Adopted: 11/98
Revised 1/7/99
Focused revision*: 7/06
Reformatted: 11/05
To be reviewed: 6/00

OSTEOPOROSIS

Primary Author: Ronald LeFebvre, DC

Contributors
Jim Gerber, DC, DABCO, DACBN
Elizabeth Olsen, RN, DC

Reviewed by CSPE committee
Tom Dobson, DC
Wendy Callander, MD
Kathleen Galligan, DC, DABCI
Karen E. Petzing, DC
Ravid Raphael, DC, DABCO
Anita Roberts, DC

Pertinent sections reviewed by Radiology Department
Beverly Harger, DC, DACBR
John Taylor, DC, DACBR
Lisa Hoffman, DC, DACBR
Timothy Stecher, DC, DACBR
Bill Adams, DC
Eve Bonic, DC
Chad Warshel, DC

ICD-9 Codes for Osteoporosis

733.00	**Generalized**
733.03	**Disuse**
733.09	**Drug-induced**
733.02	**Idiopathic**
733.01	**Postmenopausal**
733.7	**Post-traumatic**
733.01	**Senile**

The WSCC Osteoporosis Program

This care pathway, as a whole or in parts, may be applied to the following patient populations.

- **General patients in the WSCC clinic setting.** General patient education pamphlets about preventing osteoporosis should be systematically distributed to patients, women in particular but men as well. See Page 24 for further guidance on general education.

- **Patients with current risk factors for developing osteoporosis.** An example of this would be women in the perimenopausal period. Consider offering these patients a specific evaluation and management program emphasizing detection and prevention of bone loss.

- **Patients specifically seeking an evaluation for osteoporosis.**

- **Patients already diagnosed with osteoporosis or with strong clinical indication of osteoporosis, e.g., evidence of a fragility fracture.**

- **Patients whom the practitioner judges, for any reason, to be a good candidate for fall prevention screening and management.** See Pages 16 and 33.

This Care Pathway should be considered preliminary. The seed document was based on key articles from the literature which included current nationally based guidelines, review articles, some original studies, and descriptive articles outlining some of the standard contemporary approaches to evaluation and management of osteoporosis. This care pathway underwent evaluation and revision by a CSPE committee. A more complete literature search has been recently completed. The Care Pathway will be further revised at a later date, based on the results of this search and the experience of utilizing the pathway in the clinics.

---

* Focused Revision – Page 28. 700-800 IU/day is the recommended dose. 400 IU/day is inadequate.

Table of Contents

Notes

BACKGROUND

Osteoporosis is the most common metabolic bone disorder. The term represents a diverse group of diseases with varying etiologies characterized by a reduction in bone mass per unit volume to a level below that required for adequate mechanical support and function.

Pathophysiology

Osteoporosis is characterized by loss in both cortical thickness and in number and size of the trabeculae of cancellous bone. In 1993, the condition was defined by the Consensus Development Conference on Osteoporosis as a "systemic skeletal disease characterized by low bone mass and micro-architectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fracture." Significant morbidity and mortality is associated with this condition. The general clinical features of osteoporosis include fractures of vertebrae (lower thoracic and upper lumbar), wrist, hip, humerus and tibia, which can occur suddenly with trivial movements, as well as poor posture due to spinal deformities leading to mechanical pain.

Osteoporosis can be classified into 1) groups of conditions without known etiology, 2) specific disorders which result in osteoporosis with a well understood pathogenesis, and 3) specific disorders which result in osteoporosis but the pathogenesis is not understood.[1]

OSTEOPOROSIS WITH NO KNOWN ETIOLOGY OR ASSOCIATED DISEASES

Idiopathic

Juvenile
Adult (in individuals under 50 years of age)

Postmenopausal: Type 1

Female, 51-65 years old, postmenopausal
Accelerated and disproportionate loss of trabecular bone
Fracture of vertebral bodies, distal forearms

Senile: Type 2:

>75 years; more common in females than in males
Fractures of femoral neck, proximal tibia and humerus, pelvis

DISORDERS WITH OSTEOPOROSIS; PATHOGENESIS UNDERSTOOD

- Hypogonadism
- Hyperadrenocorticism
- Thyrotoxicosis
- Malabsorption
- Scurvy

- Calcium deficiency
- Immobilization
- Associated with other metabolic bone disorders or inherited disorders e.g., osteogenesis imperfecta

DISORDERS WITH OSTEOPOROSIS; PATHOGENESIS NOT UNDERSTOOD

- Rheumatoid arthritis
- Malnutrition
- Alcoholism
- Medications for epilepsy
- Diabetes mellitus
- COPD

Epidemiology

Osteoporosis affects 25 million people in the United States and is responsible for 1.5 million fractures annually. Peak bone mineralization in the hip is established by age 20, and peak bone mineralization of the spine is achieved in the early 30s. In the 40s, in both genders, skeletal bone loss begins at a rate of 0.3% to 0.5% per year. The average postmenopausal woman will lose approximately 2% of skeletal BMC (Bone Mineral Content) per year but this rate can vary from <1% to >5% in the individual.[2] Furthermore, in the years just after menopause, this rate accelerates sharply. Women can lose up to 20% of bone mass in the first 5-7 years.

Osteoporosis is responsible for 240,000 hip fractures a year and 40,000 deaths annually. The rate of vertebral body fractures begins to steadily increase as patients reach their mid-60s and the rate of hip fracture rises sharply as women reach their late 70s. It is estimated that one in every 2 women over fifty will have an osteoporosis-related fracture. There is a 15% lifetime probability that a 50 year old woman will suffer a hip fracture sometime in her life. Among patients who sustain hip fractures, 12-20% die within a year after the fracture and more than 50% of the survivors are unable to return to independent living.[3] Falls and fractures are the sixth leading cause of death in people over age 65. Wrist or forearm fracture (Colles) is also a risk and is most commonly the result of a fall on the outstretched hand. It is estimated that the lifetime risk is approximately 15% in American women. About 20% of 70-year-old women have had at least one wrist fracture.[4] It is estimated that about 20% of osteoporosis cases are men. Their total lifetime losses of bone density may reach 30-49%, and approximately one in eight will suffer an osteoporosis-related fracture.

Other examples of morbidity associated with osteoporosis in both men and women are related to the shortening effect that multiple compression fractures can have on the axial length of the torso. In addition to back pain and fatigue, respiratory symptoms (e.g., difficulty reaching full inspiration) and gastrointestinal symptoms (e.g., feeling of fullness with even the most modest meal) can occur.[5,6]

EVALUATION

Evaluation strategy based on four clinical issues:

1. **Is the patient at risk for osteoporosis?**
2. **Does the patient have osteoporosis?**
3. **If present, is the osteoporosis due to secondary causes?**
4. **Is the patient at risk for falling and fractures?**

1. Is the patient at risk for osteoporosis?

The history should focus on risk factors. For example, ask about family history, medical problems that occurred during the adolescent growth spurt, disorders of menstruation, severe dietary deficiencies and anorexia nervosa, physical immobilization, use of alcohol, cigarettes and chronic medication.

RISK FACTORS FOR DEVELOPING OSTEOPOROSIS

Genetic factors

- Female
- Caucasian or Asian[7]
- Family history of osteoporosis
- Low body mass or significant decrease in body weight since the age of 25[13]
- Early menopause
- Maternal history of hip fracture[2,8]

Health status factors

- Oophorectomy
- Estrogen deficiency
- Intestinal malabsorption
- High gastric pH
- Vitamin D deficiency
- Amenorrhea
- Various metabolic disorders (e.g., hyperparathyroidism, hyperthyroidism, diabetes, Cushing's syndrome, metabolic acidosis)
- Various medications (e.g., prolonged corticosteroid therapy, aluminum antacids, anti-convulsants, lithium, loop diuretics, tetracycline, warfarin, prolonged use of high levels of thyroid hormone, long acting benzodiazapines, vitamin D toxicity, mephenytoin therapy, and phenobarbital therapy)

Nutritional factors

- Lifelong low calcium intake
- Very low or high protein intake
- High caffeine intake
- High phosphate intake
- High fiber intake
- High sodium intake
- Heavy alcohol consumption

Life activity choices

- Sedentary lifestyle
- Cigarette smoking
- Nulliparity
- Alcohol abuse
- Long-term intensive aerobic exercise during childhood and adolescence[9]

CORTICOSTEROIDS AND OSTEOPOROSIS

An estimated 30 million Americans are commonly treated with long-term corticosteroids. One in four long-term users sustains osteoporotic fractures. Corticosteroids are widely used for treating patients with chronic, noninfectious inflammatory diseases such as asthma, inflammatory bowel disease, multiple sclerosis, rheumatoid arthritis, and other connective tissue disease. Osteoporosis occurs in more than one-half of these patients. Persons who take 7.5 mg/day or more of oral prednisone for 6 months or longer risk rapid bone loss from the hip, spine, and forearm. The most rapid bone loss occurs in the *first 6 months* (10-20% of bone can be lost).

One study found that rheumatoid arthritis patients took 7.5 mg/day on average, and patients with obstructive airway disease took an average of 12 mg/day.[10] Patients taking low-dose inhaled corticosteroid preparations do not appear at risk. However, some data suggest that asthma patients who use inhaled corticosteroids for at least one year have an 11% prevalence of vertebral fractures. Still other data suggest that high doses of 800 micrograms or more cause bone loss. It is therefore recommended that a maximum of 7.5 mg/day of prednisone should be used in the treatment of rheumatoid arthritis.[11,12] (For management protocol see Osteoporosis Special Appendix I: Corticosteroid-induced Osteoporosis: Specific Recommendations.)

2. Does the patient have osteoporosis?

The diagnosis of osteoporosis can be made by either densitometry or by radiographs alone in the presence of a fragility fracture.

THE ROLE OF DENSITOMETRY

The relationship between bone mineral density (BMD) and fracture risk is more powerful than that between serum cholesterol concentration and coronary artery disease or between elevated systolic blood pressure and stroke.[4]

Bone densitometry makes it possible to precisely and rapidly quantify the amount of bone in the spine, proximal femur, forearm, and total body while exposing the patient to a minimum of radiation.

Bone Densitometry (DXA or DEXA) and Quantitative Computerized Tomography (QCT) are the two main techniques used in determination of bone density. There is considerable debate in the literature as to which performs better,[13] but the method most used presently in the United States is DXA, due to a combination of factors including high reproducibility and low radiation dose.[14] Availability also plays a factor.[15] (For a comparison of other BMD assessment methods, see Osteoporosis Special Appendix II: Comparison of Available Technologies to Measure BMD.)

Site selection

Measurement of both lumbar spine and femoral neck is recommended.[2,8] Measurement at each site is the best predictor for future fracture at that site. In women over 65, the femoral site alone may be sufficient.[8] Monitoring the lumbar spine has the advantage of reflecting the quickest therapeutic response, but also carries the potential of artifacts (such as a compression fracture or degeneration), which may artificially increase the BMD measurement.[2,8]

Note: Newer and smaller portable DEXA machines (also called pDEXA) are sometimes available to the general public in retail stores. Although significantly less expensive, they measure bone mass in the forearm and wrist instead of the hip and spine and, therefore, are not recommended as a substitute for appropriate testing.

Routine screening

Routine screening for osteoporosis or decreased bone density in asymptomatic, postmenopausal women is not currently recommended.[16,17]

RECOMMENDED INDICATIONS FOR BONE DENSITY STUDIES

As a general principle, bone mineral density (BMD) studies should be measured only to assist in making a clinical management choice.[8] BMD is not indicated in women who are already receiving estrogen therapy for nonskeletal indications unless they have fragility fractures.[2]

INDICATIONS FOR BMD EVALUATION

1. **When more information is needed to choose a successful management strategy.**
2. **When findings suggest that a patient may already have osteoporosis.**
3. **When an estrogen-deficient woman has <u>additional</u> risk factors for osteoporosis.**
4. **To monitor treatment response.**

(For a more specific list, see Osteoporosis Special Appendix III: Recommended Indications for Bone Density Studies.)

Diagnostic Categories for Osteoporosis

BMD is expressed as a T-score (the difference in standard deviation compared with peak bone mass) or a Z-score (the difference in standard deviation compared with healthy age-matched controls).

The following criteria from WHO have also been accepted by the International Society of Clinical Densitometry and the National Osteoporosis Foundation.

Normal

A value for BMD (Bone Mineral Density) or BMC (Bone Mineral Content) within 1 standard deviation of the young adult reference mean. T-score between +1.0 and -1.0.

Low bone mass (Osteopenia)[*]

A value for BMD or BMC more than 1 standard deviation below the young adult mean, but less than 2.5 standard deviations below this value. T-score between -1.0 and -2.5.

Osteoporosis

A value for BMD or BMC 2.5 standard deviations or more below the young adult mean. A T-score of -2.5 or more.

Severe (established)

A value for bone density more than 2.5 SD below the young adult mean <u>and</u> one or more fragility fractures.

Note: The patient with one or more low-trauma fractures is considered to have osteoporosis, regardless of the BMD value.[2] (See Osteoporosis Special Appendix IV: Sample BMD Report.)

[*]Osteopenia in this context refers to an actual amount of measured bone density as oppose to the radiographic use of the term which simply indicates <u>apparent</u> bone loss on an x-ray.

Interpreting BMD Results

Fracture risk increases 1.5-3 fold for each SD below the mean BMD for both age-matched and young adult controls.[17,18] For each 10% decrease in BMD, the fracture risk approximately doubles.[2] The relationship is not strictly linear; that is, the risk increases with age and tends to increase in an exponential fashion below 2 SDs from the mean values.

There are currently no studies determining how effective perimenopausal bone density measurements are in predicting *long-term* fracture risk because bone mass at menopause correlates only moderately with bone mass 10-20 years later.[17] BMD alone may be misleading in assessing future fracture risk because this risk remains multifactorial.[8] Other strong predictors of fracture include poor health, limited physical activity, poor vision, prior postmenopausal fracture, and psychotropic drug use. (See Page 16 for a more complete list.)

Patient Counseling

BMD results may be used to motivate patients. In one study, women who had below average bone density were more likely to take calcium, vitamins, or estrogen than those with above average values (84% vs. 38%).[19]

On the other hand, it is important that women with normal values do not get a false sense of security that inhibits them from smoking cessation or managing their calcium intake.

Re-testing

In cases where the results are indicative of osteopenia (T-score between -1.0 and -2.5), follow up studies are indicated every one to five years depending on the severity of the osteopenia. If osteoporosis is discovered (T-score $\leq$ -2.5*)*, then follow-up examinations at one to two years are indicated depending on the nature and aggressiveness of the treatment.[20] For patients being treated with corticosteroids, follow-up bone density testing is indicated at six months and then annually to monitor loss.

THE ROLE OF RADIOGRAPHS

Radiographs play an important role in confirming the presence of a suspected fracture, but seldom play a role in establishing bone density in order to make a diagnosis of osteoporosis.

According to AHCPR guidelines on acute low back pain, patients over the age of 50 who have sustained mild trauma or any patient over the age of 70 with new back pain should be x-rayed to screen for compression fractures. Compression fractures of the spine are often associated with forward bending, twisting (e.g., bending over to make a bed) or with compressive forces in neutral or flexion (e.g., holding a bag or box that is too heavy, a sudden jarring on the heels, a fall on the buttock). However, they can also be spontaneous. Fragility fractures are common at the hip and wrist, but can also occur in the ribs and elsewhere in the appendicular skeletal. In general, if x-rays are taken, then they should be taken at the site of pain.

Although skeletal radiographs can detect focal bone disorders and fractures, they do not reliably detect bone loss of less than 30%.[21] They are of limited value in estimating bone mass. More sophisticated studies, such as DEXA or quantitative CT, are often necessary to

make an early diagnosis, a definitive diagnosis, ascertain the degree of severity of bone loss, or establish a baseline. In 90-95% of cases, correlative radiographs are not needed.[13] They may occasionally be useful in identifying pre-existing abnormalities like severe aortic calcification, degenerative osteoarthritic, and pre-existing vertebral compression fractures, all of which may falsely elevate DXA results.

Therefore, due to the inherent limitations of plain film radiography for the detection of osteoporosis, radiography should not be used as a screening tool for osteoporosis in WSCC clinics.[22] In cases of low bone mineral loss (less than 30%), no reliable information is added to the clinical decision making process.

Radiologists may use qualitative statements such as "mild, moderate, or severe" to describe radiographically apparent bone loss. These grades represent radiographic findings and do not reflect actual bone mass. Because such subjective estimates can vary among individual assessors,[22] it is not recommended that they be used as a precise guide for modification of therapy. Still, moderate or severe radiographic osteopenia* can be viewed as evidence of a significant degree of osteoporosis and suggests a need for further evaluation or treatment modification. On the other hand, radiographic determinations of mild or no osteopenia should not be construed as a guarantee of adequate bone mass.[22]

It is common to manipulate older patients or postmenopausal women who have not been previously diagnosed with this condition and whose problems do not appear to be part of an osteoporosis presentation. While a certain level of caution should be used with this group, for those who are discovered to have multiple risk factors for osteoporosis, clinical judgment should be used to determine if it is necessary to modify manipulative techniques (e.g., avoiding compression of the thorax to prevent rib fractures and avoiding using pressures directed through the hip). Again, neither radiography nor densitometry is indicated for this group of patients unless other factors raise a red flag as an indication for radiography. Such factors would include any evidence of compression fracture in the absence of significant trauma or bone disease. If these indications are present, then radiographs are justifiable and should be used prior to densitometry to identify fracture or disease.[22]

Features of Standard Plain Film Radiology

It takes up to 30-50% bone loss before standard x-rays detect bone loss.[21] The following is a list of radiographic findings.

