- Each year approximately 1.5 million osteoporotic fractures in the United States lead 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 the placement of nearly 180,000 individuals in nursing homes. <sup>(6)</sup>
- The most devastating type of fracture is a hip fractures, accounting for nearly 300,000 hospitalizations each year. <sup>(6)</sup>

#### b) Morbidity & Mortality

- Of patients who experience a hip fracture, about 10-20% will die within the first year. Furthermore, those who survive a hip fracture, have a 2.5 fold increase of a subsequent hip fracture. <sup>(3)</sup> 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.<sup>(4,5)</sup> Only 40% of those who experience a hip fracture will regain function at the same level as before the event.<sup>(3)</sup>

### 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.<sup>(3,4,5)</sup>
- It has been estimated that 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.<sup>(3)</sup>

## 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). (Tables 1 & 2)<sup>(3,4,5,51)</sup>

**Table 1: T-score and Z-score: Terminology to Describe Bone Mineral Density (BMD)**

Term	Definition
<b>T-score</b>	The normal expected BMD for a “young” adult of the same sex. <ul style="list-style-type: none"> <li>• Women’s reference age = 30 years old*</li> <li>• Men’s reference age = 30years old*</li> </ul>
<b>Z-score</b>	The normal expected BMD for someone of the same age & sex.

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

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

Classification	Bone Mineral Density Result
<b>Normal</b>	BMD within 1 SD of a “young normal” adult (T-score at -1.0 and above)
<b>Osteopenia</b>	BMD is between 1 and 2.5 SD below that of a “young normal” (T-score between -1.0 and -2.5)
<b>Osteoporosis</b>	BMD is 2.5 SD or more below that of a “young normal” adult (T-score at or below -2.5)

WHO = World Health Organization; SD = standard deviation

### **a) Types of Osteoporosis: Primary and Secondary <sup>(7)</sup>**

- (1) 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. Primary osteoporosis can be further divided into two subtypes.
  - (a) Type I: Occurs in postmenopausal women about 15-20 years after menopause.
  - (b) Type II: Often referred to as “age-related” osteoporosis, it is a consequence of bone loss over time.
- (2) Secondary osteoporosis is bone loss from secondary factors such as other disease states (ex.,hypogonadism) or the use of medications which affect bone metabolism (ex., 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. <sup>(8)</sup> 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. <sup>(51)</sup>

Throughout life, a constant process of building bone and breaking it down occurs, which is called remodeling. At any given time, 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. <sup>(1)</sup> 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.<sup>(1,8)</sup> Some of these factors will be discussed under osteoporosis risk factors. (See Section B.5).

### c) Bone composition

Bone itself is composed of inorganic minerals (50-70%), mainly in the form of calcium phosphate (hydroxyapatite crystals  $[Ca_{10}(PO_4)_6OH_2]$ ), and an organic matrix (30-50%) made from collagen, different proteins and cells (osteoclasts, osteoblasts and osteocytes).<sup>(8)</sup> The skeleton contains 99% of the calcium and 85% of the phosphorus found in the body.<sup>(8)</sup>

### d) Bone remodeling

The process of remodeling occurs in 4 phases: resorption, reversal, formation and quiescence.<sup>(1)</sup> 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.<sup>(8)</sup>

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.<sup>(1)</sup> 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.<sup>(8)</sup> Once these phases are completed, a latent period begins, quiescence.<sup>(1)</sup>

The activities of osteoclasts and osteoblasts are coupled to assist with the maintenance and integrity of the bone structure. In 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.<sup>(1)</sup>

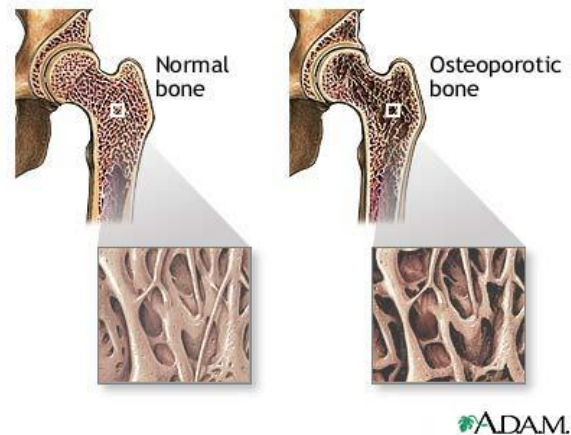
**Helpful Hint:**  
“Clasts” = *Cleave*  
“Blasts” = *Build*

### 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).<sup>(1,8)</sup> The appearance of the trabecular bone is like structural beams of a house, and the inner spaces or rooms are filled with bone marrow.

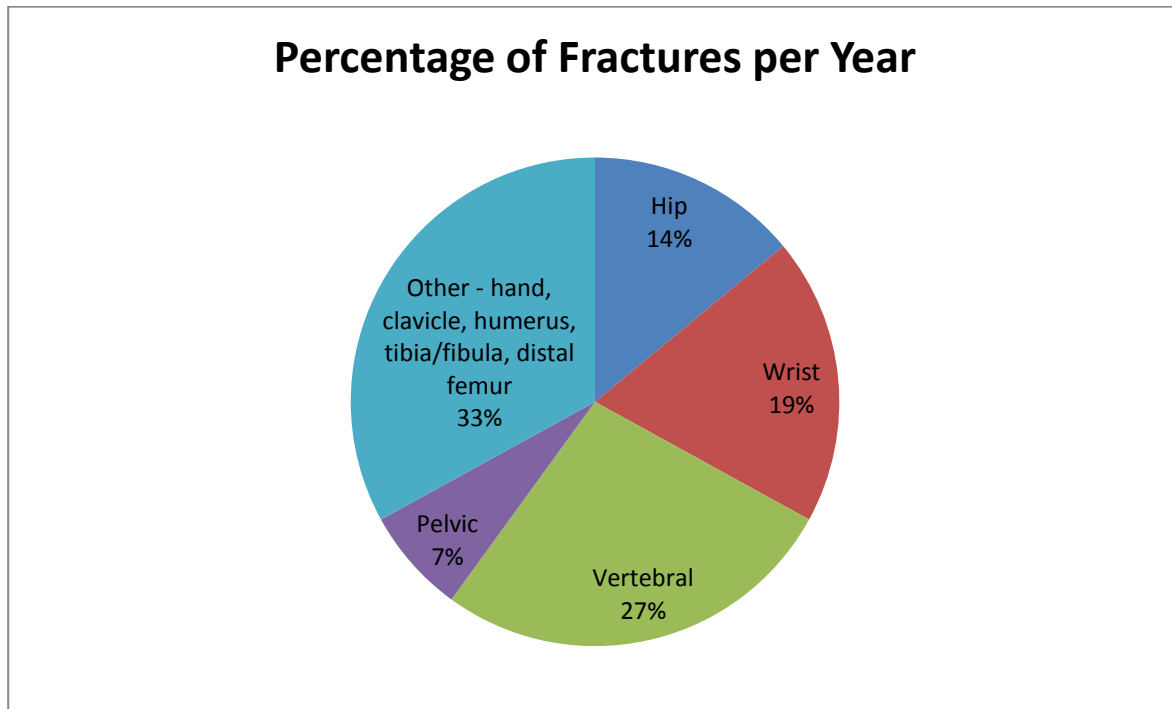
**Figure 1: Picture of Normal and Osteoporotic Trabecular Hip Bone**



#### **f) Sites Affected by Osteoporosis**

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 compared to compact, cortical bone. Trabecular bone has a faster rate of remodeling than cortical bone, therefore, increasing the risk of bone loss and subsequent fracture.<sup>(1,9)</sup> Figure 2 demonstrates the relationship between the ratio of trabecular and cortical bone as it pertains to the most common sites of osteoporotic fractures.

**Figure 2: Percentage of Fractures per Year<sup>(4)</sup>**



\* = based on estimated 1.5 million osteoporosis-related fractures per year. <sup>(4)</sup>

### **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.<sup>(1,8)</sup> Table 3 summarizes the hormonal actions on calcium homeostasis.

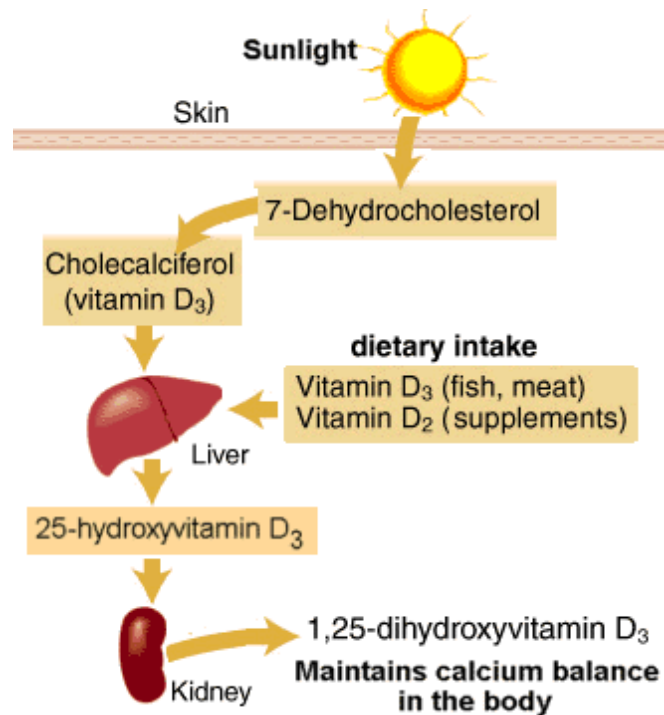
#### **(1) Parathyroid Hormone (PTH)**

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.<sup>(1,8)</sup>

## (2) Vitamin D

The active form of vitamin D is calcitriol (1,25-dihydroxyvitamin D<sub>3</sub>). 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).<sup>(1,8)</sup>

**Figure 3: Activation of Calcitriol (1,25-dihydroxyvitamin D<sub>3</sub>)**<sup>(61)</sup>



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.<sup>(1,8)</sup>

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).<sup>(10,11)</sup> In the elderly population, the skin's ability to synthesize vitamin D is not as efficient as it once was, which can easily lead to a deficiency.<sup>(10)</sup> 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.<sup>(1,8)</sup>

### (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.<sup>(1)</sup>

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

Tissue	PTH	Vitamin D	Calcitonin
Gastrointestinal tract	No direct effect	↑ Ca <sup>2+</sup> absorption	No direct effect
Kidney	↑ Ca <sup>2+</sup> retention ↑ Vitamin D synthesis	↑ Ca <sup>2+</sup> retention	↓ Ca <sup>2+</sup> retention
Bone	↑ bone resorption	↑ bone resorption	↓ bone resorption
Effect on plasma [Ca <sup>2+</sup> ]	↑ [Ca <sup>2+</sup> ]	↑ [Ca <sup>2+</sup> ]	↓ [Ca <sup>2+</sup> ]

PTH = parathyroid hormone, Vitamin D = 1, 25-OH-Vitamin D<sub>3</sub>

## 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 after menopause.<sup>(5)</sup>

#### (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 causes crowding out of bone formation sites.<sup>(13,14)</sup>

#### (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.<sup>(14)</sup>

**Table 4: Bone Densities by Race<sup>(60)</sup>**

<b>Ethnic/Racial Group</b>	<b>Osteopenia</b>	<b>Osteoporosis</b>
Asian	50%	10%
Hispanic	47%	10%
Native American	45%	12%
Caucasian	40%	7%
African-American	28%	4%

**(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.<sup>(15)</sup>

**(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.<sup>(1,3,4,5)</sup>

**(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.<sup>(3,4,14)</sup>

**(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.<sup>(3,4)</sup>

**(8) Nicotine products**

**Cigarettes**

Exposure to cigarette smoke (both active and passive) has detrimental effects on bone density.<sup>(3)</sup> 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.<sup>(17)</sup>

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.<sup>(17)</sup> When comparing smokers to non-smokers, by the age of 80, the smokers' bone density will be 6-10% lower than the non-smokers.<sup>(17)</sup> This correlates to a doubling of the spinal fracture risk and a 50% increase in the risk of hip fracture.<sup>(17)</sup>

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.<sup>(18)</sup>

### **Smokeless tobacco**

In the U.S., the incidence of smoking has been declining, however, the use of smokeless tobacco products has tripled since the 1970's.<sup>(19)</sup> In 2009, the Montana Adult Tobacco Survey reported that 13% of male Montanans use chewing tobacco, nearly double the national average.<sup>(20,56)</sup> According to population based surveys, the racial subgroups that report the highest use of smokeless tobacco products are African Americans and Native Americans.<sup>(21)</sup>

Currently, the evidence is lacking to show whether smokeless tobacco causes 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 2005, a cross-sectional study of 240 women over the age of 60 was conducted in North Carolina. The purpose of this research was to determine if a link occurs between smokeless tobacco use and low bone density. Data was collected at health screenings using a questionnaire and a bone density test with a portable dual energy x-ray absorptiometry (DEXA) device. The women were asked about their use of smokeless tobacco products, 16% were current users and 10% were former users. The findings show smokeless tobacco use was not an independent predictor of low bone density, but a correlation was seen between use and age. Increased age was associated with lower bone density in all subjects, but a significant decrease in bone density was measured in both former and current users of smokeless tobacco. The investigators determined that smokeless tobacco use increases age-related bone density loss.<sup>(22)</sup>

Although further human studies are needed to provide sufficient evidence to list smokeless tobacco as a risk factor for osteoporosis, it may be a contributor to bone density loss.

### **(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.<sup>(3,23)</sup>

### **(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 (ex., anorexia nervosa), malabsorption disorders (ex., celiac sprue, inflammatory bowel disease, gastrectomy or gastric bypass), or inadequate diet are at greater risk of developing osteoporosis.<sup>(3,4,5)</sup>

### **(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 (ex., prednisone and hydrocortisone), older anti-seizure medications (ex., phenytoin and phenobarbital), medroxyprogesterone for contraception and loop diuretics (ex., furosemide). Other less common medications involved are methotrexate (usually for chronic use as an immunosuppressant for diseases such as rheumatoid arthritis), long-term total parenteral nutrition, lithium, and supra-therapeutic doses of thyroid hormone.<sup>(3,24)</sup>

## (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.<sup>(1)</sup> 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.<sup>(1)</sup> After this point, the rate of loss resumes to the normal age-related decline, which is approximately 0.5% annually.<sup>(1)</sup>

For many years, estrogen replacement was considered a first line therapy for the prevention and treatment of osteoporosis. At that time, several studies showed estrogen replacement had beneficial effects to reduce heart disease risk and improve lipid profiles. However, these observational studies had a number of biases. In 2004, the landmark Women's Health Initiative (WHI) trial was published. This study found that using either estrogen replacement alone or hormone replacement therapy (HRT) can increase bone mass and decrease fracture rates. Unfortunately, the incidence of negative effects such as heart disease events, strokes, breast cancer cases and thromboembolism were increased and preclude the use of HRT as a first line therapeutic option to prevent or treat osteoporosis.<sup>(1,26,27,28)</sup> 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:<sup>(3,4,5,29)</sup>

- (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 (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 in all age groups, 11 per 100,000 compared to 6 per 100,000 nationally. As Montana's older population continues to grow, injuries from falls are expected to increase, leading to premature deaths for the elderly in Montana.<sup>(30)</sup>

### **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).<sup>(31)</sup> 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: 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  $\geq 1.8$ , (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.<sup>(31)</sup> 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 an algorithm 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.<sup>(53)</sup> A major osteoporotic fracture is defined as a clinical spine, hip, forearm or humerus fracture. The probability is obtained by entering patient data into the questionnaire form. This includes 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. A score is calculated and a 10-year fracture risk percentage is determined.<sup>(53,54)</sup> 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  $< -1.0$ ).<sup>(53)</sup> 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%.<sup>(54)</sup>

This tool can be used in conjunction with the CUBAClinical device to more accurately determine the patient's risk for fractures.