*In the context of radiography, the term "osteopenia" indicates a finding of decreased radiographic density of bone and does not equate with the WHO definition of "osteopenia" as a given range of bone mass as measured by densitometry.

Vertebrae

- Loss of bone density
- Loss of horizontal trabeculae
- Apparent accentuation of vertical trabeculae (pseudohemangiomatous appearance)
- Apparent increased density of end plates
- Codfish (biconcave) vertebra configurations
- Collapse with loss of anterior body height (vertebrae plana)

Long Bones

- Loss of bone density
- Thinned cortex
- Accentuated stress trabeculae, e.g. Wards Triangle in the proximal femur

3. Are there secondary causes?

Osteoporosis may be secondary to other treatable diseases or may be aggravated by underlying disease. If there is a secondary cause, it must be identified and managed appropriately.

DIFFERENTIAL DIAGNOSES FOR OSTEOPOROSIS

Calcium deficiency
Cheney syndrome
Corticosteroid therapy
Cushing's disease
Estrogen deficiency
Gaucher's disease
Hemochromatosis
Heparin therapy (>6 mo)
Homocystinuria
Hyperparathyroidism
Hyperthyroidism
Hypogonadism
Idiopathic juvenile osteoporosis
Immobilization
Immunosuppressive therapy
Infection
Insulin-dependent diabetes mellitus
Liver failure
Malabsorption
Malignancy
Malnutrition
Marfan's syndrome
Multiple myeloma
Mutation type 1 collagen
Osteogenesis imperfecta
Osteomalacia
Complex regional pain syndrome
Renal insufficiency
Rheumatoid arthritis
Sarcoidosis
Scleroderma
Sickle-cell disease
Transient osteoporosis of the hip
Transplant therapy
Vitamin D deficiency
Vitamin D receptor allele anomaly

APPROPRIATE WORK UP FOR PATIENTS WITH OSTEOPOROSIS

A comprehensive assessment would include a comparative measurement of height and weight with personal historical data, as well as a complete physical examination including a gynecologic examination.[2] The purpose of the exam is to assess the patient's general health status and biomechanical function as well as screen for any indications of secondary causes of osteoporosis.

Summary of Recommended Physical Examination

- Vitals (include height and weight)
- Posture
- Skin
- Ophthalmoscopic examination
- Thyroid palpation
- Lymph nodes
- Breast exam (men and women)
- Gynecological exam (optional after 65)
- Testicular exam
- Heart auscultation
- Abdominal exam (palpation, auscultation in patients over 50)
- Gross range of motion of spine and extremities
- Spinal palpation for joint dysfunction

For patients at risk for falls, see additional exam procedures on Page 18.

In addition, appropriate laboratory tests should be ordered based on the patient's symptoms, medical history, and physical examination findings. Although the work-up should be individualized, the laboratory tests listed below should be considered. The most obvious benefit of obtaining these laboratory values is earlier and optimal intervention for any underlying pathological cause. In addition, various combinations of the measures listed below have been advocated when attempting to identify fast bone losers.

Guidelines for Laboratory Evaluation

Screen for metabolic and metastatic disorders as appropriate based on the patient's complaints, medical history and physical findings.

Initial screening laboratory tests[2] *:*

- Complete blood count
- Serum chemistry (especially calcium, phosphorus, alkaline phosphatase, creatinine, liver enzymes, total protein, albumin, globulin, A/G ratio, electrolytes)
- Urinalysis, including pH

Based on clinical suspicion, the following tests may be appropriate[20,23]

- Bone-specific alkaline phosphatase
- Cortisol
- Erythrocyte sedimentation rate
- Estradiol level
- Follicular-stimulating hormone/luteinizing hormone levels
- Glucose
- Liver function tests
- Osteocalcin
- Parathyroid hormone
- 24-hour urine for total calcium and phosphate
- Serum protein electrophoresis and urinary light chain analysis
- Testosterone level
- Thyroid-stimulating hormone
- Urine hydroxyproline/creatinine ratio
- Urine calcium/creatinine ratio
- Vitamin D level (25-hydroxy vit D)

Laboratory findings in idiopathic osteoporosis

Serum and urine findings are essentially normal. Postmenopausal osteoporosis may reveal slight hyperphosphatemia, mildly elevated alkaline phosphatase especially with fractures, slight hypercalciuria, or slight increase urinary hydroxyproline. Disuse type may reveal slight hypercalcemia.

Note: Hypercalcemia should be further investigated because it can indicate metastatic bone cancer or hyperparathyroidism.

At this time, the use of serum markers to monitor bone turnover, appears to have questionable value. In clinical trials, changes in serum markers such as collagen cross-links, bone-specific alkaline phosphatase, osteocalcin, and hydroxyproline, have indicated early response to therapy. While there is currently no well-defined role for biochemical markers of bone turnover in the management of the individual patient, some authors recommend that they may be useful in determining treatment response for women who cannot or will not have BMD assessed.[24] Preliminary evidence also suggests that high turnover may be an independent risk factor for fracture, but this relationship requires confirmation.[2] These markers vary from day to day. In the rare circumstance that a practitioner ordered any of these tests, several measurements should be made before and during treatment to be useful for monitoring.

4. Evaluate for falling/fracture potential.

TRAUMA/OSTEOPOROTIC FRACTURE: RISK FACTORS AND PREVENTION

Patients who do not form optimal peak bone mass in younger years can be at severe risk of fracture, even if they institute therapy to minimize bone loss in later life. Once bone mass is known, a number of variables independently contribute to the risk of falls and fractures.

Risk factors for hip fracture

- Maternal history of hip fracture
- Greater height (this may be associated with a longer hip axis which is more susceptible to fracture)
- Increased likelihood of falling[25]

Other risk factors for falls and fragility fractures

- History of suffering a fracture after the age of 40. These patients have roughly twice the risk of another fracture. [2]
- Postural instability
- Gait disorder
- Muscle weakness
- Poor vision
- Multiple medications
- Environmental hazards, including slippery surfaces, loose wires and rugs, snow and ice, inadequate walking aids, unfamiliar environment[4]
- Depression
- Poor health
- Psychotropic drugs, minor and major tranquilizers, alcohol, loop diuretics and hypotensive agents, hypocalcemic agents, digoxin and dysrhythmia inducing agents, or any medication that slows reaction times[4]
- Limited physical activity
- Smoking [17]

Note on depression. According to a study of 7,518 women by Whooley, depression increases the risk of osteoporotic fractures by 40% among women over the age of 65.[26]

Note on weakness and endurance. Falls can be the result of over all muscle weakness and poor endurance. Drinkwater estimates that fifty percent of the weakness that is normally attributed to aging is often a condition known as *hypokinesia*, a disease of *functional disuse* of muscles and bones. In addition, the declining cardiopulmonary system associated with aging can influence osteoporosis, balance, and fall risk.[27]

PHYSICAL EXAMINATION SCREEN FOR PREVENTION OF FALLS

This portion of the osteoporosis evaluation is for patients who have an increased risk for falls (see those cited on previous page). The following assessment may also be recommended for elderly patients in general, patients who for a variety of reasons may be deconditioned, to establish baselines, or in response to patient's desire to improve mechanics.

Patients who cannot be placed into the risk categories cited above need not undergo these procedures.

Summary of Exam Procedures

- Vision
- Posture
- Gait
- Balance (using a timed one-leg stand)
- AROM (spine and extremity)
- Sensory testing of lower extremity, especially the feet
- Strength testing (to include grip, quads, ankle)
- Wall sit/slide test
- Abdominal strength evaluation
- Muscle tightness (to include pecs, lats, psoas, hamstrings, adductors, calf muscles)
- Spinal palpation for joint dysfunction

Other Options

- Timed loaded standing test (indicated for kyphotic patients with limited reaching ability)
- Timed Up-and-Go Test (indicated for patients with difficult ambulation)
- Breathing pattern (indicated for patients with kyphosis)
- Pelvic floor test for strength
- Lung auscultation and excursion (indicated in patients with rib fracture or kyphosis)

Changes in the musculoskeletal system are a normal part of aging. Significant changes relevant to osteoporotic posture and balance include (1) weakness in the postural muscles of the neck and trunk, influencing head righting and stabilization strategies; (2) weakened and tight abdominal musculature, further contributing to postural deformity of the inferiorly shifting rib cage and abdominal organs; (3) weakened pelvic floor musculature, necessary for pelvic stabilization; (4) weakened lower extremity musculature and other biomechanical faults, influencing speed and quality of gait and transition activities; (5) weakened upper extremity musculature, limiting many functional activities of daily living; and (6) poorer balance control.

General screen

Check visual acuity both with and without glasses. Ascertain if the patient requires glasses, needs a new prescription, or should simply wear their glasses during normal activities.
Test position sense (e.g., identify the position of the toe as up or down), vibration sense, light touch, and pain awareness to identify deficits in the lower extremity.

Motion and static palpation of the spine can denote local vertebral dysfunctions as well as larger patterns of aberrant motion.

Note: In patients who have kyphosis secondary to compression fractures or a history of rib fractures, the ability to breathe diaphragmatically needs to be assessed in all positions and during each exercise given. Respiratory sounds should be checked, with special consideration to the bases, which may be compromised either by kyphosis or a history of rib fractures. The

first and second ribs may be held in an inspired position because of an upper chest breathing pattern and should be palpated during the breathing cycle.[1]

Rationale
Vision is important for maintaining balance and for navigating around obstacles that may cause a patient to fall. If a patient has neurological deficits, it may be important to create a balance treatment program that compensates for or adapts to these decrements. Testing these senses as they relate to the foot and ankle is especially important because age-related peripheral neuropathy can have severe effects on balance.[28]

Evaluate balance

One method to evaluate balance is the timed one-leg (bilaterally) and two-leg stands. The end point of the one-leg stand is marked when the patient's raised foot touches the floor or when the weight bearing foot repositions itself in order to maintain balance. **Note:** Balance may vary based on whether the patient is barefoot, wearing shoes, and the type of shoe. Make sure any repeat testing is done with the patient either barefoot or wearing the same shoes as with the initial test.

Two-leg stand
Young and old should be able to stand for 30 seconds with eyes open or closed.

One-leg stand, eyes open
Target (average):
29-30 seconds for subjects 20-59 years old;
22.5 seconds for those 60-69;
14.2 seconds for those 70-79.

On-leg stand, eyes closed
Target for young people is about 30 sec;
21-28.8 seconds for subjects 20-59 years old;
10 seconds for those 60-69;
4.3 seconds for those 70-79.

Rationale
A study by Sinaki suggests that there are differences in balance control strategies and sway amplitude between patients with and without osteoporosis.[29]

Evaluate lower extremity alignment

A useful clinical measure to evaluate the lower extremity is a modified squat with the knees positioned over the center of the second metatarsal. This maneuver is timed in seconds and can be used in assessment and goal setting. According to Lindsay, the faulty foot, knee, and hip alignment problems most frequently encountered clinically with osteoporotic patients are passive internal rotation of the hip, valgus and often hyper-extended knees, and pronated feet.[1]
Rationale
Postural asymmetries and poor gait mechanics may result in unusual or painful joint loading as well as making the patient more susceptible to falling.

Evaluate lower extremity strength and flexibility

The wall slide/sit test. Although the CSPE committee was unable to identify normative values for this test, it still may be used to establish a baseline for monitoring treatment response and patient goal setting. The test assesses overall lower extremity function applicable to walking, climbing, and balance activities. The patient stands, back against a wall, with the knee positioned over the second metatarsal. The patient squats down *as far as possible* (though not past a 90 degree knee angle) while maintaining contact with the wall. The practitioner then measures the hip flexion angle as well as the time the position can be maintained. The test is terminated when the patient begins to lose balance, begins to shake, can no longer maintain contact against the wall, or (based on the CSPE committee's recommendation) one minute elapses.[1] (See Osteoporosis Special Appendix VIII: Wall Slide/Sit Test and Exercises.)

Ankle strength can be tested by manual methods or by repetitive (e.g., 10) toe raises and heel marching.

Ankle range of motion in dorsiflexion should be checked to screen for tight heel cords. A modified Thomas test can be used to screen for hypertonic psoas. In addition, consider applying standard length testing procedures to check for hamstring and adductor tightness.

Rationale
Soft tissue and muscle deficits can significantly compromise a patient's sense of balance. Declining quadriceps and ankle strength have all been correlated with increased risk of injurious falls and should be evaluated. There is ample evidence that older adults who fall have weaker dorsiflexion and tighter heel cords than nonfallers. A short and tight psoas is also commonly found.[1]

Evaluate gait

Timed Up and Go Test. This test is particularly useful for the elderly or the partially disabled. Measure how long it takes the patient to stand up from a standard arm chair (approximate seat height of 46 cm), walk a distance of 3 meters, turn, walk back, and sit down again. Patients should wear their regular footwear and use any walking aid that they employ customarily. No physical assistance is given.

The starting point is with the back resting against the chair and arms either resting on the chair or on the thighs. On the word "go," the patient gets up and walks at a comfortable, safe pace. Patients walk through the test once, then it is repeated and timed. Inter-examiner reliability appears to be acceptable. Patients who score under 10 seconds are usually self-sufficient relative to mobility. Patients who take between 20-29 seconds vary relative to ability to balance, gait speed, and functional capacity. In one study, patients who took longer than 29 seconds were more dependent on the assistance of others for many mobility tasks.[30]

Rationale
Gait speed and cadence should be noted and recorded objectively because deficits in these areas are also associated with increased risk of falls.

Evaluate upper extremity biomechanics and trunk endurance

Evaluate the patient for good range of motion at the shoulder, appropriate scapular stability, and upper extremity strength.

An optional test for trunk muscle endurance of particular use in kyphotic patients with reduced reach is the "timed loaded standing test." This test measures the time a person can stand while holding a 2-pound weight in each hand with the shoulders maintained in 90 degrees of flexion and the elbows in extension. Normative values have not been found by the CSPE committee; however, the test may be used to establish a baseline for monitoring response to therapy. The CSPE committee recommends the test be terminated after 30 seconds.

Some of the single joint muscles, especially the pectoralis major and minor and latissimus dorsi, must also be assessed for tightness because they are commonly tight in kyphotic postures.

Rationale
Duncan observed that a deficit in the musculoskeletal capabilities necessary for functional reach can also put the individual at risk of falling.[31] Strong positive correlations were found between the results of the timed loaded standing test and various related measures of physical impairment (including trunk strength, shoulder strength, grip strength, 6-minute walk distance, and back impairment assessed by questionnaire). Inter-trial and test-retest reliability and validity were acceptable for older osteoporotic and non-osteoporotic women.[1]

Evaluate the abdomen

Traditional abdominal muscle testing may place an osteoporotic patient at an unacceptable risk for a compression fracture. The following is a safer method for grading strength. While the patient is lying supine, grade the ability to perform the following movements. (See Osteoporosis Special Appendix IX: Grading Abdominal Strength.)

- **Grade 1/5:** Pelvis and ribs approximate as patient contracts abdominals.

- **Grade 2/5:** Lift bent knee and return one at a time, keeping abdominals tight. Also, patient should be able to lift each upper extremity into full flexion while maintaining abdominal contraction.

- **Grade 3/5:** Lift bent knees one at a time to bilaterally flexed position, then return one at a time to starting point without losing abdominal contraction.

- **Grade 4/5:** Starting with knees bent, alternately extend each lower extremity to 5 cm from the surface, maintaining abdominal contraction.

- **Grade 5/5:** Starting with knees bent, bilaterally extend lower extremities without

losing abdominal contraction (the practitioner should be there to support the legs because the patient may be unable to perform the full-grade 5/5 test).[1]

Evaluate the pelvic floor (optional)

The patient is instructed to pull the pelvic floor up and in as if controlling the urge to urinate. The contraction is held for 10 seconds. The individual should also be able to do this procedure 10 times in a row in a variety of functional positions.[1]

MANAGEMENT

The aim of the prevention and treatment of osteoporosis is to influence bone mass and density by preventing further bone loss and encourage bone remodeling.

Summary of Management Strategy

1. **Educate patients, especially women, about how to prevent and/or manage this disorder.**
2. **Decrease bone loss and promote bone gain.**
3. **Increase balance and biomechanical integrity to prevent falls.**
4. **Treat pain from postural loads and fractures while maximizing function.**

In chiropractic settings, prevention and education are essential, with therapy focusing on exercise programs, nutritional supplementation, and patient education concerning treatment and lifestyle options. Treatments inhibiting bone turnover include the use of estrogen replacement therapy (ERT), mixed estrogen and progesterone hormone therapy (HRT), calcitonins, bisphosphonates (such as alendronate), and calcium and vitamin D derivatives. The use of fluoride, anabolic steroids, parathyroid hormone and peptides, and intermittent calcitonin/phosphate therapy are ways to promote bone formation.[23]

In addition, management is aimed at protecting patients from fractures by improving balance, lower extremity strength and endurance, joint function, and biomechanics in general. Finally, patients suffering pain and disability from fractures and kyphotic postures must be treated and rehabilitated.

MANAGEMENT INTERVENTIONS

- Manage predisposing medical conditions
- Muscle strength exercises
- Balance and gait training
- Vision correction
- Regular medications review
- Calcium/vitamin D therapy
- Weight-bearing exercise to tolerance
- Moderate protein intake
- Alcohol, salt and smoking restrictions
- General micronutrient support
- Estrogen replacement therapy
- Medical therapies
- Home safety check

PREVENTION OF OSTEOPOROSIS

Education should be targeted by age group as well as the individual. Patient education materials, as they become available, should be systematically distributed to the WSCC patient population. In addition**,** the clinics should aide patients in finding additional support based on specific risk behaviors, e.g., smoking cessation or alcohol abuse.