Figure 4: Image of FRAX® tool <sup>(53,54)</sup>

The image shows a screenshot of the FRAX® tool questionnaire. At the top, there are fields for 'Country: US (Caucasian)', 'Name / ID:', and 'About the risk factors' with an information icon. The main section is titled 'Questionnaire:' and contains 12 numbered questions. Questions 1-4 are demographic: 1. Age (between 40-90 years) or Date of birth (with sub-fields for Age, Date of birth: Y, M, D); 2. Sex (Male/Female radio buttons); 3. Weight (kg); 4. Height (cm). Questions 5-9 are medical history: 5. Previous fracture; 6. Parent fractured hip; 7. Current smoking; 8. Glucocorticoids; 9. Rheumatoid arthritis. Questions 10-12 are clinical: 10. Secondary osteoporosis; 11. Alcohol 3 or more units per day; 12. Femoral neck BMD (g/cm²) with a 'Select DXA' dropdown and a text input field. At the bottom right are 'Clear' and 'Calculate' buttons.

## 5. Osteoporosis in Males

While the majority of patients with osteoporosis are women, men should not be excluded from this topic. 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.<sup>(1)</sup> In addition, men experience 30% of the hip fractures, and are more likely to die within the year following the fracture.<sup>(1,32)</sup>

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.<sup>(5,32)</sup>

## II. Osteoporosis Screening

### A. Who should be screened?<sup>(3)</sup>

In 2010, the National Osteoporosis Foundation (NOF) published updated recommendations for bone density testing. It should be noted that screening individuals who fall outside these recommendations is not inappropriate but cannot be justified based on current research.

1. Women age 65 and older and men age 70 and older, regardless of clinical risk factors
2. Younger postmenopausal women and men age 50-69 when there is concern based on their clinical risk factor profile
3. Women in the menopausal transition, if there is a specific risk factor associated with increased fracture risk, such as low body weight, prior low-trauma fracture, or high risk medication.
4. Adults who have a low-trauma fracture after age 50
5. Adults with a condition (e.g., rheumatoid arthritis) or who are taking a medication (e.g., glucocorticoids,  $\geq 5\text{mg/day}$  for  $\geq 3$  months) associated with low bone mass or bone loss
6. Anyone being considered for pharmacologic therapy for osteoporosis
7. Anyone being treated for osteoporosis, to monitor treatment effect
8. Anyone not receiving therapy in whom evidence of bone loss would lead to treatment
9. Postmenopausal women discontinuing estrogen should also be considered for screening

## 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.<sup>(33)</sup> 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<sup>(33,34)</sup>**

Technology	Detection Method	Sites tested	Comments
Dual-energy X-ray absorptiometry (DEXA)	X-ray radiation	Total body, spine, proximal femur, forearm, heel, & finger	<ul style="list-style-type: none"> <li>• Gold standard for diagnosis</li> <li>• Expensive</li> <li>• Need skilled technician</li> </ul>
Single-energy X-ray absorptiometry (SEXA)	X-ray radiation	Forearm, finger, & heel	<ul style="list-style-type: none"> <li>• Only on peripheral sites</li> <li>• Less expensive than DEXA</li> <li>• Good for screening</li> </ul>
Quantitative computed tomography (QCT)	Radiation	Spine & forearm	<ul style="list-style-type: none"> <li>• Can be used to diagnose</li> <li>• Expensive</li> <li>• Need skilled technician</li> </ul>
Radiographic absorptiometry	X-ray radiation	Fingers	<ul style="list-style-type: none"> <li>• Expensive</li> <li>• Need skilled technician</li> <li>• Good for screening</li> </ul>
Qualitative ultrasound (QUS)	Sound waves	Heel, tibia, & patella	<ul style="list-style-type: none"> <li>• Portable device</li> <li>• Inexpensive</li> <li>• Good for screening</li> </ul>

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

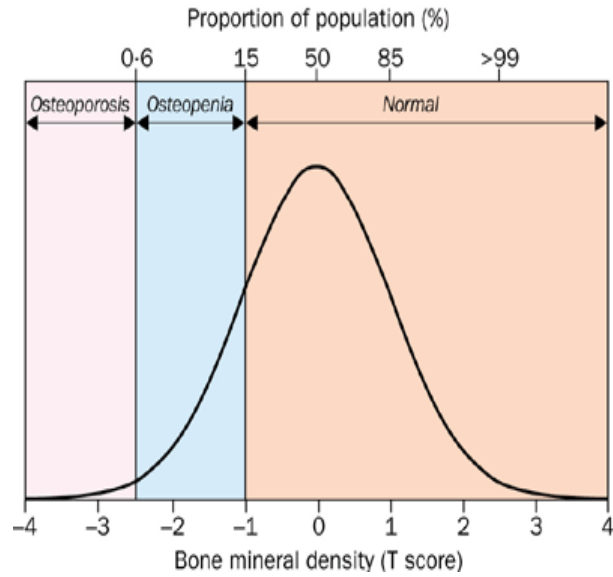
faster than weakened bone, displaying a higher SOS. Therefore, structurally complex (or normal) bone has a higher BUA and SOS compared to weakened, osteoporotic bone. BUA and SOS are then used to estimate a patient's bone mineral density.<sup>(33,34)</sup>

The greatest utility of screening devices is not their ability to measure bone mineral density, but rather their ability to predict 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.<sup>(29)</sup> Although the technology may be different between screening devices, their ability to predict future fractures is similar and has been validated with multiple studies.<sup>(35-37)</sup>

### **C. Interpreting Results**

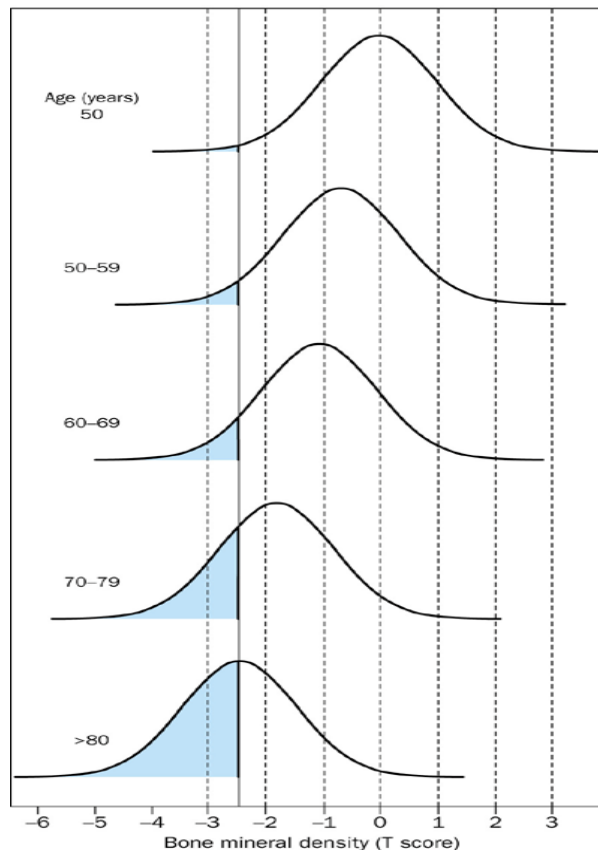
In order to understand the topic of fracture risk, one must first understand how bone density tests are reported: T-score and Z-score. Recall from statistics that, if we assume a normal population, it should have a Gaussian distribution which has a bell-shaped curve. Bone mineral content follows a Gaussian distribution and therefore can be represented in terms of the number of standard deviations (SD) from the normal. The number of standard deviations approximates a certain percentage of the population: 1 SD = 68%, 2 SD = 95%, and 3 SD = 99.7%. Because the loss of bone density is the concern, the left side or the negative side of the bell curve is the focus of osteoporosis-related discussions. The T-score value is the number of SDs away from mean bone density for normal young women or men at peak bone mass (which occurs for women in their late twenties to early thirties and for men in their mid-forties.) 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.<sup>(29,34)</sup> 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**



**Figure 6: Shifts in normal distribution curves with increasing age**

Figures reprinted from Lancet with permission:  
Elsevier Publishing<sup>(29)</sup>



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.<sup>(35-37)</sup>

One final distinction needs to be made among the screening technologies; QUS devices are not intended to diagnose osteoporosis, as this diagnosis can only be made by a DEXA scan. Instead, QUS offers us a 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 health care provider.<sup>(29)</sup>

## **D. Quantitative Ultrasound (QUS): CUBAClinical Device<sup>(34)</sup>**

### **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)

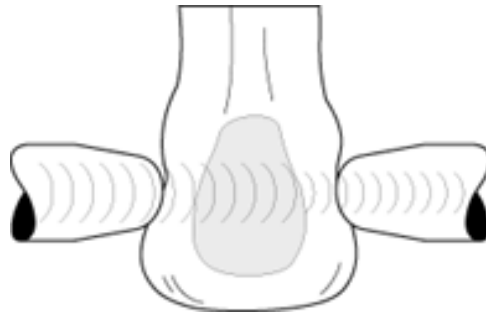


### **2. How it measures?**

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 calcaneus (heel bone).

(See Figure 8).

**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.

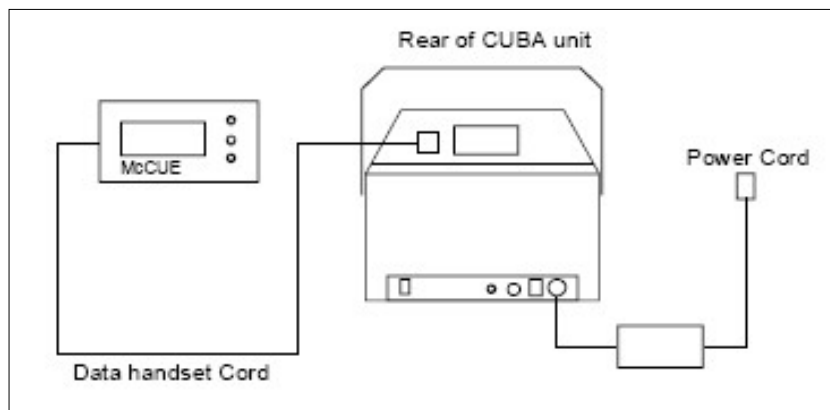
The more structurally 'dense' bones are, the more the sound wave will be channeled through the bone. This attenuation results in the sound wave passing through more quickly and a higher BUA measurement. Conversely, as bone becomes more osteoporotic, the speed of the sound wave will slow down and a lower BUA will be measured.<sup>(34)</sup>

## **E. How to use the Quantitative Ultrasound (CUBAClinical)<sup>(34)</sup>**

### **1. Setting up the device**

- a) Connect the cable between the Data Controller and the CUBAClinical device.
- b) Connect the CUBAClinical, using the correct lead, to the mains supply.
- c) Switch on the CUBAClinical (the mechanism will automatically open if it is not already in the open position).
- d) Open the calf plate (the hinged lid over the footwell).

**Figure 9: Diagram of CUBAClinical Set Up**



## **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 measure 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 their 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. 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.

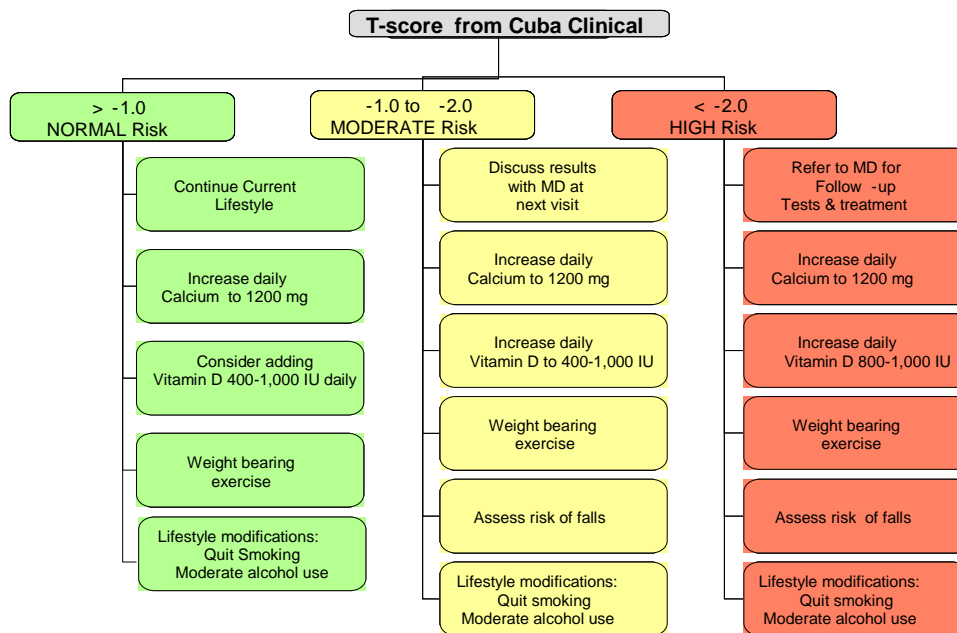
At the completion of the test, the transducers will automatically retract to the open position and the patient can easily remove his or her foot. Remaining ultrasound gel should be removed from the patient’s foot and the transducers. Additionally, the footwell and insert plates should be cleansed with 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. 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 CUBAClinical 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<sup>(34)</sup>**



## G. Sources of Error <sup>(34)</sup>

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, non-physician providers are not able to bill for services which they provide, but they may be able to charge for services incident to the screening process by performing the screening assessment in a physician's office. Medicare does cover bone density (CPT Code 76977) testing every two years in patients 65 years or older, including but not limited to:<sup>(3,38)</sup>

- a) Estrogen deficient women at clinical risk of osteoporosis
- b) Individuals with vertebral abnormalities
- c) Individuals receiving, or planning to receive, long-term glucocorticoid (steroid) therapy  $\geq 5\text{mg/d}$  of prednisone or an equivalent dose for  $\geq 3$  months
- d) Individuals with primary hyperparathyroidism
- e) Individuals being monitored to assess the response or efficacy of an approved osteoporosis drug therapy

### 2. Examples of successful programs

Implementation of bone density testing has been successfully accomplished in community pharmacy settings.<sup>(38-40)</sup>

## 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 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 Persons*.

### A. Non-pharmacologic interventions

#### 1. Lifestyle modifications<sup>(3-5)</sup>

- a) Avoid the use of tobacco products
- b) Moderate alcohol intake (no more than 2 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. 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<sup>(3-5)</sup>

The average American diet for men and women over 50 years of age consists of about 600-700mg 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, and Table 7 demonstrates the calcium content of common foods and Table 8 shows the estimated calcium content of some calcium fortified foods. A more sophisticated calculator can be found on the following website: <http://www.iofbonehealth.org/patients-public/calcium-calculator.html>

**Table 6: Simplified Calculation of Daily Dietary Calcium<sup>(3)</sup>**

Estimate of high calcium-containing food			
Food	# of servings	Calcium amount per serving	Total Calcium
Milk (8 oz)		X 300mg	=
Yogurt (8 oz)		X 400 mg	=
Cheese (1 oz)		X 200 mg	=
Non-dairy calcium sources	-----	-----	= 250 mg
Estimated sum total of daily calcium →			=

**Table 7: Estimated Calcium Content of Common Foods<sup>(4,42)</sup>**

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

**Table 8: Estimated Calcium Content of Fortified Foods<sup>(3,38)</sup>**

Food	Serving Size	Calcium (mg) per serving
Soy beverage	1 cup (8 oz)	80-500
Orange Juice	6 oz	378
Ready-to-eat cereal	1 cup	100-1,000

### 3. Fall prevention

Ninety-five percent of hip fractures are related to falls and roughly 55% of fractures in the elderly occur at home.<sup>(42)</sup> Therefore, it is important to identify patients at risk for falls and to make recommendations to prevent them.