Adolescent Girls and Young Women

Young women need to be informed about the importance of early prevention and building a peak bone mass at least by the age of 35. Key educational points should include:

- Proper nutrition with adequate calcium and vitamin D. (See next page for age-based recommended intakes; Osteoporosis Special Appendix V: Calcium Sources in Food; and Special Appendix VI: Dietary Sources of Vitamin D.)

- Regular weight-bearing exercise and weight resistance training. These activities enhance bone development.

- Strongly discourage the use of tobacco. Women who smoke are thinner with less bone mass and may have an earlier menopause.

- Discourage excessive alcohol consumption. Excessive alcohol can also have a negative impact on lifetime health and bone structure.

Middle-aged Women

In addition to the educational points cited above, middle-aged women may need to be counseled on assessing BMD (see Osteoporosis Special Appendix III: Recommended Indications for Bone Density Studies), the risks and benefits of hormone replacement therapy (HRT), as well as other alternative pharmacological, botanical, and lifestyle interventions. This group should also be taught balance training and be encouraged to increase physical activities that will help minimize the likelihood of falls.

Senior Women

Senior women also need to focus on the educational points cited above. Dietary intake of vitamin D should be emphasized as well as the importance of supervision/counseling if they are planning to embark on an exercise or weight lifting program. Fall prevention strategies and training should receive special emphasis.

Men and osteoporosis

Men need to be alerted to the fact that they can be at risk, too. Each year 80,000 men suffer a hip fracture.[32] Calcium deficiency and age-related bone loss as well as physical inactivity all play a role. Alcohol abuse may need to be addressed as a factor. Occasionally men may need counseling regarding testosterone replacement therapy.

Dietary Considerations

Summary of Recommendations

- Counsel on smoking, alcohol, caffeine, protein, and phosphates
- Dietary calcium and supplements should equal 1,000-1,500 mg/d
- Supplement Vitamin D up to 400-800 IU/d
- Consider adding RDA supplements of zinc, copper, and manganese

Smoking, alcohol, caffeine, protein, and phosphates

Habits such as smoking or excessive alcohol and caffeine consumption are more common among women who develop osteoporosis and fragility fractures. Diets rich in protein also can adversely affect calcium levels. And, while not yet studied in a human population, animal studies have shown that excessive intake of phosphorus (which frequently shows up on food labels as phosphate additives) may also have a negative effect on bone.

Dietary Calcium Intake

Most authorities consider calcium to be the most important nutritional component in the prevention and treatment of osteoporosis. Therefore, practitioners should ensure that osteoporosis patients and those at risk of developing it are getting adequate calcium intake through a combination of diet and supplementation.[2] Many believe that optimal calcium intake in childhood and young adulthood is critical to achieving peak adult bone mass.

Optimal daily intake group[33]	(in mg of calcium)
Infant Birth to 6 months	400
6 months to 1 year	600
Children 1-5 years	800
6-10 years	800-1200
Adolescents/Young Adults 11-24 years	1200-1500
Men 25-65	1000
over 65	1500
Women 25-50	1000
over 50	1500
on estrogens	1500*
over 65	1500
pregnant and nursing	1200-1500

*** Other sources suggest 1,000 mg/d if patient is on estrogen replacement.**

Some practitioners suggest that supplements using more than one source of calcium may be better absorbed and/or tolerated. If patients exhibit any side effects related to taking calcium, altering the source should be tried before stopping supplementation altogether.

These levels of daily calcium may be found in diets which *regularly* include large amounts of dairy products, canned fish with edible bones, dark green vegetables, calcium-processed tofu, calcium fortified orange juice, and other rich sources. *Many adults and most older women may need supplementation.*

Note: Reduced-fat or no-fat dairy products contain as much calcium per serving size as high-fat dairy products. Nondairy alternative sources are indicated for individuals who may be sensitive to milk products.

(For a list of calcium containing foods, see Osteoporosis Special Appendix V: Calcium Sources in Food.)

Calcium supplements[34]

Choices depend on individual preferences, cost and convenience. Consider the following chart comparing three common forms of supplemental calcium.

Calcium source	*Cost per month*	*% Calcium absorption*	*Average pills/day for 1000 mg*
Calcium carbonate	$	13.8-64	2-4
Calcium citrate	$$	12.3-31.4	3-6
Calcium gluconate	$$$$	21.8-67.5	8-10

- Serum calcium levels appear to be elevated equally by a variety of commercial calcium salts. One small study suggested that calcium carbonate and calcium citrate lowered PTH significantly more than the others, below the normal PTH range, and maintained the decrease longer.[35]

- Absorption of these calcium sources is quite variable, depending on age, amount of calcium taken, whether taken with a meal, and other factors. The ranges of percent absorption are fairly similar and are comparable to absorption from dietary calcium sources such as dairy products and dark green vegetables.

- Absorption is usually improved if the calcium is taken with a meal rather than on an empty stomach. Studies also indicate that absorption may also be better if taken at bedtime.[36] In addition, calcium ingested at bedtime may more effectively suppress nocturnal bone resorption and parathyroid hormone levels compared to ingestion with meals[36,37,38]

- The amount of elemental or absorbable calcium in supplements varies. For example, a tablet of calcium carbonate containing 40% or the maximum percentage of bioavailable calcium may be labeled as 700 mg calcium when it contains only 300 mg elemental calcium.

- Some patients may better tolerate tribasic calcium phosphate (not in the chart above) or calcium citrate, which contains lower percentages of absorbable calcium.

- Cost and number of pills required per day is probably a more important consideration for most women; therefore, calcium carbonate seems to be the best bargain.

- The calcium carbonate in antacids (TUMS, for example) is a very weak antacid but can be an acceptable source of calcium if used according to label directions. Aluminum-containing antacids (such as Rolaids or Maalox) should be avoided, as they contain little or no calcium.

- Calcium products such as dolomite or bone meal have been reported to contain lead and should be avoided.[20]

Side-effects of increasing calcium intake

Calcium intake, up to a total intake of 2000 mg/day, appears to be safe in most individuals with relatively few side effects. Above that level of intake, gastrointestinal side effects of calcium supplements have been observed as have cases of constipation. Because the calcium ion stimulates gastrin secretion and gastric acid secretion, some patients may develop "rebound hyperacidity."

A sudden increase in calcium intake may cause bloating and constipation. Therefore, if a patient suffers this reaction, a gradual increase in calcium supplementation should be advised.

Levels of calcium intake above 4000 mg/day can have potentially adverse effects. Cases of antacid abuse have led to hypercalcemia, severe renal damage, and ectopic calcium deposition (milk alkali-syndrome). Even at intake levels less than 4000 mg/day, certain otherwise healthy persons may be more susceptible to developing hypercalcemia or hypercalciuria. Nevertheless, in intervention studies (albeit of relative short-term duration—less than 4 years), no adverse effects of moderate supplementation up to 1500 mg/day have been reported. Hypercalciuria is unusual at dosages 1500 mg/day or lower.[2]

Contraindications and precautions

Renal disorders, hypercalcemia, and the presence of a malignancy should be considered before significantly increasing calcium intake. Patients with hypercalciuria should not receive calcium supplementation.[2]

Likewise, subjects with mild or subclinical illnesses marked by dysregulation of 1,25 dihydroxy-vitamin D synthesis (e.g. primary hyperparathyroidism and sarcoidosis) may be at increased risk from higher calcium intake.

Calcium can interfere with absorption of other nutrients. Iron absorption can be decreased by as much as 50 percent by milk ingestion and by certain forms of calcium supplements. However, those forms that contain citrate and ascorbic acid actually enhance iron absorption. Although not common, increased intake of specific sources of calcium might induce iron deficiency in individuals with marginal iron status. Whether calcium supplements interfere with absorption of other nutrients has not been thoroughly studied. Calcium may also interfere with absorption of certain medications, such as tetracycline.

Caution should be used in supplementing individuals who have a history of kidney stones because high calcium intake can increase urinary calcium excretion and might increase the risk of stone formation in these patients**.** Taking calcium with meals decreases this risk. Paradoxically, one large study suggested that within the current ranges of calcium intake in the population, a higher calcium intake in men is associated with a *decreased* risk in stone formation.

Calcium rationale, efficacy, and controversy

Most of the recommendations for calcium are based on small clinical intervention studies and statements of consensus groups.[2]

Calcium supplementation is thought to reduce the rate of bone loss in older women (> 5 years postmenopausal) and presumably promotes optimal bone stores in the young adult. Fracture reduction efficacy has been demonstrated in women older than 75 years of age.[2]

In a 1996 study, very high calcium intake (over 2000 mg/day) can overcome age-related increases in parathyroid hormone (PTH) secretion and the accompanying increase in bone resorption in elderly women.[39]

A 1998 study also found that long-term calcium administration resulted in decreased bone loss. This loss was associated with a reverse in age-related increases in serum parathyroid hormone levels and bone resorption.[38]

In at least one short-term prospective clinical trial, Chapuy has suggested that when women over the age of 80 (mean 84 years) consume calcium (1200 mg) and vitamin D (800 IU) as daily *supplements,* hip and other extremity fractures decrease within as few as 18 months.[40]

In a three-year trial, Bess Dawson-Hughes and colleagues compared calcium (500 mg/day) plus vitamin D (700 IU) to placebo in 389 healthy men (mean age 70) and women (mean age 71). Total bone mineral density (BMD) improved in the treatment group while it went down in the placebo group. Although there was *no significant* difference in BMD at specific skeletal sites, including the femoral neck and spine, subjects taking placebo had significantly more nonvertebral fractures (26 vs. 11*).*[41]

However, large scale epidemiological studies (in which calcium intake is based on uncontrolled self-reporting) introduce conflicting findings. There appears to be generally good agreement that somewhere between the ages of 65 and 80—and definitely over age 80 in men and women—the relationship between calcium intake and fracture is meaningful. However, between 30 and 65 years, there is probably no real connection between calcium intake and fracture.

Feskanich and colleagues prospectively tracked 77,761 women between the ages of 34-59 (at baseline in 1980) over a 12-year period. At follow-up in 1992, the cohort had suffered 133 hip fractures and 1046 forearm fractures due to low or moderate trauma. In a multivariate analysis, the authors corrected for many of the known suspected factors affecting bone density. There was no benefit from milk consumption, even in women who took vitamin D supplements or who drank three or more glasses of milk per day.[42]

In another prospective study from the Harvard School of Public Health in 1997, Owusu could find no correlation between calcium consumption and hip or forearm fractures in 43,036 men who were 48-73 years old at eight year follow-up.[43] In still another study from Norway encompassing over 90% of all men and women in a single county (52-72 years old at average, 11 year follow-up), Meyer could show "no clear association between calcium intake. . .and hip fracture." [44]

Vitamin D

Assure adequate vitamin D intake, through food sources and/or supplementation.[2] Supplements of 700-800 IU of vitamin D per day (the amount often found in 1 or 2 multi-vitamins) are recommended. Supplementation may be especially important in regions of the country where there is inadequate sunlight (like Portland).

Note: Elderly patients may lose some of the body's ability to use vitamin D. Women who have been diagnosed with osteoporosis should be tested for this problem and may require a prescription form of vitamin D known as calcitriol.[45]

(For more information, see Osteoporosis Special Appendix VI: Dietary Sources of Vitamin D.)

Rationale and efficacy

Adequate vitamin D is essential for optimal calcium absorption and appears to benefit the neuromusculoskeletal system to help prevent falling.[46]. Vitamin D supplementation in combination with calcium can reduce the rate of bone loss in older women. Fracture prevention is reliably achieved with doses of 700-800 IU/day whereas 400 IU/day is not effective.[47]

Other nutrients

Recent research suggests that elderly people require slightly higher protein intake than younger adults (about 1.0 g/kg v. 0.8 g/kg) to maintain nitrogen balance.[48]

A 1994 study showed that adding supplements of zinc, copper, and manganese to standard calcium therapy actually halted bone loss from the spine, while calcium alone only slowed the bone loss process.[49] There has also been interest in the roles of magnesium,[50] vitamin K,[51] and boron,[52] but little is known so far about the true value of these nutrients in the control of osteoporosis.

Specific Therapeutic Procedures

MANIPULATION AND MOBILIZATION

It is important that patients maintain good joint function to help decrease the pain that may accompany kyphosis-induced postural overloads. In addition, good joint function can have a bearing on flexibility, speed of contraction, and proper proprioceptive feedback—all of which are important in fall prevention.

When manipulating patients with osteoporosis, various degrees of caution must be exercised, depending on the degree of osteoporosis and the fragility of the patient's bones.

For patients with moderate to severe osteoporosis, clinicians should be very cautious. Low- or non-force techniques can be chosen. Procedures aimed at restoring proper joint function could include grade I to grade IV joint mobilization, muscle energy techniques, pelvic blocking, gentle flexion distraction, or use of a mechanical adjusting instrument (on the lowest setting).

In general, thrust techniques (grade V mobilization) should be used only by experienced adjustors, using carefully controlled amplitude. Special care should be used whenever treating the ribs or thoracic spine or when applying force through the hip.

Maitland's Grades of Mobilization[53]

- Grade I: Small-amplitude, rhythmic oscillations are performed at the beginning of the range.
- Grade II: Large-amplitude, rhythmic oscillations are performed within the range below tissue resistance, not reaching the anatomic limit.
- Grade III: Large-amplitude, rhythmic oscillations are performed up to the limit of the available motion and stressed into the tissue resistance.
- Grade IV: Small-amplitude, rhythmic oscillations are performed at the limit of the available motion and stressed into the tissue resistance.
- Grade V: A small-amplitude, high velocity thrust technique is performed to stretch adhesions at the limit of the available motion.

Note: Other soft tissue therapies can be used for muscles and tendons.

PARQ CONFERENCE AND CHARTING

It is very important that the patient be made aware of any additional risks that he or she may have for manual therapy and that proper informed consent be documented if osteoporosis is suspected. When making the PARQ entry, add brief notes concerning the nature or degree of the patient's risk and what additional precautions, if any, will be used to further minimize side effects (e.g., "low force techniques will be used when treating the ribs"). In such cases, a treatment alert should be placed prominently on the left side of the chart.

Record the grade of mobilization used. Grade V mobilization should be recorded in the usual fashion for adjusting: listing, adjustive procedure, response.

PHYSIOTHERAPEUTIC MODALITIES: SPECIAL PRECAUTIONS

If traction procedures are used, caution should be exercised. Manual traction or flexion distraction should be done very gently. Additional caution is recommended in moderate to severe cases of osteoporosis, especially when using mechanized traction. Mechanized massage or mobilization tables (e.g., the Spinolator) should be set at lower settings.

Short wave diathermy should be avoided or used sparingly on patients with osteoporosis due to the possibility of further demineralization (hyperemic decalcification).

Osteoporosis and Exercise

Patients should be given advice on the benefits of exercise. A specific program should be prescribed whenever appropriate.[2] Exercise is one the best ways to protect bones from osteoporosis, and women who exercise generally experience fewer problems. Furthermore, the best form of exercise is one which stimulates the parts of the skeleton most likely to fracture due to osteoporosis. These are *the hip, spine and the forearm*. Therefore, weight-bearing exercise such as walking is appropriate, but so are arm exercises like moderate weightlifting.

The goals of the exercise program are to choose activities that will have a positive influence on overall bone mass, to correct postural stresses (including those that result from compression-fracture-induced kyphosis), and to increase neuromuscular function so that falls are less likely. In general, exercises can be divided into those that promote bone mass and those that may help prevent falls. (See next page for summary of interventions.)

CAUTION: EXERCISES AND ACTIVITIES TO AVOID

Trunk flexion and trunk rotation should be avoided to protect the vertebral bodies from potential fracture forces, especially in older patients. This includes abdominal exercise with any type of supine head and upper trunk lifting motion. Jarring or high impact exercises should also be discouraged.

Summary of Interventions

Increase bone density
Weight bearing activities 40-60 minutes, 3 times a week to daily
Upper extremity strengthening exercise
Weight lifting
Tubing exercises

Prevent falls/increase bone density
Postural training
- Chin tucks
- Standing and seated Brügger positions
- Scapular retraction exercises

Gait training
- Stylized gait
- Chair rises

Balance exercises
- "Sink" exercises
- Rocker board
- Wall push

Lower extremity strengthening exercises
- Walking
- Stair climbing
- Wall slide/wall sit
- Bridge
- Quadruped leg kicks
- Timed up and go

Exercises to increase range in extension
- Standing back arch
- Seated back arch
- Cat stretch

Low back strengthening exercises
- Prone leg lifts
- Prone trunk lifts
- Quadruped leg kicks

Pelvic floor strengthening (optional)
- Lying down
- Sitting or standing
- Dynamic

Breathing exercises (optional)

Note: Many of the exercises above can be combined with Tai Chi or a related activity. Other similar exercises can be freely substituted in any of the categories.

Safety issues

Of course, excessively strenuous exercise can cause many kinds of injuries, so the patient and practitioner should choose activities, exercises, and a schedule that is safe and one the patient will enjoy.