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 CUBAClinical 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.<sup>(43,44)</sup>

#### a) Intrinsic Factors:

- (1) Difficulties with gait & balance
- (2) Visual problems
- (3) Decreased muscle strength
- (4) Co-existing disease states (Ex., hypotension, arrhythmias, and epilepsy)
- (5) High risk medications
  - (a) Central nervous system drugs: benzodiazepines, antipsychotics, antidepressants, and anticonvulsants.
  - (b) Antihypertensive drugs which can lead to hypotension.

#### b) Extrinsic Factors:

- (1) Tripping over loose rugs or clutter
- (2) No stair railings
- (3) Poor lighting
- (4) No handrails in bathrooms and tubs
- (5) Introduction to a new or foreign environment
- (6) Slippery conditions

c) Suggestions to help minimize a patient's risk for falling <sup>(4,16,43,44)</sup>

- (1) Exercise to improve balance and strength. Exercise is beneficial for a patient with osteoporosis as it helps strengthen the bones as well as improving 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.
- (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 (OTC)**

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

#### **a) Calcium**

The general consensus for the recommended daily intake of elemental calcium in the elderly population is 1000mg – 1200mg<sup>(1)</sup> 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.<sup>(1,42,45)</sup>

#### **b) Vitamin D**

The National Osteoporosis Foundation recommends an intake of 400-800 IU of vitamin D<sub>3</sub> for adults under 50 and 800-1,000 IU for adults over 50.<sup>(2,11,46)</sup> 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 D<sub>2</sub> (ergocalciferol) and vitamin D<sub>3</sub> (cholecalciferol) are both good for bone health.<sup>(46,59)</sup> For most adults; the safe upper limit of Vitamin D is 4000 IU per day. Recommendations at screening events should not exceed 2000 IU per day unless serum vitamin D concentrations are monitored.<sup>(3,50)</sup> 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, the elderly benefit from taking their calcium carbonate supplement at meal times when their acid production is usually at its highest.<sup>(45)</sup>

Similarly, patients who take medications which decrease gastric acidity, such as proton pump inhibitors (see Table 9), should be advised to use the calcium citrate products as they do not require an acidic environment to dissolve effectively.<sup>(45)</sup>

**Table 9: Common Proton Pump Inhibitors**

Proton Pump Inhibitors	
Generic	Brand
• Esomeprazole	Nexium®
• Lansoprazole	Prevacid®
• Omeprazole	Prilosec®
• Pantoprazole	Protonix®
• Rabeprazole	Aciphex®

### 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.<sup>(45)</sup>

### 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. Diets deficient in vitamin D or exposure to sunlight will require vitamin D supplementation.<sup>(3,4,45)</sup> 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 represents the levels of concern, insufficient and sufficient 25-hydroxyvitamin D concentrations according to the Institute of Medicine.<sup>(10,51)</sup>

**Table 10: Serum 25-Hydroxyvitamin D [25(OH)D] Concentrations and Health**  
(10,51)

ng/mL	(nmol/L)	Health Status
<12	(<30)	Associated with risk of Vitamin D deficiency
12-20	(30-50)	Inadequate for bone health
>20	(>50)	Adequate for bone health
>50	(>125)	Reason for concern and potential side effects

### 3. Comparison of common supplement preparations

There are numerous calcium supplements on the market with some as 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).<sup>(4,45)</sup>

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, in the last couple years, products have been marketed which claim to be superior in their ability to be absorbed, namely coral calcium. Since 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.<sup>(47)</sup>

**Table 11: Common Preparations of Calcium Products<sup>(3,45)</sup>**

Calcium carbonate (40% elemental calcium)					
Product	Tablet mg	Elemental mg/Tablet	Vitamin D Content/Tablet	Tablets per day*	Average 30-day cost*
Caltrate <sup>®</sup> 600	1500 mg	600 mg	-	2	\$5.40
Caltrate <sup>®</sup> 600+D	1500 mg	600 mg	200 IU	2	\$8.49
Os-Cal <sup>®</sup> +D	1250 mg	500 mg	200 IU	2	\$4.57
Tums <sup>®</sup>	500 mg	200 mg	-	6	\$6.59
Tums <sup>®</sup> EX	750 mg	300 mg	-	4	\$6.86
Tums <sup>®</sup> Ultra	1000 mg	400 mg	-	3	\$5.62
Viactiv <sup>®</sup> +D+K	1250 mg	500 mg	500 IU	2	\$7.03
Calcium liquid softgel (Nature Made)	1500 mg	600 mg	200 IU	2	\$7.00
Coral calcium (GNC)	500 mg	200 mg	100 IU	5	\$18.32
Calcium citrate (21% elemental calcium)					
Citracal+D <sup>®</sup>	1190 mg	250 mg	200 IU	4	\$7.79
Citracal Gummies+D <sup>®</sup>	1190 mg	250 mg	250 IU	4	\$20.98
Calcium Citrate Plus (GNC)	952 mg	200 mg	200 IU	5	\$13.99

\* = based on recommended daily calcium dose of 1000 mg to 1200 mg per day.

# = based on prices obtained from [www.drugstore.com](http://www.drugstore.com)

IU – international units

#### 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.<sup>(4)</sup>

#### 5. Potential drug-drug interactions with calcium products<sup>(48)</sup>

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 (ex., ciprofloxacin, levofloxacin, gatifloxacin)
- Tetracycline antibiotics (including doxycycline)
- Thyroid hormones (ex., 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 (ex., 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<sup>(36)</sup>**

Drug Class	Mechanism of Action	Generic (Brand) Name	Dose, Route, Frequency	Cost per month <sup>#</sup>
Bisphosphonates	Inhibits bone resorption	Alendronate (Fosamax <sup>®</sup> )	10 mg po daily or 70 mg po weekly	<b>Weekly Generic - \$14</b> <b>Weekly Brand - \$88</b>
		Alendronate + Vitamin D3 (Fosamax Plus D <sup>®</sup> )	70mg alendronate/ 5600 IU Vitamin D3 po weekly	<b>\$116</b>
		Risedronate (Actonel <sup>®</sup> )	5 mg po daily or 35 mg po weekly 150 mg po monthly	<b>\$141</b> <b>\$131</b> <b>\$140</b>
		Ibandronate (Boniva <sup>®</sup> )	2.5mg po daily or 150mg po monthly 3 mg IV every 3 months	<b>\$129</b> <b>\$474/dose (drug only)</b>
		Zoledronic Acid (Reclast <sup>®</sup> )	5mg IV infusion annually	<b>\$1,137/yr (drug only)</b>
Estrogen replacement	Decreases menopausal bone loss	Various products	Oral	<b>\$14-50</b>
			Transdermal (patch)	<b>\$37</b>
Selective Estrogen Receptor Modulator	Acts like estrogen on the bone to decrease bone loss	Raloxifene (Evista <sup>®</sup> )	60 mg po daily	<b>\$150</b>
Calcitonin	Inhibits bone resorption	Calcitonin (Miacalcin <sup>®</sup> )	200 units nasally daily	<b>Generic - \$113</b> <b>Brand - \$143</b>
		Calcitonin (Fortical <sup>®</sup> )	200 units nasally daily	<b>\$90</b>
Parathyroid hormone analog	Stimulates osteoblasts, increases calcium absorption, & increases renal reabsorption	Teriparatide (Forteo <sup>®</sup> )	20 mcg subQ daily	<b>\$1,016</b>
RANK-L Inhibitor	Binds to RANK-L, inhibiting osteoclast formation	Denosumab (Prolia <sup>®</sup> )	60mg subQ every 6 months	<b>\$1,650 *per year</b>

# = based on prices obtained from [www.drugstore.com](http://www.drugstore.com)

## D. Summary for Patient Counseling

Each counseling session should include a discussion of medications, brief medical history, 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.

## E. Frequently Encountered Scenarios from Osteoporosis Screening

**Example 1:** *Elderly women 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).

**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, ex., 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.<sup>(9,47)</sup> The patient should be assessed and recommendations based 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 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 8) 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 their future risk of a fracture, and more definitive testing would have to be conducted using other technologies.

## IV. Useful Websites

### 1. Specific to Osteoporosis

- a) National Osteoporosis Foundation: <http://www.nof.org>
- b) Physician's Guide to Prevention and Treatment of Osteoporosis: <http://www.nof.org/professionals/clinical-guidelines>
- c) WHO Fracture Assessment Tool: <http://www.shef.ac.uk/FRAX/>
- d) National Institutes of Health: Osteoporosis and Related Diseases, National Resource Center: [http://www.niams.nih.gov/Health\\_Info/Bone/](http://www.niams.nih.gov/Health_Info/Bone/)
- e) The Bone Thief from The National Institute on Aging: <http://www.nia.nih.gov/health/publication/osteoporosis-bone-thief>
- f) International Osteoporosis Foundation: <http://www.iofbonehealth.org/contact.html>
- g) Osteoporosis and Bone Physiology, University of Washington: <http://courses.washington.edu/bonephys/>
- h) Calcium calculator (by the IOF): <http://www.iofbonehealth.org/patients-public/calcium-calculator.html>
- i) FRAX- WHO Fracture Risk Assessment Tool: <http://www.shef.ac.uk/FRAX/>

### 2. Information on Aging or Elderly Patients

- a) The Merck Manual of Geriatrics: [http://www.merck.com/mrkshared/mm\\_geriatrics/home.jsp](http://www.merck.com/mrkshared/mm_geriatrics/home.jsp)
- b) The Merck Manual on Health and Aging: [http://www.merck.com/pubs/mmanual\\_ha/contents.html](http://www.merck.com/pubs/mmanual_ha/contents.html)
- c) National Institute on Aging: <http://www.nia.nih.gov/>
- d) Montana Senior and Long Term Care: <http://www.dphhs.mt.gov/sltc/index.shtml>

## V. References

1. O'Connell MB, Vondracek SF. Osteoporosis. In: DiPiro JT, Talbert RL, Yee GC, Matzke GR, Wells BG, Posey BG, editors. *Pharmacotherapy: a pathophysiologic approach*. 8<sup>th</sup> ed. New York (NY): McGraw Hill; 2011. p. 1559-1581
2. National Osteoporosis Foundation. *America's Bone Health: The State of Osteoporosis and Low Bone Mass in Our Nation*. National Osteoporosis Foundation, Washington, DC, pp.1-55,2002.
3. National Osteoporosis Foundation. *Clinician's Guide to Prevention and Treatment of Osteoporosis*. 2010. Available at: [http://www.nof.org/sites/default/files/pdfs/NOF\\_ClinicianGuide2009\\_v7.pdf](http://www.nof.org/sites/default/files/pdfs/NOF_ClinicianGuide2009_v7.pdf). Accessed December 1, 2011.
4. American Association for Clinical Endocrinologists. *Medical guidelines for clinical practice for the diagnosis and treatment of postmenopausal osteoporosis*. *Endocr Pract*. 2010;16(Suppl 3) Available at: <https://www.aace.com/sites/default/files/OsteoGuidelines2010.pdf>.
5. National Institute of Health Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Therapy. *Osteoporosis Prevention, Diagnosis, and Therapy*. *JAMA* 2001;285(6):785-95.
6. U.S. Department of Health and Human Services. *Bone Health and Osteoporosis: A Report of the Surgeon General*. Rockville, MD: U.S. Department of Health and Human Services, Office of the Surgeon General, 2004.
7. Navas LR, Lyles KW. Osteoporosis. In: Duthie EH, Katz PR, editors. *Practice of Geriatrics*. 4<sup>rd</sup> edition. Philadelphia (PA): WB Saunders Company; 2007. p 217-27.
8. Hormonal control of calcium & phosphate metabolism & the physiology of bone. In: *Ganong's review of medical physiology*. 23<sup>rd</sup> ed. New York (NY): Lange Medical Books/McGraw Hill; 2009.
9. *Fast Facts on Osteoporosis*. National Osteoporosis Foundation. Available at <http://www.nof.org/node/40>. Accessed December 1, 2011.
10. National Institute of Health Office of Dietary Supplements. *Dietary Supplement Fact Sheet: Vitamin D*. National Institutes of Health, Bethesda, Maryland, 2011. Available at: <http://ods.od.nih.gov/factsheets/VitaminD-HealthProfessional>. Accessed December 6, 2011.
11. *Prevention and treatment of vitamin D deficiency*. *Pharmacist's letter/Prescriber's letter* 2008;24(3):240311.
12. *The Merck Manual of Geriatrics*. Beers MH, Berkow R, editors. 3<sup>rd</sup> edition. Copyright© 1995-2004 Merck & Company, Inc., Whitehouse Station (NJ). Accessed September 7, 2004, from [www.merckmedicus.com](http://www.merckmedicus.com)
13. Chan GK, Duque G. Age-related bone loss: old bone, new facts. *Gerontology* 2002;48:62-71.
14. Meier D, Luckey M, Wallenstein S, et al. Racial differences in pre- and postmenopausal bone homeostasis: association with bone density. *J Bone Miner Res* 1992;7:1181-9.
15. Seeman E. Osteoporosis II: pathogenesis of bone fragility in women and men. *Lancet* 2002; 359:1841-50.
16. *Fall Risk for Older Adults (6/9/2011)*. Centers for Disease Control Web site. Available at: <http://www.cdc.gov/features/fallrisks/>. Accessed December 14, 2011.
17. Vogt M. The Effect of Cigarette Smoking on the Development of Osteoporosis and Related Fractures. *Medscape General Medicine* 1999;1(3):1-12.
18. Smoking and Bone Health (1/2011). National Institutes of Health Osteoporosis and Related Bone Diseases Web site. Available at [http://www.niams.nih.gov/Health\\_Info/Bone/Osteoporosis/Conditions\\_Behaviors/bone\\_smoking.asp](http://www.niams.nih.gov/Health_Info/Bone/Osteoporosis/Conditions_Behaviors/bone_smoking.asp). Accessed: December 14, 2011.
19. Office of the Inspector General: *Spit Tobacco and Youth*. Washington, DC, Department of Health and Human Services, OEI 06-92-00500, 1992.
20. *Montana Adult Tobacco Use: Results of the 2009 Montana Adult Tobacco Survey (5/2010)*. Montana Department of Public Health & Human Services Web site. Available at: <http://tobaccofree.mt.gov/publications/surveillancereports/may2010.pdf>. Accessed December 14, 2011.
21. Bell RA, Spangler JG, Quandt SA. *Smokeless Tobacco Use Among Adults in the Southeast*. *South Med J* 2000;93(5):456-462.
22. Quandt S, Spangler JG, Case LD, et al. *Smokeless tobacco use accelerates age-related loss of bone mineral density among older women in a multi-ethnic rural community*. *J Cross Cult Gerontology* 2005;20:109-125