In those osteoporotic patients who are initially underweight, weight loss as a result of physical activity should be avoided.[54]

EXERCISES TO IMPROVE BONE MASS

Patients must be placed on a weight-bearing exercise program. Bone mass response will depend on the intensity and type of activity, hormonal level, and diet. Recommendations for exercise schedules vary. The US Centers for Disease Control and Prevention and the American College of Sports Medicine encourage all adults to engage in 39 minutes or more of moderate intensity physical activity on most, preferably all, days of the week.[55] Mannello suggests 50 to 60 minutes of physical activity three times per week is necessary to be effective.[23] These sessions can be broken into several 10- to15-minute periods per day if the patient wishes.[32]

The course of exercise prescribed depends on the patient's physical capabilities. Exercise to increase bone mass must provide mechanical loading, such as walking or stair climbing and resistance training for the upper extremity. *Practitioners should take care to instruct older patients to stay warm and well hydrated.*

Weight bearing, low impact activities include walking, cross-country ski machines, stair-step machines, rowing machines, water aerobics, deep water-walking, and low impact aerobics.

Patients should increase upper extremity strength. Tubing exercises or light weights can be used to target the biceps, triceps, deltoids, and rotator cuff muscles. Weight resistance training should be done 2-3 times a week, working up to weights that demand 80% of maximum effort. A reasonable formula is to gradually work up to 3 sets of 8-10 repetitions with a 1-to-5 minute rest between sets.[32]

EXERCISES TO HELP PREVENT FALLS

There appears to be a correlation between decreased incidence of hip fractures and the maintenance of some form of regular physical activity in older individuals.[1] Regular exercise helps to improve coordination, balance, and muscle mass. A 1995 meta-analysis of seven studies on falls and elderly patients (FICSIT) also concluded that treatments that include exercise reduce the risk of falls.[56]

Patients with established osteoporosis, a history of falls, or fragility fractures, and elderly patients in general would benefit from this program. (See Page 15 to review risk factors for falls and fractures.) Based on individual assessment, some or all of the following components should be part of a program to help decrease the risk of falls.

Exercise prescription

A meta-analysis of the FICSIT trials suggested that poor balance could be more directly implicated in falling than deficits in strength, endurance, or flexibility.[56] Therefore, balance exercises should be included in the treatment program for most patients.

In general, it is wise to start with three exercises at a time. Begin with three repetitions working up to 10 as a maximum. When patients can do a particular exercise with ease at a particular level of difficulty for three sessions, they then advance in difficulty in that exercise or move on to a different exercise.[32] Balance and postural exercises should be done twice daily. The other activities can range from 3 times a week to daily.

When possible, encourage the patient to join a club or find a partner with whom to exercise. The more social the experience, the better the compliance.

Patients should begin their exercise routines with gentle stretching, making sure to include the hamstrings and calf muscles.

Posture

Exercises Options

- Chin tucks (See Osteoporosis Special Appendix X: Postural Exercises.)
- Standing and seated Brügger position
- Scapular retraction exercises

As the patient is given a variety of exercises, attention should be paid to posture. Building a healthy axial posture with the feet and lower extremities as the base has proven useful with the osteoporotic patient.[1]

Brügger position: seated or standing

- When standing, knees slightly flexed and externally rotated over second ray of the foot
- Pelvis held in a neutral range
- Slight abdominal bracing
- Sternum lifted up and out
- Head held straight and high
- Slight tuck to the chin.

Brügger can be used as 10-15 second breaks throughout the day and while performing the other seated or standing exercises. (See the Shoulder Impingement Syndrome Care Pathway, Special Appendix, Figure VI for a photo of the seated Brügger position.)

Start scapular retraction exercises early in the program.

The patient sits or stands up tall with chin retracted, stomach tight, sternum lifted up and out. The arms are abducted and externally rotated (forming a “W”). The shoulders should be relaxed, not hunched. The scapula are retracted and elbows pulled back and held for a slow count of three. The patient should then relax for a count of three and repeat the exercise. This

exercise can be made more challenging by interlacing the fingers behind the head. The patient again retracts the scapula while placing a gentle counter force against the back of the head. (See Osteoporosis Special Appendix X: Postural Exercises.)

Check for problems with pronation.
When exercise and specific cueing are not enough to correct pronation, orthotics, either off the shelf or custom-made, need to be fitted to support the scaphoid and metatarsal arches. Similarly, if a true leg length discrepancy is found, the patient should be fitted with either a heel or whole sole lift, as needed, to lessen a compensatory scoliosis.

Rationale

Practicing the styled postures outlined above will help train muscle groups important for spinal stability. Improving posture may also be particularly important in patients who have already had compression fractures resulting in increased kyphosis. Hyperkyphosis can be a cause of pain and alter the patient's sense of balance and ability to recover from falling.

Proper movement: gait, sitting-to-standing

Exercise Options

- Stylized gait
- Chair rises (sitting-to-standing maneuvers)

- Patients respond well to *conscious* gait and stair exercises for 1 to 5 minutes per day, with the goal of gradually incorporating the new patterns into all their gait activities. Emphasizing *heel-toe* roll and pushing off with the gluteals, in addition to the corrected alignment of the anterior-superior iliac spine, center of knee, and center of second metatarsal, is helpful. All these issues must be attended to in all activities and speeds used by the individual (i.e., a good walking pattern does not necessarily translate into a good stair-climbing posture without specific training).

- The patient should practice sitting-to-standing maneuvers, emphasizing quality of movement. Watch for poor mechanics such as the knees falling inward because of lack of gluteus medius and vastus medialis oblique use, or throwing the head forward to substitute ballistic momentum in the place of hip extensor and quadriceps power. Good mechanics would include the use of the hands to push into the chair arms during chair raise, keeping the knees forward and apart, and pinching the shoulder blades together. This action facilitates improved trunk and head position through use of tibialis anterior, quadriceps, gluteals, scapular adductors, and mid- and lower-trapezii.[1] (See Osteoporosis Special Appendix XI: Chair Rises.)

Rationale

Proper gait and patterns of movement help the patient feel more stable during activities of daily living.

Balance

Exercises to improve balance and reaction time are another important component in osteoporosis therapy and will help prevent falls. Balance exercises represent an integration of strength in the trunk and legs, proprioception, and central vestibular input. Exercises aimed specifically at balance, such as Tai Chi[57] and Tinetti's progressive balance exercises ("sink exercises")[58] have been shown to prevent falls.[56]

General Guidelines

When starting a patient on a regimen of balance training, consider the following recommendations.

- Patients should be taken through the program incrementally, starting first with simple, safe exercises leading to progressively more difficult balance demands.

- It is sometimes advantageous to first address head position. Head position exercises (such as chin retraction) should be given not only in stereotypical neutral standing or seated positions, but should be incorporated into a variety of body stances. These training postures should be movements mimicking the activities of daily living that the patient needs to engage in.

- Balance activities should be done very carefully under the direct supervision of the practitioner. Simple verbal feedback or use of mirrors is useful as well as light touch over the muscle bellies that need to be activated.

- Once patients demonstrate sufficient control, give them homework. Homework can include sensory motor training done with the patient holding onto a bathroom sink and, in many cases, can progress to the use of a balance board.

- A stance that emphasizes slight external rotation of the knees (over the second ray of the foot), a neutral pelvis with abdominal bracing, sternal lift, and slight chin retraction should be encouraged when performing the balance exercises.

- Adding perturbations should lead to improved reaction time and enhanced ability to recover before a fall.[59]

The Balance Protocol ("Sink exercises")
The patient goes through a sequence of exercises requiring varying degrees of balance. See Osteoporosis Special Appendix XII: Balance Exercises.

This protocol was used with success in a 1993 Yale study with a population of patients 70 years old or above. Possible balance goals are as follows:

Two leg stand: 30 seconds with eyes open or closed
One leg stand, eyes open: average of 30 seconds for subjects 20-59 years old; 22 seconds for those 60-69; 14 seconds for those 70-79
One leg stand, eyes closed: for young people, about 30 seconds; average of 21-28 seconds for subjects 20-59 years old; 10 seconds for those 60-69; 4 seconds for those 70-79

The "small foot" option
As an option, balance exercises can be performed with the "small foot." The small foot is a particular position of the foot that the patient maintains emphasizing a deep arch with minimal inversion or toe curling. It may amplify the training effect of upright and balance exercises, but an inordinate amount of time should not be spent teaching patients who cannot master it (unless, perhaps, the patient also has a pronation problem.) If a patient must wear special orthotics, some initial work with the small foot may be beneficial in arousing afferents, but otherwise the standing exercises should be performed with the orthotic.

Preliminary treatment may include stimulating the skin receptors of the foot with a soft brush for 30 seconds, adjusting joint restrictions throughout the foot and knee up to the proximal fibula, stimulating the foot by having the patient walk in place on an uneven surface such as a small bag of pebbles. (The pebble bag may be used by the patient as a tactile stimulus throughout the program.)

Balance board exercises
Use of the balance board may not be appropriate with very frail or very osteoporotic patients. The balance or rocker board should always be placed on a carpeted surface. The patient may position it facing a corner of the room so the walls can prevent falling. The exercises ideally should be performed barefoot (however, if the patient wears an orthotic, then the exercises should be done with the orthotic). Towels or egg cartons can be used to "slow" the rocker board down in the early phases of training.

The rocker board progression:

- Slowly rock the board back and forth in a controlled manner.
- Balance on the board in different positions or slowly rock. Positions include legs straight, legs bent, eyes open and closed while standing on the rocker board lengthwise, widthwise and diagonally.
- One leg (eyes open, then closed) in different positions
- Raise arms above head (to raise the center of gravity) or elevate arms mimicking various work positions, with and without resistance.

The practitioner should check for the "small foot" (if being used) and the other key components of the stylized standing posture (see posture/Brügger position, beginning on Page 33.). Patients should be encouraged to check these items whenever doing home exercises.

Tai Chi

Clinical studies suggest that Tai Chi can substantially improve changes in sway, enhance stability and kinesthetic sense, and increase lower extremity strength.[60,61,62] In a study of 200 women from Atlanta, the 72 women assigned to Tai Chi exercise decreased their risk of falling by almost 40% (IR 0.63, $p = 0.01$).[62] A combined exercise program of lower extremity strengthening, walking, and postural exercises that included Tai Chi movements was the first to demonstrate improvement in single stance sway in older women.[63]

Other suggestions

- The wall push is an exercise that will help improve lower extremity strength and balance. The patient stands sideways against a wall, holding on to a chair to provide stability. The elbow, hip, and knee nearest the wall are flexed to about 90 degrees. The patient pushes against the wall while trying to maintain balance. Patients are instructed to breathe and hold for 3-10 seconds. Exercise both sides. (See Osteoporosis Special Appendix XIII: Wall Push Exercise.)

- Having patients do some of their balancing program on foam surfaces will help train vestibular and visual input because it decreases reliance on proprioceptive input from the joints.[1]

- If the patient has sensory deficits, especially in the lower extremity, the use of a cane during weight bearing exercises or activities can enhance balance.

Special problems: Patients with poor vestibular function

Patients with significant vestibular problems may need to be referred to a physical therapy clinic. Any exercises that are given should be individualized to accommodate patient limitations. Follow these guidelines.

- Start treatment early in the acute phase with slow and careful head movements.
- Begin with brief exercise periods.
- Begin exercises that facilitate adaptation of the vestibular system using gentle active head movements.
- Increase and alternate the speed of the exercises.
- Exercises should be done in different positions, starting with sitting, progressing to standing (with a wide stance), and finally walking.

In general, cautiously increase the variety and complexity of the tasks and environmental situations.[1]

Lower extremity strength

Exercise Options

- Walking
- Stair climbing
- Step ups with bands or tubing
- Wall slide/wall sit
- Bridge
- Quadruped
- Timed Up and Go

To improve ankle balance strategies, work on strengthening the tibialis anterior during sways. To improve walking speed and stair climbing, strengthen the quadriceps and hip extensors.

- Prescribe daily walking at the most brisk pace the patient can safely go. Use of an assistive device may give the patient greater confidence at faster speeds and may increase sensory input.[64] When walking, the patient should try to maintain a training posture. (See tips on posture on Page 33.) Wear comfortable shoes with good grip. Be careful to see that heels land gently during gait to prevent a potential compression fracture.

- Walking up and down a flight of stairs can be good exercise if the patient does not have serious balance problems. The patient should hold the rail, keeping feet at least 6 inches apart for better stability.

- The *wall sit/slide* exercise will promote lower extremity strength. The patient stands with back against a wall and the chin tucked. The knees should be positioned over the second metatarsal. The stomach should be gently hollowed (contracted) while still allowing the patient to breathe. The patient performs a partial squat without losing contact with the wall. It is not necessary to squat past a 90-degree knee angle. The exercise should be terminated immediately if the patient begins to lose balance or begins to shake. To increase the difficulty of the exercise, move the feet 1 to 1 1/2 shoe lengths from the wall and hold the "wall sit" for up to 30 seconds, 4 times a day. (See Osteoporosis Special Appendix VIII: Wall Slide/Sit Test and Exercises.) Floor exercises that will strengthen the gluteus muscles and quadriceps include bridges and quadruped exercises. (For details, see Osteoporosis Special Appendix XIV: Floor Exercises; Low Back Rehabilitation protocol.)

- Practice the Timed Up-and-Go test. The goal would be getting up from a chair, walking 25 feet, and returning within 10 seconds.

Rationale

Muscular weakness is another intrinsic factor leading to falls. The prevention of falls through improvement of strength in the lower extremities is a well-recognized fact.[65] With strength training, one can better negotiate stairs and uneven surfaces.

Increase range in low back extension

Exercise Options

- Standing back bend
- Standing or seated back arch
- Cat stretch

This patient population should practice kyphosis reversal in the prone position daily. This exercise should also be practiced in a variety of other positions and during activities. Activities of daily living incorporating extension stretches can be taught as daily exercises for the first two weeks of therapy.[1]

- Placing two fists behind the back just below the waist, the patient bends backward. This should be done slowly while taking a deep breath, with the abdomen slightly contracted. To increase the effect, the fists (which serve as a pivot point) can be raised to waist level or higher.

- Sitting in a chair facing a wall, the patient folds the arms above the head and places them against the wall. While breathing out and relaxing, the patient then slowly drops the sternum at a 45 degree angle toward the floor. (For picture of the standing back arch, see Osteoporosis Special Appendix XV: Extension/Flexibility Exercises.)

- The cat stretch is a safe exercise for stretching the gluteals and mildly lengthening the paraspinals in a position that does not stress the anterior vertebral bodies.[32] The patient starts on all fours and then slowly sits back on heels while reaching hands and arms forward along the floor. Exhaling, the patient relaxes as the back flattens and the sternum sags downward. (See Osteoporosis Special Appendix XV: Extension Flexibility Exercises.)

Rationale
Besides improving posture in general, it makes sense to promote trunk extension for both treatment and prevention of kyphosis and anterior vertebral compression fractures.[65]

Low back strength

Exercise Options

- Prone leg lifts
- Prone trunk lifts
- Quadruped leg kicks

- Prone leg lifts are considered a moderate level exercise. The patient lies on the stomach, with hands at the sides. A rolled up towel may be placed under the pelvis to induce slight flexion and another beneath the forehead. With knee bent slightly, one leg is raised off the ground and then slowly lowered. Alternate legs. (See Osteoporosis Special Appendix XIV: Floor Exercises.)

- Prone trunk lifts are usually more difficult than leg lifts for patients. The patient positioning is the same as above. The stomach is tightened (abdominal bracing), the shoulder blades are pinched together and the patient lifts head and shoulders off the ground. Hold for 1 to 3 seconds. Inhale while extending, exhale and relax while *slowly* easing down. See Osteoporosis Special Appendix XIV: Floor Exercises.)

Note: Leg lifts and trunk lifts should not be done simultaneously because of the high compressive load on the spine.[66]

- Quadruped exercises are another option. (See Low Back Rehabilitation protocol for details). Holding the single leg extension works the muscles sufficiently to achieve a training effect with minimal spinal loading.[66]

Rationale

Persons with stronger back muscles may have a diminished risk of vertebral fractures. The risk of falls might be decreased through a combination of strengthening exercises for the back and lower extremities.[65]

Low back extensor strengthening exercises can contribute to the reduction of kyphotic posture. A study done by Sinaki supports the important role of back extensor strength in preventing the disfiguring effect of osteoporosis on spinal posture.[65]

Pelvic floor (optional)

Exercise progression

- Perform while lying down
- Perform while sitting or standing
- Perform while walking, coughing, or rising from a seated position.

Without moving the back or buttocks, the patient should pinch closed the bladder, vaginal, and rectal openings. Patients should sense the feeling of holding everything in as if resisting a strong urge to urinate. Have the patient imagine the pelvic floor muscles as an elevator that closes its doors after taking in passengers then travels to the first then second floors. Do 10 repetitions, holding for up to 5-10 seconds. Repeat 5-10 times. Perform 2 to 4 times per day.

Rationale
Treating pelvic floor inadequacies with a strengthening program can help with many instances of otherwise resistant back pain.[1] For patients who have demonstrated poor endurance of their pelvic floor muscles, rehabilitative exercises can be given. Teaching pelvic floor stabilization techniques may provide additional stability to the spine.

Breathing (recommended for patients with hyperkyphosis, optional for others)

When breathing is impaired after a vertebral compression or rib fracture, specific exercises to restore function are important. Treating the dysfunctional rib with low force or no-force manipulation procedures (e.g., muscle energy techniques) is valuable when simple active exercise does not restore normal respiratory rhythm in all segments. Use of an inspiratory volume feedback device is also of great value for home practice.

Besides helping the patient to breathe deeply and encouraging good mobility of the rib cage, abdominal breathing patterns should also be encouraged. A soft belt or towel slung across the lower abdomen can be used as a feedback device to teach how to breathe from the abdomen. If patients still have difficulty learning this abdominal movement, have them pretend to blow out a candle rapidly. This will cause the abdominal muscles to contact.

If there is lung congestion, gentle postural drainage with vibration is indicated. Percussion must be gentle to protect the ribs.

General Self-Care Advice

- All patients with osteoporosis or a history of falls or fractures should have their eyes examined.[67] By improving vision, patients can maneuver better in poorly lit settings, thus reducing the risk of falls. If a patient has newly prescribed bifocals, special care should be taken while the patient is getting used to them.

- Be aware of side effects of prescription and over-the-counter drugs. Sometimes a medication can cause dizziness or lightheadedness, leading to falls.

- Limit the intake of alcoholic beverages.

- Wear supportive, rubber-soled, low-heeled shoes. Avoid walking in socks or slip-on slippers.

ENVIRONMENT

The practitioner should discuss the living environment with the patient. In some cases, a home inspection would be warranted. Lighting may be an environmental factor contributing to falls. Stairs and curbs, especially without handrails become obstacles for individuals with impaired balance. Wet surfaces also contribute to falls and can be mitigated by mats or non-slip rugs or tape. For a more complete list, see Osteoporosis Special Appendix VII: Safety Tips.

SEXUAL ACTIVITY

From the National Osteoporosis Foundation, Osteoporosis Center, University of Connecticut Health Center, *Boning Up on Osteoporosis,* 1997.

“People with osteoporosis can remain sexually active. It is best to avoid positions that cause twisting or forward bending of the spine. In general, the partner should not put full body weight on the person with osteoporosis. Also, pillows or folded towels under the knees can help maintain spinal alignment.

“Maintaining communication and sharing your concerns with your partner are probably the most important steps you can take toward continuing a satisfying sexual relationship. Don’t be afraid to try different positions until you find one that is comfortable for both of you.”

OTHER PREVENTIVE MEASURES

Vertebral compression or rib fractures happen with a variety of flexion postures, such as sneezing, coughing, brushing teeth, picking up a child, or even receiving a hug.

- Educate patients so that they protect themselves while coughing or sneezing. A safe position is to support the spine in relative extension. If the patient can assume this position, it should be practiced for 2 weeks. (See Osteoporosis Special Appendix XVI: Avoiding Stress to Bones and Joints When Coughing.)

Canes or Swedish walkers are very useful to help decrease kyphosis and maintain standing height in patients with multiple compression fractures.[1]

Follow up and Re-evaluation

It is imperative for practitioners to perform annual follow-up assessments of all high risk patients or any patients on an osteoporosis prevention or treatment plan. The evaluation should consist of an interim history; physical examination including stature measurement, breast examination, and pelvic examination, assessment of compliance and activity level; and reinforcement of the therapeutic program. BMD measurements should also be obtained periodically to monitor changes in bone mass. A change of 5% in BMD in less than 2 years with DXA technique is considered clinically significant.

The following guidelines are recommended by the American Association of Clinical Endocrinologists for performing DXA BMD measurements. For patients with abnormal baseline BMD (T score > 1.5), follow-up measurements should be obtained every 2-3 years. For patients in an osteoporosis treatment program, a BMD evaluation should be performed every 1-2 years until bone mass stabilizes. Thereafter, it should be performed every 2-3 years. For patients who have accelerated bone loss due to medications or secondary conditions (see Page 7)**,** BMD should be performed yearly.[2]

Outcome Measures

Outcome measures should be used to assess changes in bone density, changes in fall risk, improvement in biomechanics and function, as well as quality of life.

Measures that relate pain to function are extremely important in defining goals and judging progress. Time before onset of symptoms (e.g., “I can only walk for 10 minutes before my back hurts and I have to lie down”) and then time for recovery must be recorded specifically. Other functional outcomes that can be tracked include changes in posture or kyphosis, strength, balance (e.g., the timed one leg stand), and specific functions (e.g., the Timed Up-and-Go test.)

References

1. Lindsay R. Osteoporosis: A Guide to Diagnosis, Prevention and Treatment. National Osteoporosis Foundation. New York: Raven Press, 1992.
2. The American Association of Clinical Endocrinologists and the American College of Endocrinology. AACE clinical practice guidelines for the prevention and treatment of postmenopausal osteoporosis, 1996 on-line. Endocrine Practice 1996;2(2):155.
3. Riggs BL, Melton LJ III. Involutional osteoporosis. NEJM 1986;9:1005-10.
4. Kanis J. Osteoporosis and its consequences. In: Osteoporosis. Cambridge, MA: Blackwell Science Inc., 1994:1-20.
5. Hawker G. The Epidemiology of Osteoporosis. J Rheumatol 1996 Suppl. 1996;45(23): 2-5.
6. Glaser D, Kaplan F. Osteoporosis: Definition and clinical presentation. Spine 1997;22(24S):12S-16S.
7. Silverman S, Madison R. Decreased incidence of hip fracture in Hispanics, Asians, and Blacks: California Hospital Discharge Data. Am J Public Health 1988;78(11):1482-3.
8. Prevention and management of osteoporosis: consensus statements from the Advisory Board of the Osteoporosis Society of Canada. Can Med Assoc J 1996;155(7):921-61.
9. Bass S, Pearce G, et al. Bone mass during growth: the effects of exercise. Exercise and mineral accrual. Acta Universitatis Carolinae-Medica. 1994;40(1-4):3-6.
10. Bell R, Carr A, Thompson P. Managing corticosteroid induced osteoporosis in medical outpatients. JR Coll Physicians Lond. 1997;31(2):158-61.
11. Merck Manual (17th ed.) Merck Sharp & Dohme Research Laboratories. Rahway, NJ., 1992:1311.
12. From The American College of Rheumatology guidelines, JAMA 1997 Jan 8;277:2:98-100.
13. Genant H, et al. Noninvasive assessment of bone mineral and structure: State of the art. J Bone and Mineral Research 1996;11(6):707-30.
14. Levis S, Altman R. Bone densitometry. Arthritis and Rheumatism 1998;41(4):577-87.
15. Kleerekoper M, Nelson D. Which bone density measurement? J Bone and Mineral Research 1997;12(5):712-14.
16. Canadian Task Force on the Periodic Health Examination. Canadian guide to clinical preventive health care. Canada Communications Group: Ottawa; 1994:620-31.
17. Guide to Clinical Preventive Services (2nd ed.) Report of the U.S. Preventive Task Force. Baltimore, MD: Williams and Wilkins; 1996.
18. Kanis J, Melton LJ III, et al. Perspective: the diagnosis of osteoporosis. J Bone Miner Res. 1994;9:1137-41.
19. Rubin SM, Cummings SR. Results of bone densitometry affect women's decisions about taking measures to prevent fractures. Ann Intern Med 1992;116:990-5.
20. Scheiber L, Torregrosa L. Evaluation and treatment of postmenopausal osteoporosis. Seminars in Arthritis and Rheumatism. 1998;27(4), 245-261.
21. Finsen V, Anda S. Accuracy of visually estimated bone mineralization in routine radiographs of the lower extremity. Skeletal Radiol. 1988;17(4):270-5.
22. Consensus of WSCC radiology department.
23. Mannello DM. Osteoporosis: Assessment and treatment options. Topics Clin Chiro.
1997; 4 (3) 30-43.
24. Wood MD. Treatment of postmenopausal osteoporosis, Review article. NEJM. 1998;338(11):736-746.
25. Cummings S, Nevitt M, et al. Risk fractures for hip fractures in white women: Study of Osteoporotic Fracture Group: NEJM. 1995;332:767-773.
26. Whooley MA, et al. Association between depressive symptoms and mortality in older women. Study of Osteoporotic Fractures Research Group. Arch Intern Med.1998;158(19): 2129-35.
27. Drinkwater BL. Exercise in the prevention of osteoporosis. Osteoporosis Int. 1993;3(suppl): 169-171.
28. DiFabio R, Anacker S. Identifying fallers in community-living elders with a clinical test of sensory interaction for balance. Eur J Phys Med Rehabil. 1996; 6:61-66.
29. Sinaki M, Mikkelson BA: Postmenopausal spinal osteoporosis: Flexion versus extension exercises. Arch Phys Med Rehabil. 1984; 65:593-596.

30. Podsiadlo, D, Richardson S. The timed “up and go”: a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc. 1991;39(2)142-148.
31. Duncan P, Weiner D, Chandler J, et al: Functional reach: A new clinical measure of balance. J Gerontol. 1990;45:M192-M197.
32. Boning Up on Osteoporosis: A Guide to Prevention and Treatment. National Osteoporosis Foundation, 1997.
33. NIH Consensus Development panel on Optimal Calcium Intake. Optimal calcium intake. JAMA. 1994;272:1942-9.
34. ***NIH Consensus Development Panel on Optimal Calcium Intake. Optimal calcium intake. JAMA. 1994;272:1942-8.***
35.Deroisy R, Zartarian M,et al. Acute changes in serum calcium and parathyroid hormone circulating levels induced by the oral intake of five currently available calcium salts in healthy male volunteers. Clin Rheumatol 1997 May;16(3):249-53. **Eighteen male volunteers, aged 18 to 35, were given 500 mg calcium in the form of 5 different commercially available supplements (carbonate, gluconolactate and carbonate, citrate, picolate and carbonate, or ossein-hydroxyapatite complex) or a calcium-free carrier. Each subject took all 6 treatments, with a week between tests. Test substances were ingested with 200 ml apple juice in the morning after an overnight fast; no food and only 1.5 L deionized water were allowed during the 6 hour test. Serum calcium rose equivalently with all calcium supplements, with the peak occurring between 90 and 120 minutes. PTH dropped with all supplements, with the nadir occurring at 90 to 120 minutes. This study did not take into account the effects of food on absorption or the effects of conditions such as achlorhydria.**
36. Blumsohn A, Herrington K, et al., The effect of calcium supplementation on the circadian rhythm of bone resorption. J Clin Endocrinol Metab. 1994;79:730-5.
37. Fujita T, Ohgitani S, Fujita Y. Overnight suppression of parathyroid hormone and bone resorption markers by active absorbable algae calcium: a double-blind crossover study. Calcif Tissue Int 1997;60:506-512.
38. Riggs BL, O'Fallon, et al. Long-term effects of calcium supplementation on serum parathyroid hormone level, bone turnover, and bone loss in elderly women. J Bone Miner Res 1998;13:168-174.
39.McKane WR, Khosla S, et al., Role of calcium intake in modulating age-related increases in parathyroid function and bone resorption. J Clin Endocrinol Metab. 1996;81(5):1699-703. **In a 3-year study, 28 elderly women, 65 to 74 years of age and at least 12 years postmenopausal, consumed either calcium citrate tablets (each providing 600 mg Ca) (n=13) or placebo tablets (n=15) in addition to their usual calcium (Ca) intake (800 mg/day) with each of the 3 meals and at bedtime. A group of young women (n=12), average age of 30, whose Ca intake was similar to that of the elderly women of the placebo group, was used for comparison. After 3 years of experimental treatments, serum PTH levels and urinary pyridinoline and deoxypyridinoline, markers of bone resorption, were significantly lower in the high Ca group and the young group than in the elderly low Ca group; the high Ca and young groups were indistinguishable. The authors concluded that age-related increases in Ca requirement are responsible for increased PTH secretion and increased bone resorption experienced by postmenopausal women and that the condition can be overcome by increasing daily Ca intake.)**
40. Chapuy MC et al. Vitamin D3 and calcium to prevent hip fractures in the elderly woman. NEJM, 1992; 327: 1637-42.
41. Dawson-Hughes B, Harris SS, et al. Effect of calcium and vitamin D supplementation on bone density in men and women 65 years of age or older. NEJM, 1997; 337; 670-6.
42. Feskanich ScD, et al. American Journal of Public Health, 1997;87; 992-7.
43. Owusu W, et al. Calcium intake and the incidence of forearm and hip fractures among men. J Nutr. 1997: 127(9); 1782-7.
44. Meyer HE, et al. Dietary factors and the incidence of hip fracture in middle-aged Norwegians. A prospective study. Am J of Epidemiol. 1997; 145(2): 117-23.
45. Segal LG, Lane NE. Corticosteroid-induced osteoporosis: Assess the risk, protect your patient. J Muskuloskel Med.1997;14(1):43-6.
46. Bischoff-Ferrari HA, Dawson-Hughes B, Willett WC, et al. Effect of Vitamin D on falls: a meta-analysis.

JAMA 2004;291:1999-2006. Review.
47. Bischoff-Ferrari HA, Willett WC, Wong JB, et al. Fracture prevention with vitamin D supplementation: a meta-analysis of randomized controlled trials. JAMA 2005;293):2257-64. Review.
48. Campbell WW, Crim MC, et al. Increased protein requirements in elderly people: new data and retrospective reassessments. Am J Clin Nutr. 1994;60:501-9.
49. Strause L, Saltman P, et al. Effect of calcium and trace mineral supplementation on spinal bone loss in postmenopausal women. J Nutr. 1994;124:1060-4.
50. Sojka JE, Weaver CM. Magnesium supplementation and osteoporosis. Nutr Rev.1995; 53(3):71-4.
51. Binkly NC, Suttie JW. Vitamin K nutrition and osteoporosis. J Nutr. 1995;125:1812-21.
52. Beattie JH, Peace HS. The influence of a low-boron diet and boron supplementation on bone, major mineral and sex steroid metabolism in postmenopausal women. Br J Nutr. 1993;69:871-84.
53. Maitland GH. Peripheral Manipulation. Boston, Mass:Butterworths; 1977.
54. Prior JC, Ban SI, et al. Physical Activity as Therapy for Osteoporosis in Prevention and Management of Osteoporosis: Consensus Statements from the Scientific Advisory Board of the Osteoporosis Society of Canada, Can Med Assoc J. October, 1996.
55. Pate RR, Pratt M, et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine [review]. JAMA. 1995;273:402-7.
56. Province MA, Evan CH, et al. The effects of exercise on falls in elderly patients. A pre-planned meta-analysis of the FICSIT trials. JAMA. 1995;273(17):1341-1347.
57. Wolf S, Kutner NG, Green R, et al. The Atlanta FICSIT study: Two exercise interventions to reduce frailty in elders. J Am Geriatr Soc. 1993;41:329-32.
58. Tinetti ME, Baker DI, Garrett PA, et al. Yale FICIT: Risk factor abatement strategy for fall prevention. J Am Geriatr Soc. 1993;41:315-20.
59. Horak FB, Henry SH, Shumway-Cook A: Postural perturbations: New insights for treatment of balance disorders. Phys Ther. 1997;77:517-533.
60. Jacobson BH, Chen HC, et al. The effect of T'ai Chi Chuan training on balance, kinesthetic sense, and strength. Percept Mot Skills1997; 84:27-33.
61. Channer KS, Barrow D, et a. Changes in hemodynamic parameters following T'ai Chi Chuan and aerobic exercise in patients recovering from acute myocardial infarction. Postgrad Med J. 1996;72:349-351.
62. Wolf S, Barnhart H, et al. The effect of T'ai Chi Quan and computerized balance training on postural stability in older subjects. Phys Ther. 1987;77:371-384.
63. Judge JO, Lindsey C, et al. Balance improvements in older women: Effects of exercise testing. Phys Ther. 1993;73:254-264.
64. Tinetti M, Speechley M, Ginter SF: Risk factors for falls among elderly persons living in the community. NEJM.1988;319:1701-1707.
65. Sinaki M, Wollan PC, et al. Can strong back extensors prevent vertebral fractures in women with osteoporosis. Mayo Clin Proc. 1996; 71:951-6.
66. McGill SM. Low back exercises: Evidence for improving exercise regimens. Phys Ther. 1998;78(7):754-65.
67. Swezey RL. Preventing osteoporotic fractures: the role of exercise, posture, and safety. J Musculoskeletal Medicine. 1997;14(4):9-28.

Osteoporosis Special Appendix

Special Appendix I: Corticosteroid-Induced Osteoporosis: Specific Recommendations

Corticosteroid-induced osteoporosis presents health care providers with additional challenges. The following is a summary of care.

- The lowest effective short-acting corticosteroid dosage should be used to prevent or minimize bone loss.

- It is important to begin osteoporosis prevention measures immediately, given that bone loss is most rapid during the first 6 months of corticosteroid therapy.

- A program of calcium supplements, vitamin D, ovarian hormone replacement, and weight-bearing exercises (30 minutes, three or four times a week) are first-line therapies. Resistive exercises that maintain muscle mass are important therapies that may prevent some aspects of corticosteroid-induced bone loss.

- Corticosteroids are catabolic agents that also cause muscle wasting.

- Sodium restriction and thiazide diuretics improve gastrointestinal absorption and decrease urinary excretion of calcium, thus reducing the hypercalciuria associated with corticosteroid use. Their effect on bone density in patients taking corticosteroids has not been adequately assessed, although in the absence of corticosteroid treatment, thiazide use is associated with increased bone density and reduced fracture risk.

- Serum calcium levels must be monitored carefully in patients receiving both vitamin D and thiazide, because of the potential of hypercalcemia. Approximately 1 month after starting therapy, serum potassium and 24-hour urinary calcium levels are measured. The decision to use a thiazide, with or without potassium supplementation, will depend on the results of these laboratory tests.

- Vitamin D may also prevent corticosteroid-induced bone loss. One study showed that the addition of vitamin D (50,000 IU two or three times per week) or 25-hydroxyvitamin D approximately 40 micrograms/day) with 500 mg of elemental calcium had beneficial effects on bone density in patients who were taking corticosteroids for rheumatic disease. One study suggests monitoring serum and urinary calcium levels within the first few months of therapy to minimize the risk of vitamin D intoxication. Serum levels of vitamin D should be maintained within the upper limits of normal. Corticosteroid-induced hypogonadism should be corrected. A small case-control study showed that estrogen and progesterone replacement prevented bone loss for one year in postmenopausal, asthmatic women who had been receiving prednisone. Premenopausal women who experience menstrual irregularities while taking corticosteroids, as well as postmenopausal women, should receive estrogen therapy unless contraindicated.