23. Siris ES, Miller PD, Barrett-Connor E, Faulkner KG, Wehren LE, Abbott TA, et al. Identification and fracture outcomes of undiagnosed low bone mineral density in postmenopausal women: results from the national osteoporosis risk assessment (NORA). *JAMA* 2001;286:2815-22.
24. Tannirandom P, Epstein S. Drug-induced bone loss. *Osteoporos Int.* 2000; 11:637-59.
25. Whiting SJ. Nutritional Interventions in Osteoporosis. *Geriatrics Aging.* 2005;8(9):14-20.
26. Writing Group for the Women's Health Initiative Investigators. Risks and benefits of estrogen plus progestin in healthy postmenopausal women: principal results from the Women's Health Initiative randomized controlled trial. *JAMA* 2002;288:321-33.
27. Cauley JA, Robbins J, Chen Z, Cummings SR, Jackson RD, LaCroix AZ, et al. Effects of estrogen plus progestin on risk of fracture and bone mineral density. *JAMA* 2003;290:1729-38.
28. The Women's Health Initiative Steering Committee. Effects of conjugated equine estrogen in postmenopausal women with hysterectomy: the Women's Health Initiative randomized controlled trial. *JAMA* 2004;291:1701-12.
29. Kanis JA. Diagnosis of osteoporosis and assessment of fracture risk. *Lancet* 2002; 359:1929-36.
30. The prevalence of falls among older Montanans (08/09). Montana Department of Public Health Website. Available at: <http://www.dphhs.mt.gov/ems/prevention/documents/MTPublicHealthReport2009.pdf>. Accessed December 19, 2011.
31. Miller PD, Barlas S, Brenneman SK, Abbott TA, Chen YT, Barrett-Connor E, Siris ES. An approach to identifying osteopenic women at increased short-term risk of fracture. *Arch Intern Med.* 2004;164:1113-20.
32. Ebeling PR. Osteoporosis in Men. *NEJM* 2008;358;14:1474-1482.
33. Cummings SR, Bates D, Black DM. Clinical use of bone densitometry. *JAMA* 2002; 288(15):1889-97.
34. CUBAClinical, User Manual.Revision C. McCue, Corporation, Inc., Warwick (RI).
35. Greenspan SL, Bouxsein ML, Melton ME, Kolodny AH, Clair JH, Delucca PT, et al. Precision and discriminatory ability of calcaneal bone assessment technologies. *J Bone Miner Res* 1997; 12:1303-13.
36. Khaw KT, Reeve J, Luben R, Bingham S, Welch A, Wareham N, et al. Prediction of total and hip fracture in men and women by quantitative ultrasound of the calcaneus: EPIC-Network prospective population study. *Lancet* 2004; 363:197-202.
37. Hans P, Dargent-Molina P, Schott AM, Sebert JL, Cormier C, Kotzki PO, et al. Ultrasonographic heel measurements to predict hip fracture in elderly women: the EPIDOS prospective study. *Lancet* 1996; 348:511-14.
38. Rosenthal WM. Implementing bone mineral density testing in the community pharmacy. *J Amer Pharm Assoc.* 2000;40(6):737-45.
39. Goode JV, Swiger K, Bluml BM. Regional osteoporosis screening, referral and monitoring program in community pharmacies: findings from project ImPACT osteoporosis. *J Am Pharm Assoc.* 2004;44:152-60.
40. Elliott ME, Meek PD, Kanous NL, Schill GR, Weinswig PA, Bohlman JP, et al. Osteoporosis screening by community pharmacists: use of national osteoporosis foundation resources. *J Am Pharm Assoc.* 2002;42(1):101-10.
41. The International Society of Clinical Densitometry. 2007 Official Positions of the ISCD. 2007. Accessed May 19, 2008 from <http://www.ISCD.org>.
42. The North American Menopause Society. The role of calcium in peri- and postmenopausal women: 2006 position statement of The North American Menopause Society. *Menopause* 2006; 13:862-877.
43. Stevens JA, Olson S. Reducing falls and resulting hip fractures among older women. National Center for Injury Prevention and Control, Division of Unintentional Injury Prevention. Accessed August 26, 2004 from [www.cdc.gov/mmwr/preview/mmwrhtml/rr4902a2.htm](http://www.cdc.gov/mmwr/preview/mmwrhtml/rr4902a2.htm)
44. Tinetti ME. Preventing falls in elderly persons. *N Engl J Med* 2003; 348:42-9
45. Huckleberry Y, Rollins CJ. Essential and Conditionally Essential Nutrients. In Berardi RR, Ferreri SP, Hume AL, Kroon KA, Newton GD, Popovich NG, et.al., editors. *Handbook of nonprescription drugs.* 16<sup>th</sup> ed. Washington (DC): American Pharmaceutical Association;2009. p. 389-418.
46. National Osteoporosis Foundation. Vitamin D recommendations. Accessed June 9, 2008 from <http://www.nof.org/prevention/vitaminD.htm>.

47. Deceptive marketing practices for dietary supplements halted. FDA Consumer Magazine. U.S. Food and Drug Administration. September-October, 2003. Retrieved on September 19, 2004 from [findarticles.com/p/articles/mi\\_m1370/is\\_5\\_37/ai\\_109906669/](http://findarticles.com/p/articles/mi_m1370/is_5_37/ai_109906669/)
48. Lexi-Comp (Lexi-Interact) [computer program]. Lexi-comp; June 9, 2004.
49. Recommendations for the prevention and treatment of glucocorticoid-induced osteoporosis: 2001 update. American College of Rheumatology Ad Hoc Committee on Glucocorticoid-Induced Osteoporosis. *Arthritis Rheum* 2001;44:1496-1503.
50. Overview of Vitamin D. In: Institute of Medicine of the National Academies. *Dietary Reference Intakes for Calcium and Vitamin D*. Washington (DC): National Academy Press;2011. Available at: [http://books.nap.edu/openbook.php?record\\_id=13050&page=R1](http://books.nap.edu/openbook.php?record_id=13050&page=R1). Accessed December 7, 2011.
51. NIH Osteoporosis and Related Bone Diseases National Resource Center. Osteoporosis in Men. Available at: [http://www.niams.nih.gov/Health\\_Info/Bone/Osteoporosis/men.asp](http://www.niams.nih.gov/Health_Info/Bone/Osteoporosis/men.asp). Accessed December 7, 2011.
52. Burge R. Incidence and Economic Burden of Osteoporosis-Related Fractures in the United States, 2005-2025
53. The fracture risk assessment tool (FRAX®): Applications in clinical practice.
54. Assessment of individual fracture risk: FRAX and beyond.
55. FRAX website
56. Smoking and Tobacco Use. Centers for Disease Control and Prevention Web site. Available at: [http://www.cdc.gov/tobacco/data\\_statistics/fact\\_sheets/smokeless/smokeless\\_facts/#use](http://www.cdc.gov/tobacco/data_statistics/fact_sheets/smokeless/smokeless_facts/#use). Accessed December 14, 2011.
57. Calcium: What you should know. National Osteoporosis Foundation Web site. Available at: <http://www.nof.org/aboutosteoporosis/prevention/calcium>. Accessed December 22, 2011.
58. National Institute of Health Office of Dietary Supplements. Dietary Supplement Fact Sheet: Calcium. National Institutes of Health, Bethesda, Maryland. Available at: <http://ods.od.nih.gov/factsheets/calcium>. Accessed January 10, 2012.
59. Holick MF, Binkley NC, Bischoff-Ferrari HA, et al. *J Clin Endocrinol Metab* July 2011, 96(7):1911-1930. Evaluation, Treatment, and Prevention of Vitamin D Deficiency: An Endocrine Society Clinical Practice Guideline.
60. Barrett-Connor E, Siris ES, Wehren LE, et al. *J Bone Miner Res* 2005;20:185-194. Bone Density and the Risk of Fractures.
61. Vitamin D crucial for immune response. Center for Structural Wellness Web site. Available at: <http://structuralevolution.org/blog/2010/03/13/vitamin-d-crucial-to-immune-response/>. Accessed January 10, 2012.