- In patients who cannot receive ovarian hormone replacement, who have established osteoporosis, or who show deterioration in spinal BMD despite the interventions, other

agents such as biphoshonates or calcitonin (either the subcutaneous or intranasal form) may be indicated.

Summary of Recommendations

Patients on corticosteroids should maintain a well-balanced diet that contains a maximum of 2-3 g/day of sodium, 1500 mg/day calcium supplement, and at least 800 IU of Vitamin D. They should also limit alcohol intake, quit smoking, and participate in weight-bearing exercise 30-60 minutes a day. A thiazide diuretic may be necessary to control hypercalciuria. Post - menopausal women should be on replacement therapy. Men with low testosterone levels should be on replacement therapy. Calcitonin and bisphosphonates are effective in reducing bone loss for those who cannot or do not receive HRT. Measure bone density at baseline and every 12 months during the first two years of therapy to assess the effectiveness of therapy.

Testosterone for men taking corticosteroids

Men taking corticosteroids who have low testosterone levels may benefit from testosterone replacement to reduce the potential for osteoporosis. Medroxyprogesterone acetate, 200 mg intramuscularly every 6 weeks given with calcium, 1000 mg/day, has been shown to prevent trabecular bone loss in the lumbar spine over one year in men with corticosteroid-induced osteoporosis It is important to monitor levels of prostate specific antigen and to examine the prostate every 6 months in men receiving testosterone therapy, since testosterone increases the risk of prostate cancer.

Special Appendix II: Comparison of Other Available Technologies to Measure BMD

Modality	Advantages	Disadvantages
DXA	Considered gold standard Hip/spine/wrist measurements Total body measurements Low radiation exposure Moderate to low cost per test May perform serial tests	Area measurement study Limited mobility of equipment Moderate cost of the equipment
Peripheral DXA	Low cost per test/equipment Low radiation exposure Equipment mobile	Limited to study of wrist or heel Area measurement only Limited correlation to spine/hip fx
QCT	Volumetric measurement May perform serial tests	High radiation exposure Recalibration between tests Moderate cost per test Limited mobility of equipment
RA	Low cost per test/equipment Requires only an x-ray unit & phantom Equipment mobile	Limited to study of phalanges Limited at screening test Limited correlation to hip/spine
SXA	Low cost per test/equipment Equipment mobile	Limited to forearm/heel study Limited at screening test Limited correlation to hip/spine
Ultrasound	Low cost per test/equipment Equipment mobile Radiation-free	Limited to calcareous study Limited at screening test Limited correlation to hip/spine

Abbreviations:

DXA – dual x-ray absorptiometry
QCT – quantitative computed tomography
RA – radioabsorptiometry
SXA – single x-ray absorptiometry

Special Appendix III: Recommended Indications for Bone Density Studies

1. BMD can help when a clinician and patient feel that they need more information to choose a successful management strategy.

- Perimenopausal/post-menopausal women who are concerned about osteoporosis in general and who are willing to accept available interventions**.**

- Women who are specifically considering hormone replacement therapy, but who need more information to make a decision (identify her current bone mass).

- Women who are considering positive lifestyle changes, but who require more information to be appropriately motivated to make the necessary commitment for management to be effective.

2. BMD should be tested when patients present with findings that suggest that they may already have osteoporosis.

- In patients with insufficiency fractures or who present with vertebral fractures or deformity, hip fractures, or wrist fractures without significant trauma.

- In patients with radiographs that suggest osteopenia.

3. A BMD test should be considered in estrogen-deficient women who have <u>additional</u> risk factors for osteoporosis. Note: Although the risks cited below as well as those on pp 8-9 can be used to suggest who <u>should</u> have their BMD measured, these risks are insufficiently sensitive to efficiently determine who should <u>not</u> be screened. That is to say, it is acknowledged that a significant proportion of patients without additional risk factors may still have low bone mass. Nonetheless, prevailing opinion is that the number of cases which will go undetected is not sufficient to justify general screening.

- In patients receiving or initiating long-term corticosteroid therapy. Current indications for bone densitometry delineated by the Scientific Advisory Board of the National Osteoporosis Foundation include patients taking 7.5 mg/day or more of prednisone for 3 months or longer. If only one site is measured, the spine is preferred for patients younger than 60 years and the hip is preferred for those who are older since morbidity and mortality with hip fracture is greater than with vertebral fractures.

  The schedule for testing is as follows:

  1) At onset of therapy as a baseline (or at least within 4-6 weeks)
  2) 6 and 12 months after initiation and annually thereafter
  3) In a patient on long term therapy that has not had densitometry performed.

Special Appendix III: Recommended Indications for Bone Density Studies, c*ontinued...*

- Patients with hyperparathyroidism, with or without symptoms (to help determine the need for parathyroidectomy).
- Patients that require long-term renal dialysis
- Patients with long-standing rheumatoid arthritis
- Patients that have experienced long-term immobilization
- Hypogonadal male
- Patients with malabsorption syndromes
- Patients receiving chronic anticonvulsant therapy
- Amenorrhea in younger women for any reason (anorexia, excessive exercise regimes, etc.)

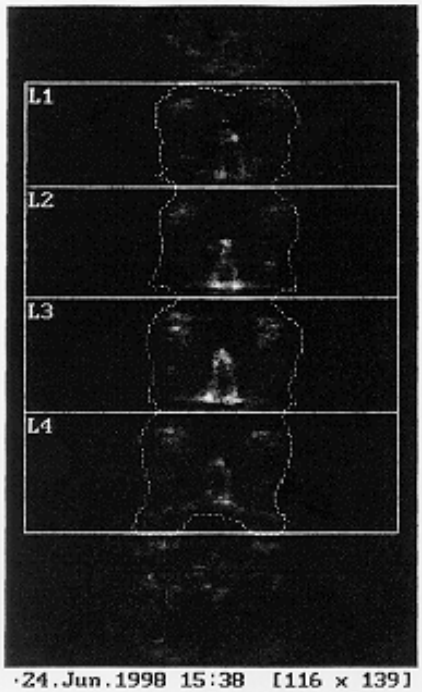
Note: Amenorrhea is based on an interruption of menses for 3 months or more in women with regular cycles, 6 months or longer in women with a history of irregular cycles.

- Consult list of secondary causes (See p. 14.)

4. BMD can be helpful in monitoring a patient's response to therapy whether the therapy is pharmacologic, such as alendronate, or nonpharmacologic, such as lifestyle changes and supplementation in a patient believed to be at high risk. (WSCC)

Special Appendix IV: Sample BMD Report

k = 1.136 d0 = 44.4(1.000H) 7.557 HOLOGIC



24.Jun.1998 15:38 [116 x 139]
Hologic QDR-4500C (S/N 48346)
Lumbar Spine V8.20f:5

00624980B Wed 24.Jun.1998 15:36
Name:
Comment: baseline/heel bd done
I.D.: 0081 Sex: F
S.S.#: - - Ethnic: W
ZIPCode: Height: 157.00 cm
Operator: CR Weight: 67.00 kg
BirthDate: 30.Jan.47 Age: 51
Physician:
Image not for diagnostic use

TOTAL BMD CV FOR L1 - L4 1.0%

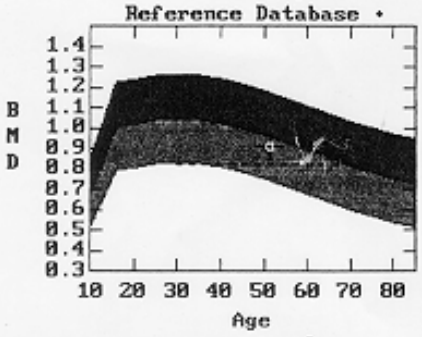
C.F. 1.035 1.008 1.000

Region	Est.Area (cm^2)	Est.BMC (grams)	BMD (gms/cm^2)
L1	12.73	11.82	0.929
L2	14.13	12.09	0.856
L3	15.67	14.80	0.944
L4	16.25	14.60	0.898
TOTAL	58.78	53.31	0.907

HOLOGIC

HOLOGIC

f Lumbar Spine
Reference Database *



BMD(L1-L4) = 0.907 g/cm^2

Region	BMD	T(30.0)		Z	
L1	0.929	+0.04	100%	+0.75	110%
L2	0.856	-1.57	83%	-0.77	91%
L3	0.944	-1.27	87%	-0.42	95%
L4	0.898	-1.98	80%	-1.11	88%
L1-L4	0.907	-1.27	87%	-0.45	95%

* Age and sex matched
T = peak bone mass

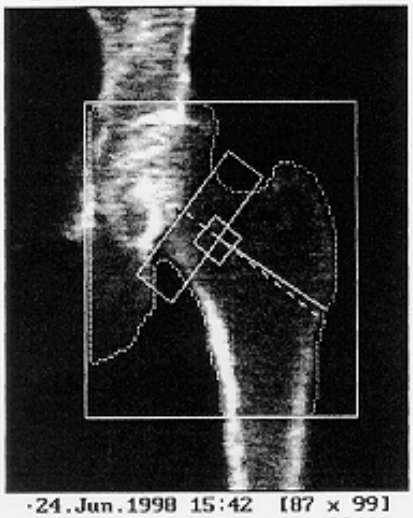
00624980B Wed 24.Jun.1998 15:36
Name:
Comment: baseline/heel bd done
I.D.: 0081 Sex: F
S.S.#: - - Ethnic: W
ZIPCode: Height: 157.00 cm
Operator: CR Weight: 67.00 kg
BirthDate: 30.Jan.47 Age: 51
Physician:

HOLOGIC

Special Appendix IV: Sample BMD Report, *continued…*

HOLOGIC

k = 1.134 d0 = 45.9(1.000H) 6.802



·24.Jun.1998 15:42 [87 x 99]
Hologic QDR-4500C (S/N 48346)
Left Hip V8.20f:S

00624980C Wed 24.Jun.1998 15:40
Name:
Comment: baseline/heel bd done
I.D.: 0081 Sex: F
S.S.#: - - Ethnic: W
ZIPCode: Height: 157.00 cm
Operator: CR Weight: 67.00 kg
BirthDate: 30.Jan.47 Age: 51
Physician:
Image not for diagnostic use

TOTAL BMD CV 1.0%
C.F. 1.035 1.000 1.000

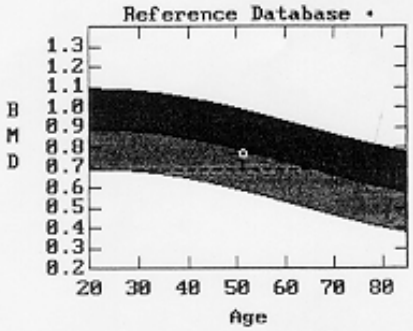
Region	Est.Area (cm^2)	Est.BMC (grams)	BMD (gms/cm^2)
Neck	4.93	3.76	0.763
Troch	10.58	6.54	0.618
Inter	16.17	14.92	0.923
TOTAL	31.68	25.22	0.796
Ward's	1.26	0.71	0.564

Midline (84,110)-(152, 58)
Neck -49 x 15 at [24, 14]
Troch 5 x 41 at [0, 0]
Ward's -11 x 11 at [5, 5]

HOLOGIC

HOLOGIC

f Left Hip
Reference Database •



BMD(Neck[L]) = 0.763 g/cm^2

Region	BMD	T	Z
Neck	0.763	-1.32 85% (22.0)	-0.26 97%
Troch	0.618	-1.16 86% (30.0)	-0.58 92%
Inter	0.923	-1.61 80% (29.0)	-1.06 86%
TOTAL	0.796	-1.49 82% (28.0)	-0.88 88%
Ward's	0.564	-2.11 71% (20.0)	-0.36 94%

• Age and sex matched
T = peak bone mass

00624980C Wed 24.Jun.1998 15:40
Name:
Comment: baseline/heel bd done
I.D.: 0081 Sex: F
S.S.#: - - Ethnic: W
ZIPCode: Height: 157.00 cm
Operator: CR Weight: 67.00 kg
BirthDate: 30.Jan.47 Age: 51
Physician:

HOLOGIC

Special Appendix IV: Sample BMD Report, *continued…*
INTERPRETING BONE MINERAL DENSITY REPORTS AND DXA SCAN PRINTOUTS

Special Appendix IV contains sample BMD printouts and reports of a patient's lumbar spine and hip. The following information should be present on all scans:

A. PATIENT INFORMATION
Name
Identification (ID) number
Sex (M or F)
Age
Ethnicity (W, white; B, black etc.)
Birth Date
Address or zip code
Height (in cm)
Weight (in Kg)
Clinical indication (i.e., osteoporosis, hyperparathyroidism, etc.)

B. GENERAL INFORMATION
Date of examination
Time of examination
Physician's name
Operator's or technician's name
Disclaimer (indication that images are not for diagnostic use)
Equipment specifications (i.e., Hologic QDR-4500C)
Calibration information
Area of interest (i.e., lumbar spine, hip, radius)
Comments on whether study is baseline (first scan) or follow-up (subsequent scan)

C. SPECIFIC BONE DENSITY DATA IN DXA SCAN PRINTOUT
Image: A Dual X-ray absorptiometry (DXA) image of the patient's spine (or hip or radius) is displayed illustrating the areas being assessed
Region: Area of interest being assessed (i.e., L1, L2, L3 etc.)
Est. Area: Area of bone being assessed expressed in cm^2
Est. BMC: Bone mineral content expressed in grams
BMD: Bone mineral density expressed in grams/cm^2

D. COMPARISON OF PATIENT BONE DENSITY TO NORMAL POPULATIONS
The patient's BMD is compared in table form to the bone mineral density of the normal young adult population and of the age-matched population. These tables typically contain the following:

Region: The region of interest indicates which specific area is being studied (L1, L2, etc.) or an average of several areas (L1-L4)

BMD: Actual measured bone mineral density in each area expressed in grams/cm^2.

Percentage young adult: The patient's bone density expressed as a percentage of the young-adult population.

T-score:	The number of standard deviations the adult patient's bone mineral density is above (+) or below (-) the mean for the young, normal reference population. This score is important for categorizing the severity of osteoporosis and for calculating the estimated fracture risk.
Percentage age-matched:	The patient's bone density expressed as a percentage of the age-matched population.
Z-score:	The number of standard deviations the adult patient's bone mineral density is above (+) or below (-) the mean for the age-matched reference population. This score should not be used for categorizing the severity of osteoporosis or for calculating the estimated fracture risk.

E. CATEGORIZING BONE MINERAL DENSITY

The World Health Organization has developed criteria for classifying the severity of osteoporosis. This classification is based on the patient's T-score as follows:

World Health Organization Criteria for Osteoporosis

Diagnostic Category	T-Score
Normal >	-1
Osteopenia	< -1 and > -2.5
Osteoporosis	< -2.5 (without fracture)
Established osteoporosis	< -2.5 (with fractures)

F. ESTIMATION OF RELATIVE RISK OF FRACTURE[1]

Estimation of relative fracture risk can be obtained on the basis of spine and hip T-scores. In general, each standard deviation change in bone mineral density increases fracture risk by a factor of 2.

The formula for calculating this risk is: $\text{Risk} = 2^{\text{T-score}}$

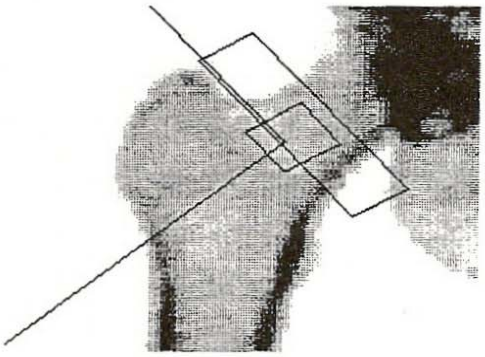
Example: If a patient has a spine T-score of –4.0, her relative risk of spine fracture is 2^{-4} or 16. Therefore, compared with young healthy adults, she is 16 times more likely to suffer a spine fracture.[1]

[1] Lenchik L, Rochmis P, Sartoris DJ. Optimized interpretation and reporting of dual X-ray absorptiometry (DXA) scans. AJR 1998;171:1509-20.

Bone Density Diagnostic Center
Department of Radiology
UNIVERSITY OF CALIFORNIA-SAN DIEGO

PATIENT ID:
NAME:

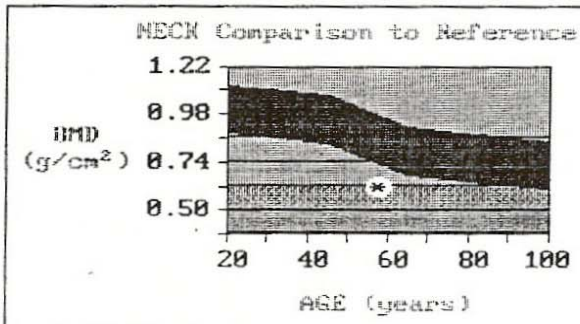
SCAN: 3.62 03/
ANALYSIS: 3.62 03/



LUNAR®

IMAGE NOT FOR DIAGNOSIS

ID: SCAN DATE: 03/1



NECK BMD (g/cm²)[1]	0.612 ±
NECK % Young Adult[2]	62 ±
NECK % Age Matched[3]	73 ±

Age (years).....	58	Large Standard.....	278.55	Scan Mode.....	
Sex.....	Female	Medium Standard.....	206.73	Scan Type.....	
Weight (lb).....	141.0	Small Standard.....	146.82	Collimation (mm).....	
Height (in).....	65	Low keV Air (cps)...	629273	Sample Size (mm).....	
Ethnic.....	White	High keV Air (cps)..	393999	Region height (mm)...	
System.....	6116	Rvalue (%Fat).....	1.337(27.4)	Region width (mm)....	
Side.....	Right	Current (uA).....	750	Region angle (deg)...	

NECK	: BMC[5] (grams) =	2.82	AREA[5] (cm²) =		
WARDS	: BMC[5] (grams) =	1.04	AREA[5] (cm²) =		
TROCH	: BMC[5] (grams) =	6.35	AREA[5] (cm²) =		

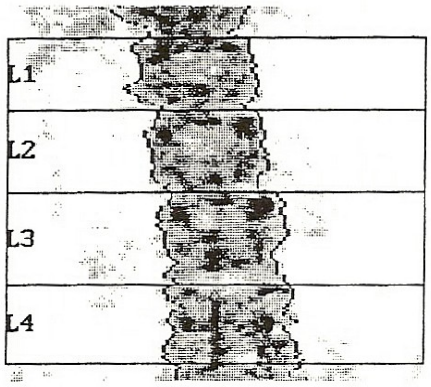
REGION	BMD[1] g/cm²	Young Adult[2] %	Young Adult[2] Z	Age Matched[3] %	Age Matched[3] Z
NECK	0.612	62	-3.06	73	-1.92
WARDS	0.441	48	-3.61	61	-2.13
TROCH	0.569	72	-2.01	79	-1.39

1 - See appendix E on precision and accuracy. Statistically 68% of repeat scans will fall within 1 S
2 - USA Femur Reference Population, Ages 20-45. See Appendices.
3 - Matched for Age, Weight(males 25-100kg; females 25-100kg), Ethnic.
5 - Results for research purposes, not clinical use.

Bone Density Diagnostic Center
Department of Radiology
UNIVERSITY OF CALIFORNIA-SAN DIEGO

PATIENT ID:
NAME:

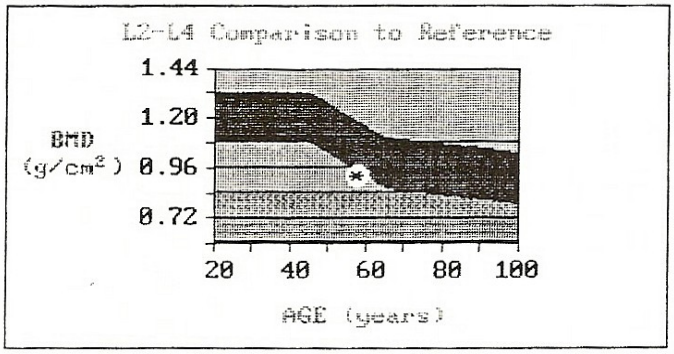
SCAN: 3.62 03/10/97
ANALYSIS: 3.62 10/16/98



LUNAR®

IMAGE NOT FOR DIAGNOSIS

ID: SCAN DATE: 03/10/97



L2-L4 BMD (g/cm^2)[1]	0.922 ± 0.01
L2-L4 % Young Adult[2]	77 ± 3
L2-L4 % Age Matched[3]	88 ± 3

Age (years).....	58	Large Standard.....	278.55	Scan Mode.....	Medium
Sex.....	Female	Medium Standard.....	206.73	Scan Type.....	DPX
Weight (lb).....	141.0	Small Standard.....	146.82	Collimation (mm).....	1.68
Height (in).....	65	Low keV Air (cps)...	629273	Sample Size (mm).....	1.2x 1.2
Ethnic.....	White	High keV Air (cps)..	393999	Current (uA).....	750
System.....	6116	Rvalue (%Fat).....	1.324(34.0)		

REGION	BMD[1] g/cm^2	Young Adult[2] %	T	Age Matched[3] %	Z
L1	0.901	80	-1.91	92	-0.68
L2	0.890	74	-2.58	85	-1.36
L3	0.929	77	-2.26	88	-1.04
L4	0.944	79	-2.14	90	-0.91
L1-L2	0.895	78	-2.12	89	-0.90
L1-L3	0.908	78	-2.18	89	-0.96
L1-L4	0.917	78	-2.19	89	-0.97
L2-L3	0.911	76	-2.41	86	-1.19
L2-L4	0.922	77	-2.32	88	-1.10
L3-L4	0.936	78	-2.20	89	-0.98

1 - See appendix E on precision and accuracy. Statistically 68% of repeat scans will fall within 1 SD.

2 - USA AP Spine Reference Population, Ages 20-45. See Appendices.

3 - Matched for Age, Weight(males 25-100kg; females 25-100kg), Ethnic.

Bone Density Diagnostic Center
Department of Radiology
UNIVERSITY OF CALIFORNIA-SAN DIEGO

PATIENT ID: SCAN: 3.62 03/10/97
NAME: ANALYSIS: 3.62 10/16/98

ANCILLARY SPINE RESULTS**

Region of Interest	BMC (grams)	Area (cm^2)	Width (cm)	Height (cm)	BMC/W (g/cm)	Volumetric Density[1]
L1	11.54	12.80	3.95	3.24	2.92	79
L2	12.55	14.10	3.79	3.72	3.31	77
L3	15.15	16.32	4.00	4.08	3.79	85
L4	14.04	14.88	4.27	3.48	3.28	88
L1-L2	24.09	26.90	3.86	6.96	6.23	78
L1-L3	39.24	43.21	3.91	11.04	10.02	81
L1-L4	53.28	58.09	4.00	14.52	13.32	83
L2-L3	27.70	30.41	3.90	7.80	7.11	81
L2-L4	41.74	45.29	4.01	11.28	10.40	84
L3-L4	29.19	31.19	4.13	7.56	7.08	87

Z-SCORE FOR VERTEBRAL HEIGHT (L2-L4)
Compared to young adult: Z = 1.76
Adjusted for stature: Z = 1.89

**Ancillary results for research purposes, not clinical use.

1 Mazess, et al., 1991, Calc. Tiss. Intl., 48:380-386.

Lewis St. Women's Center
Bone Densitometry

MRN: 1572382

DOB: 08/10/1940 Sex: F
Status: O Patient Loc:

Requested by: , M.D.
Attending Physician:Unspecified Physician

ACC:604741 03/18/199713:45
DEXA NO CHARGE

Procedure: DEXA NO CHARGE

HISTORY:
Follow-up evaluation. No hormone replacement therapy.

FINDINGS:
PROXIMAL FEMUR:
Percentage of young normal mean is 72%. T-score is - 2.47%.
Percentage age matched mean is 86%. Z-score is - 1.08.
Relative hip fracture risk is greater than six times normal.
Remaining lifetime fracture probability is 6.3%. World Health Organization Classification is advanced osteopenia bordering on osteoporosis.

COMMENTS:
Since the previous examination of 12/20/94, bone mineral density in the proximal femur has not changed significantly.

LUMBAR SPINE:
Percentage of young normal mean is 93%. T-score is - 0.69.
Percentage age matched mean is 106%. Z-score is + 0.48.
Relative vertebral fracture risk is greater than two times normal.
Remaining lifetime fracture probability is 4.8%. World Health Organization Classification is normal.

COMMENTS:
Since the previous examination of 12/20/94, bone mineral density in the L1-L4 region has not changed significantly.

IMPRESSION:
Borderline osteoporosis in the proximal femur, with significantly increased risk of hip fracture. No significant interval change since 12/20/94. Bone mineral density in the lumbar spine is within normal limits with only slightly increased risk of vertebral fracture and once again no significant change since 12/20/94. A repeat examination is suggested in approximately 2-3 years for followup if clinically indicated.

Approved by:
, M.D. /signed by/ M.D. ,Staff Radiologist
03/19/1997

Transcribed on: 03/19/199715:56
Last Edited on: 03/19/199716:29

Special Appendix V: Calcium Sources in Food

Food Item	Serving Size	Calcium Content (mg)	Calories
Milk/Eggs			
Powdered nonfat	1 tsp	50	
Milk 1	cup	290-300	
Whole 8	oz.	291	150
Skim 8	oz.	302	85
Calcimilk -- lactose reduced lowfat milk	8 oz.	500	100
Egg 1	med.	55	
Yogurt			
Plain, low-fat	8 oz.	250-400	145-230
Fruit, low-fat	8 oz.	250-400	150-250
Frozen, fruit	8 oz.	240	233
Frozen, chocolate	8 oz.	160	220
Cheese			
Mozzarella, part skim	1 oz.	207	80
Muenster 1	oz.	203	105
Cheddar 1	oz.	204	115
American 1	oz.	165-200	
Swiss 1	oz.	250-270	
Parmesan 1	Tb	70	
Ricotta, part skim	4 oz.	335	190
Cottage, low-fat (2%)	4 oz.	78	103
Ice Cream, Vanilla (11%)			
Ice cream or frozen dessert	1/2 cup	90-100	
Hard 1	cup	176	270
Soft serve	1 cup	236	375
Fish and Shellfish			
Sardines, canned in oil, drained (inc. bones)	3 oz.	375	175
Salmon, pink, canned, drained (inc. bones)	3 oz.	167	120
Shrimp, canned, drained	3 oz.	100	100
Bread			
Corn bread	2 1/2 in. sq.	80-90	
Vegetables			
Bok choy, raw	1 cup	250	25
Broccoli, fresh, cooked & drained	1 cup	136	40
Broccoli, frozen, cooked & drained	1 cup	100	50
Soybeans, cooked & drained	1 cup	175	298
Collards, fresh, cooked & drained	1 cup	200	30
Carrots 1	cup	50	50
Kale	1/2 cup, cooked	90-100	
Tofu 4	oz.	150 85	
Fortified Foods			
Calcium-fortified milk	8 oz.	500	100
Fruit juice with added calcium	8 oz.	300	120-130
Cereal with added calcium (without milk)	3/4 cup	250	110

Special Appendix VI: Dietary Sources of Vitamin D

In order to appropriately utilize dietary Vitamin D the patient needs to be able to digest fatty foods. Patients with chronic pancreatitis, celiac disease, surgical loss of the jejunum and/or ileum or other malabsorption disorders are unlikely to be able to appropriately metabolize vitamin D. Bile is also necessary for utilization and patients with biliary obstruction are at risk for deficiency. Activation of the most active form of vitamin D occurs in the kidney and patients with tubular kidney disease may require higher therapeutic doses.

Vitamin D occurs naturally in vegetable and animal food sources, but all natural food sources except for fatty fish are too low to be sufficient for patients deprived of adequate sun exposure.

The amount of vitamin D naturally occurring in animal products is variable depending on the food and lifestyle of the animal.

Food	Vitamin D IU
Fish	
Cod liver oil, 1 tsp	1275
Pickled Atlantic Herring, 3 oz	578
Catfish, 3 oz	425
Sardines, 3 oz water packed	500
Atlantic Mackeral, 3 oz	392
Pacific Oysters, med, 3 oz	273
Atlantic salmon fillet, 3 oz	204
Light tuna in water, 3 oz	136
Sole/Flounder fillet, 3 oz	51
Halibut fillet, 3 oz	34
One Large Whole Egg	26
Liver	
Chicken, 3 oz cooked	45
Calf, 3 oz cooked	12
Dairy	
Cottage Cheese, ½ cup	10
Cheese, 1 oz	5

To combat this problem of low amounts of Vitamin D in non fish food sources, the government has encouraged Vitamin D supplementation to be added to some common foods, primarily milk and breakfast cereals.

Foods Fortified with Vitamin D

Milk (whole or skim), 1 cup	100 IU
Breakfast cereals (check label), 1 cup	40 - 80 IU

Special Appendix VII: Safety Tips

Indoor Safety Tips

- Keep floors free of clutter. Remove all loose wires and cords that are in a traffic area.
- Be sure all carpets, including those on stairs, and area rugs have skid-proof backing or are tacked to the floor. Do not use slippery wax on bare floors.
- Use non-skid mats or rugs on the floor near the stove and sink. Clean up spills immediately.
- Keep stairwells well lit with light switches both at the top and the bottom, and install sturdy handrails on *both* sides. Mark the top and bottom steps with bright or fluorescent tape.
- Install grab bars on the bathroom walls beside the tub, shower, and toilet. Use a non-skid rubber mat in the shower or tub. If you are unsteady on your feet, consider using a plastic chair with a back and non-skid legs in the shower or tub and use a hand-held shower head to bathe.
- Place light switches within reach of your bed and a night light between the bedroom and bathroom. Get up slowly from sitting or lying since a drop in blood pressure may cause dizziness at these times. Keep a flashlight with fresh batteries beside your bed.
- If you live alone, you should consider wearing a personal emergency response system (PERS). Also consider purchasing a portable telephone to take from room to room so you can call for help immediately if you fall.
- Place frequently used items within easy reach to avoid frequent bending or stooping. Minimize the use of step-stools. If a stool is necessary, use a sturdy one with a handrail and wide steps.
- Learn to rely on assistive devices to help you avoid strain or injury. For example, use a long-handled grasping device to pick up items without bending or reaching. Use a pushcart to transfer heavy or hot items from the stove or counter top to the table.
- If you have had a fracture or some other problem that makes you unsteady on your feet, do not hesitate to use a cane or a walker.

Outdoor Safety Tips

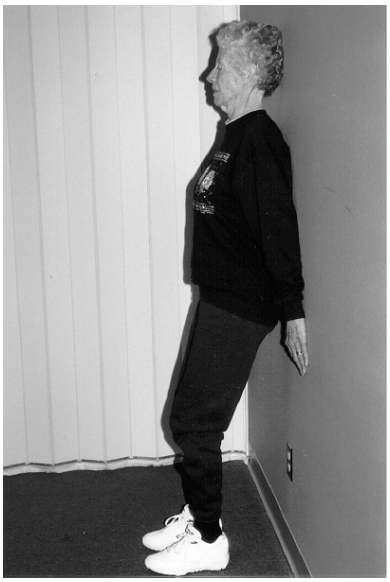
- Cover porch steps with gritty, weatherproof paint.
- Use caution when walking on floors that are slippery or have visually confusing floor patterns. You may find these in the lobby of a hotel or bank, a hospital, or the grocery store. Do not hesitate to ask for assistance or use a cane or a walker on unfamiliar or uneven ground.

- Slow down. Accidents are more likely to happen when you do things in haste.
- Remember that more fractures occur when it is wet or icy, so be extra careful in those conditions. During the winter, carry a small bag of sand in your car. If the ground is icy where you park, sprinkle the sand by your car door.

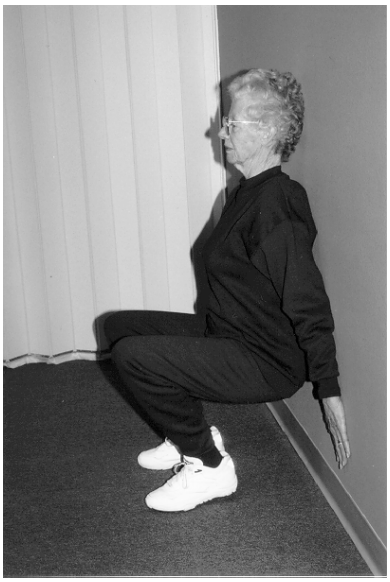
Preventing Trauma While in Transit

- Remain alert and brace yourself when riding a bus that is slowing down or turning.
- Watch for slippery pavement and other hazards when entering or leaving a vehicle.
- Have fare ready to prevent losing balance while looking for change.
- Do not carry too many packages. You should always have one hand free to grasp railings.
- Allow extra time to cross the street, especially in bad weather.
- At night, wear light-colored or fluorescent clothing and carry a flashlight.
- Reduce the time spent driving your own car if possible; try to avoid driving at night, during rush hour, or in bad weather.

Special Appendix VIII: Wall Slide/Sit Test & Exercise



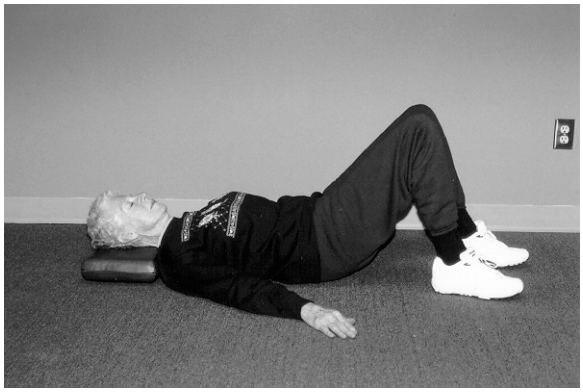
This procedure can be done as a test of lower extremity strength. Having established a base line, it can then be done as an exercise. The patient stands, back against a wall, maintaining a “training” pose: chin slightly tucked in, knees turned out over the second toe, stomach gently contracted. S/he then slides down the wall and tries to hold a partial squat for thirty seconds. It is not necessary to bend past a 90 degree knee angle (in the picture the patient's knees are flexed more than necessary). The test/exercise is terminated if the patient begins to shake or feel unsteady. Moving the feet 1 to 1 ½ shoes lengths from the wall will increase the difficulty of the exercise. Do 4 times a day. This test has no normative values. Note: the exercise can also be done with an exercise ball placed between the wall and the patient.