## 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.

Your T- Score	Your Z-Score		
		+ 2.0	<b>Normal Risk</b>
		+ 1.0	
		0	
		- 1.0	
		- 2.0	
		- 3.0	<b>High Risk</b>
		- 4.0	

## Risk Factor Assessment (check all that apply)

### Modifiable

- Menopause without estrogen replacement
- 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
- 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 (ex. prednisone) for asthma, lupus, rheumatoid arthritis, multiple sclerosis, or another condition.
- Anti-seizure medications (ex., phenytoin or phenobarbital)
- Aluminum-containing antacids (excessive use)
- Methotrexate (for cancer, rheumatoid arthritis, or lupus)
- Progestin used alone (ex., Depo-Provera) and not used with estrogen products

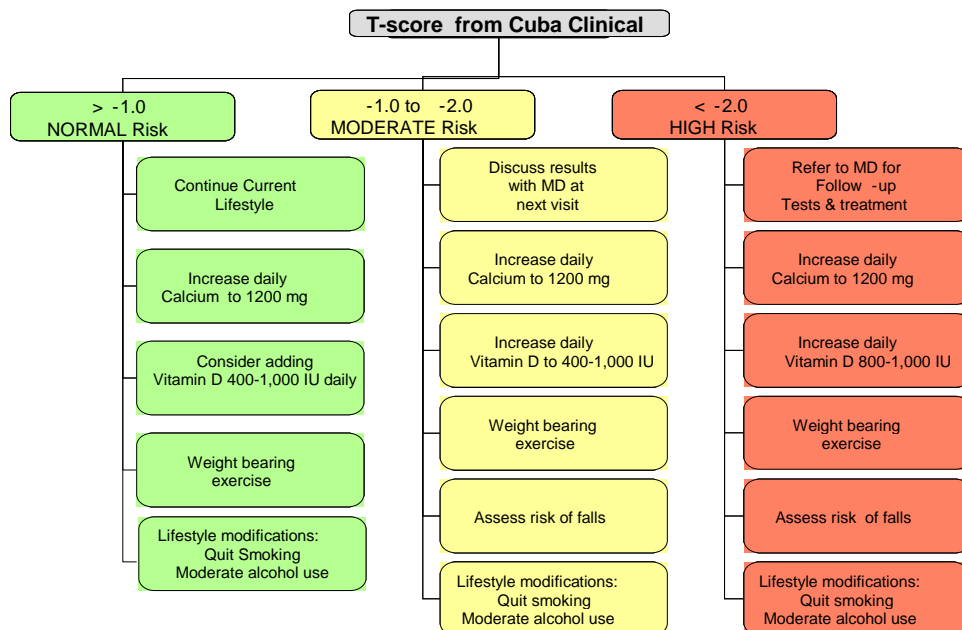
Certain diseases may cause bone loss. Do you have (past or present)....?

- 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 < 3 drinks/day or < 7 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: Post-test: *Screening for Osteoporosis in Older Persons*

### 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) About 10-20% of patients who experience an osteoporosis-related hip fracture will 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 Type II 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 not commonly seen in osteoporosis-related fractures?
  - a) Hip
  - b) Pelvis
  - 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:
- Loss of cortical bone (more than trabecular bone) is primarily responsible for osteoporosis-related fractures.
  - Peak bone mass is achieved for women in their early to mid-40's.
  - The process of building up and breaking down of bone is called resorption.
  - 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?
- Parathyroid hormone
  - Calcitonin
  - Vitamin 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:
- Cataracts causing poor eye sight
  - Initiating a new blood pressure medication
  - Difficulty walking
  - 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?
- 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.
  - 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.
  - 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.
  - 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:
- Normal
  - Moderate
  - High
  - Unknown
14. In addition to the above patient's dietary calcium (estimated at 500mg daily), which calcium supplement would be the most beneficial?
- Caltrate<sup>®</sup> 600 + D. One tablet twice a day.
  - Citracal<sup>®</sup> + D. One tablet three times a day.
  - Tums<sup>®</sup> Ultra. One tablet twice a day.
  - Viactiv<sup>®</sup> + 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:
- Normal
  - Moderate
  - High
  - Unknown
16. In the above patient, which of the following recommendations would be the **most** appropriate?
- Recommend to the patient that she continue what she is doing.
  - Recommend to the patient that she continue what she is doing and recommend a dietary supplement.
  - Recommend to the patient that she discuss the results of this screening with her primary care provider at her next scheduled appointment.
  - 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:
- Adults who have a fracture after age 50.
  - Any woman age 65 and older and men age 70 and older.
  - Any younger postmenopausal women or men age 50-70 when there is concern based on their clinical risk factor profile.
  - All of the above.
18. Which of the following bone mineral density tests does not use radiation as its method of detection?
- Quantitative computed tomography (QCT)
  - Qualitative ultrasound (QUS)
  - Single-energy X-ray absorptiometry (SEXA)
  - Dual-energy X-ray absorptiometry (DEXA)
19. Which of the following statements is FALSE regarding Qualitative Ultrasound (QUS)?
- QUS should not be used to diagnose osteopenia or osteoporosis.
  - QUS provides information regarding the quantity of minerals in the patient's bones.
  - QUS uses broadband ultrasound (BUA) and speed of sound (SOS) to determine the structural complexity of a patient's bones.
  - 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?
- The preferred foot to be used for testing is the dominant (usually the right) foot.
  - It is acceptable to use a heel if it was broken at least 20 years prior to the current screening.
  - It is possible to get an accurate test result with a person wearing nylon stockings or socks.
  - 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 Persons

### Participant Information

1. Name: \_\_\_\_\_
2. Mailing address: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
3. Date exam completed \_\_\_\_\_

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

1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D

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## Appendix D: Evaluation for MTGEC Module: Screening for Osteoporosis in Older Persons

1. Please indicate your profession: \_\_\_\_\_

	<b>Please circle or underline the appropriate number to indicate the degree to which agree with the following statements:</b>	<b>Strongly Agree</b>	<b>Agree</b>	<b>Neither Agree or disagree</b>	<b>Disagree</b>	<b>Strongly Disagree</b>	<b>Don't Know</b>
2	The overall visual presentation of the material enhanced my learning.	5	4	3	2	1	X
3	The module content was understandable.	5	4	3	2	1	X
4	The content was presented without bias.	5	4	3	2	1	X
5	The content will be useful for health-care professionals working with the elderly.	5	4	3	2	1	X
6	The objectives were clear.	5	4	3	2	1	X
7	This approach met my learning objectives.	5	4	3	2	1	X
8	The objectives of the module were achieved.	5	4	3	2	1	X
9	The module objectives related well to the overall purpose/goal of the web based curriculum.	5	4	3	2	1	X
10	The assignments were appropriate.	5	4	3	2	1	X
11	The test questions were unambiguous.	5	4	3	2	1	X
12	This test questions were appropriate to the module content.	5	4	3	2	1	X
13	The teaching method was appropriate and used effectively.	5	4	3	2	1	X
14	I would recommend this course to other health care professionals.	5	4	3	2	1	X

15	<p>How many hours did you take to complete this module including the pretest, posttest, and evaluation? Please use decimals, for example, 2.25 hours.</p> <p style="text-align: center;">_____ <b>Hours</b></p>
16	<p>How did you learn about these modules?</p>
17	<p>Describe how you plan to utilize the information you learned from these modules:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Establish a new program</li> <li><input type="checkbox"/> Provide patient information</li> <li><input type="checkbox"/> Change your practice with elderly patients</li> <li><input type="checkbox"/> Other: (Describe)</li> </ul>
18	<p>Any suggestions to enhance the curriculum?</p> <div style="display: flex; justify-content: space-between; margin-top: 20px;"> <div data-bbox="269 1289 729 1440" style="border: 1px solid black; padding: 5px;"> <p>For Credit, please return this complete form to </p> </div> <div data-bbox="748 1289 1409 1587" style="border: 1px solid black; padding: 10px; text-align: center;"> <p>Rachael Zins  <b>MTGEC/IPHARM</b>            Skaggs Building Room 317            University of Montana            32 Campus Drive            Missoula MT, 59812-1522            Phone# (406) 243-2339 &amp; Fax# (406) 243-4353</p> </div> </div>