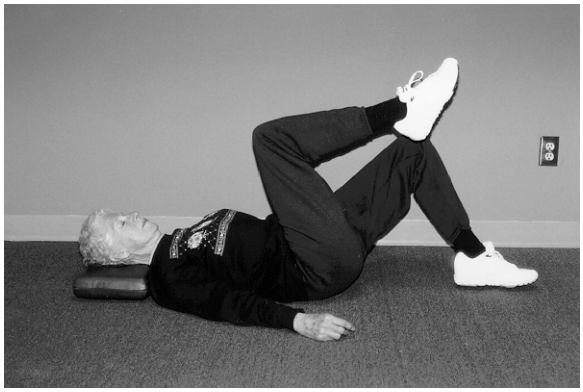


Special Appendix IX: Grading Abdominal Strength

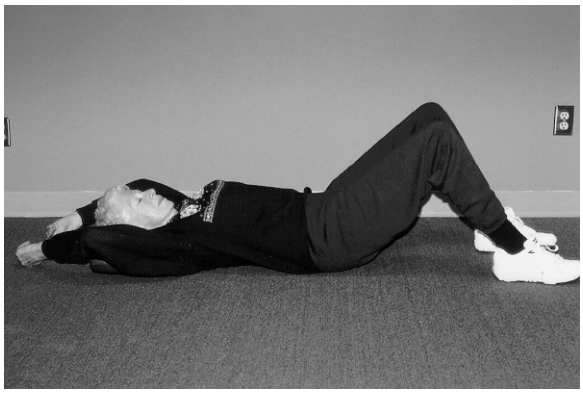
Using a traditional sit up or crunch to judge abdominal strength may be unwise in the osteoporotic patient because of the compressive load on the spine. The following is an alternative grading method.

Grade 1/5: The patient can initiate an abdominal contraction which approximates the ribs and the pelvis.





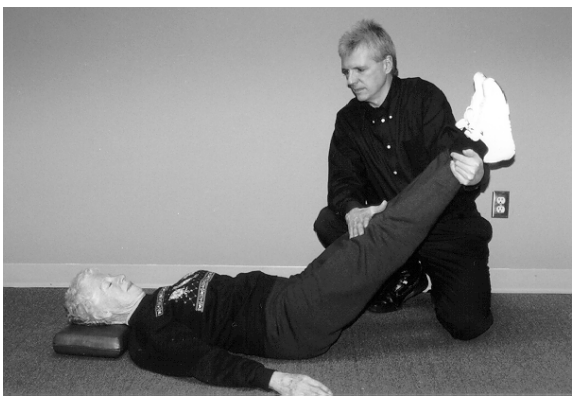
Grade 2/5: The patient can flex the hip, lifting and lowering one bent knee at a time, *while keeping abdomen tightly braced.* S/he can also raise and lower one arm above the head, again while maintaining good abdominal tone.



Grade 3/5: The patient can flex one hip, then the other, bringing both knees up (one at a time) as if sitting in a toppled chair (AKA, "90/90" position) and then return them (one at a time) to the starting position without losing the abdominal bracing.

Grade 4/5: Starting in the 90/90 position, the patient can slowly extend one leg at a time and lower it to within 5 cm of the floor/table, maintaining abdominal bracing all the while. Note: the practitioner should be present to assist patients in case they are unable to perform this grade.

Grade 5/5: Starting in the 90/90 position, the patient can simultaneously lower both legs to the horizon, while maintaining abdominal bracing. Note: the practitioner should be there to assist.

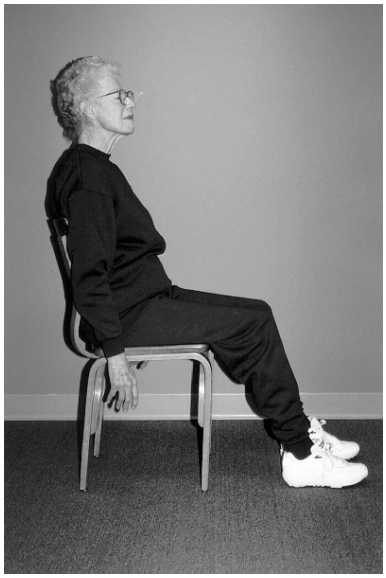


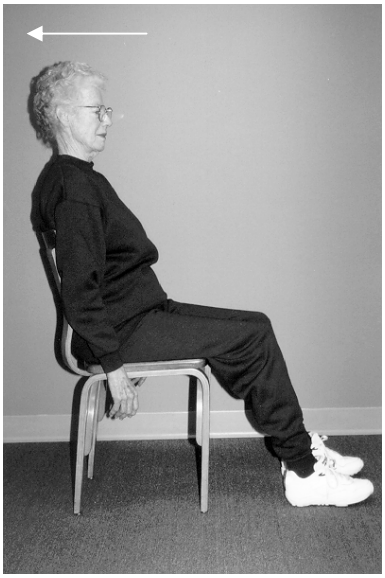
Special Appendix X: Postural Exercises

Chin Tucks

Chin tucks are very useful to retrain postural behaviors, especially in patients with forward head carriage or evidence of weak deep neck flexors. In addition, this exercise can be used to relax the upper posterior cervical muscles and is thought to "open" the atlantooccipital joint.

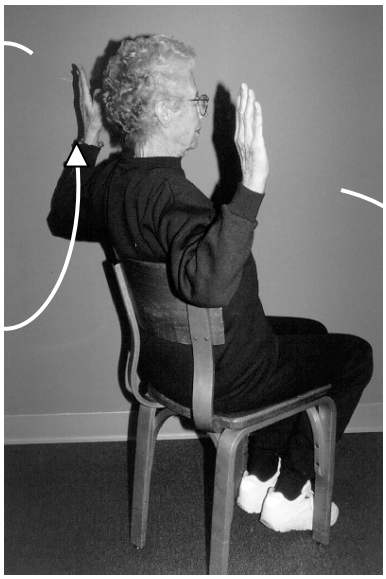
The chin is gently pulled/retracted along a straight posterior vector (a "negative Z" vector) and then is allowed to relax back into its starting position. It is not necessary to forcibly protrude the chin as part of the exercise. The neck should not be allowed to flex. One routine would be to do six repetitions of 6 second holds. This should be done multiple times throughout the day. Other routines/schedules can also be used.



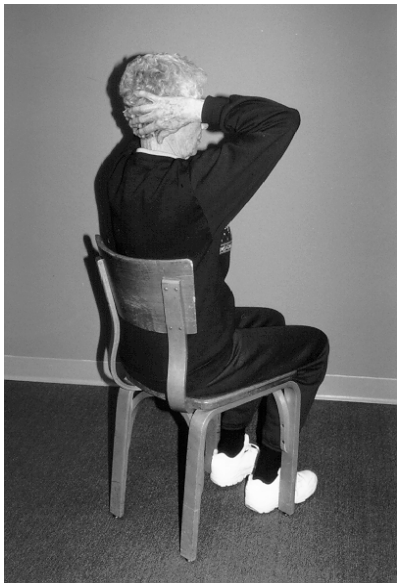


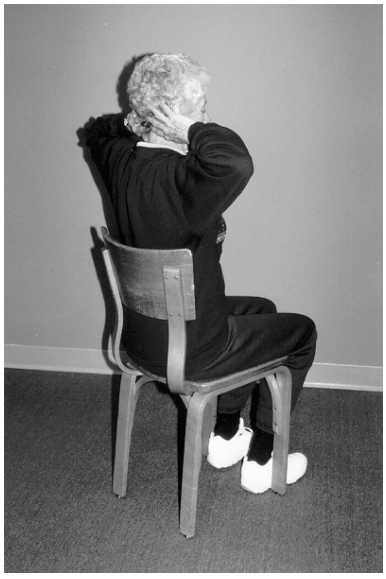
Scapular Retraction "W" Exercise

Scapular retraction exercises can be done early in the program. The patient sits or stands up tall with the chin retracted, abdomen gently contracted, and the sternum lifted up and out. The arms are held up forming a “W” in space. The shoulders should be relaxed, not hunched up. (Note: the practitioner should check to see that the contraction is occurring in the middle and lower trapezius). The patient then relaxes for a count of three and repeats the exercise up to 10 times.



This exercise can be made more difficult by interlacing the fingers behind the head and gently using the back of the head as a fulcrum. It should be emphasized that the patient maintains a good posture and should feel overall relaxed during the entire activity. For more exercises, see the protocol Scapular Training Track.

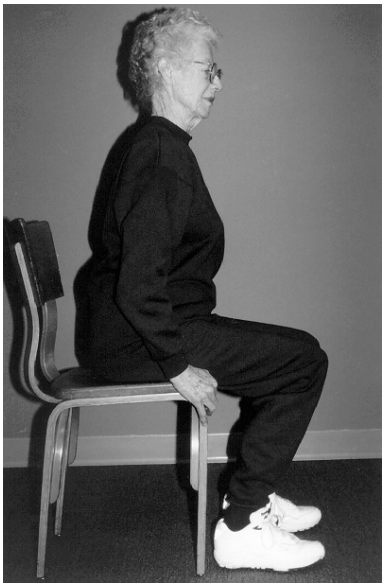


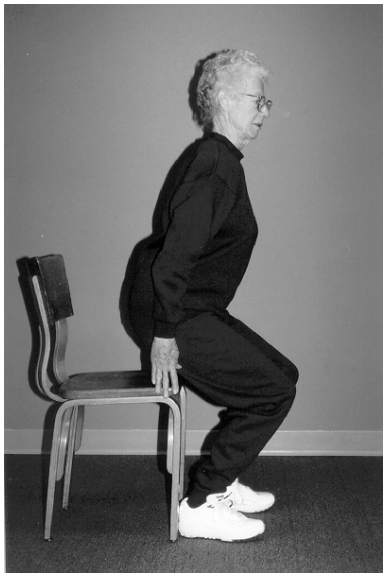


Special Appendix XI: Chair Rises

The patient should practice sit to stand maneuvers ("chair rises"), concentrating on the quality of movement. The practitioner first evaluates the patient's movement, identifying areas for improvement. The patient then practices getting in and out of a chair, consciously adopting an improved form as a training activity.

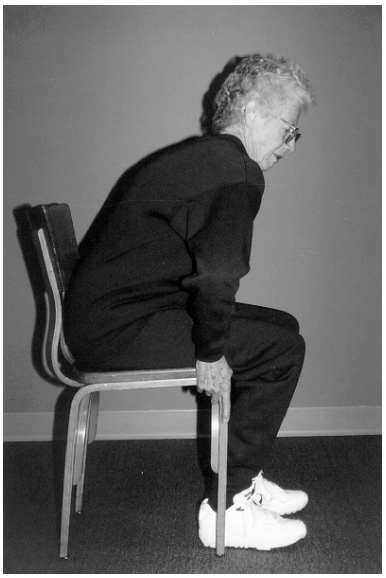
Correct

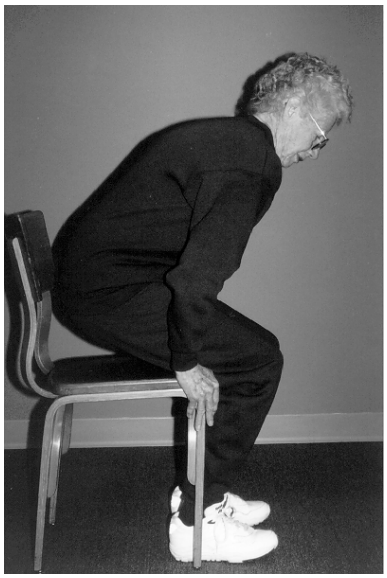




Correctable mechanics include knees rotating inward because of inhibited gluteus medius and/or vastus medialis oblique. Throwing the head forward to substitute for weak hip extensors and quadriceps. Good mechanics would include having the patient use his or her hands to push down through the arms of the chair or the thighs, while keeping the knees forward and apart, chin tucked in, while gently pinching the shoulder blades together. This action facilitates improved trunk and head position through use of the tibialis anterior, quadriceps, gluteals, scapular adductors and mid and lower traps. If the patient tends to lead with his or her chin, give Chin Tuck exercises (see appendix IX).

Incorrect





Special Appendix XII: Balance Exercise

The exercises summarized in this table are presented in detail on the following pages.

Indications: Less than normal performance during baseline assessments of sitting, standing, or reaching balance; transferring lie to sit, sit to stand, stand to sit; or during gait assessment.

Frequency: Twice per day. Each exercise performed 5 or 10 times per session.

Progression of exercises: All subjects begin at Level I and progress to higher levels when all exercises at lower level are performed correctly, safely, and without significant effort as defined by criteria listed in the procedure manual.

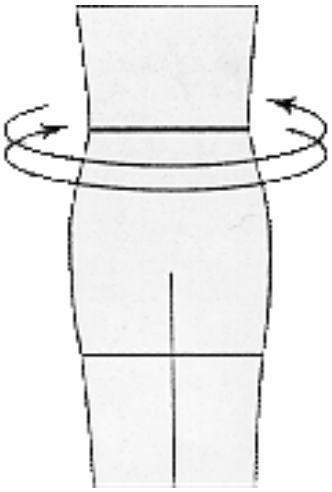
Level I	Level II	Level III	Level IV	Level V
Sink Hip Circle	Sink Toe Stand (one hand)	Heel Stand	Heel Toe Walk	Two Leg Sink Lunge
Sink Toe Stand (both hands)	One Leg Sink Stand with one hand	Sink Side Step (one hand)	Standing Arm/Leg March	Knee Lifts
One Leg Sink Stand (both hands)	Sink Side Step with both hands	Sink Toe Stand (no hands)	Tandem Walking	Forward Lunge
Sitting Arms Circles	Bed Walk (with arms)	Bedwalk (arms folded)	Cross-over Walk	Side Bend, Feet Apart
Sitting Knee Lifts; Arms to Side	Sitting Knee Lifts; Arms Across Chest	Sink Leg Cross	One Leg Sink Toe Stand	Side Bend, Feet Together
	Sitting March	One Leg Sink Stand (no hands)		Side Lunge, Hands on Hips
		Sink Leg Swing		Side Step
		Sink Leg Lift		

Special Appendix XII: Balance Exercises (Level I)

Do the exercises marked by your doctor TWICE a day.

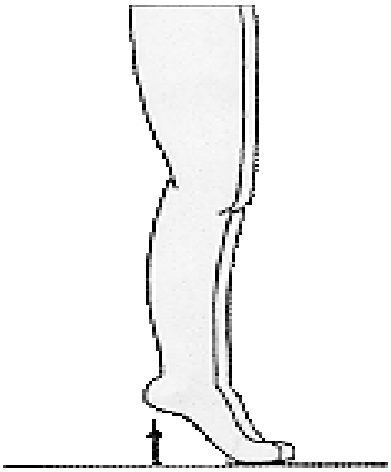
The Sink Hip Circle I

1. Stand facing kitchen/bathroom sink
2. Hold on with both hands
3. Do not move shoulders or feet
4. Make a big circle to left with hips
5. Repeat 5 times
6. Make a big circle to right with hips
7. Repeat 5 times



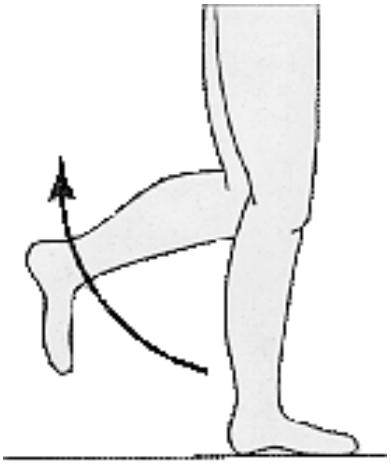
The Sink Toe Stand I

1. Stand facing sink
2. Hold on with both hands
3. Go up on your toes
4. Hold for count of 5
5. Then come down
6. Repeat 10 times



One Leg Sink Stand I

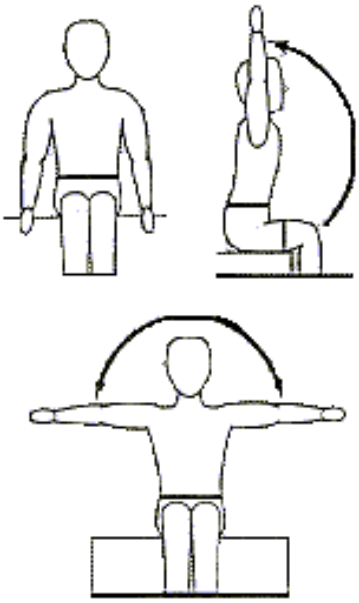
1. Stand facing sink
2. Hold on with both hands
3. Stand on your left leg for count of 5
4. Stand on your right leg for count of 5
5. Do each leg 10 times



With permission from M. Gottschalk, MS, PT (Yale FICSIT).

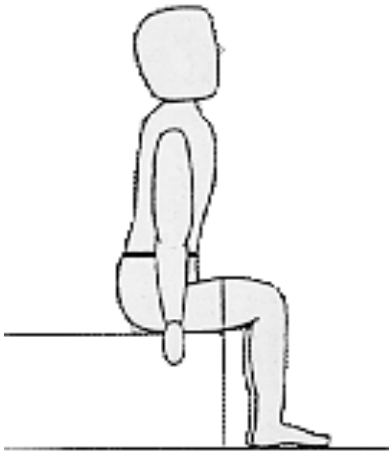
Sitting Arm Circles I

1. Sit on bed
2. Arms by your side
3. Raise both arms up overhead
4. Then arms out to side shoulder level
5. Then arms down
6. Repeat 10 times



Sitting Knee Lifts I

1. Sit on bed
2. Arms by your side
3. Lift left knee up towards ceiling
4. Lower left knee
5. Lift right knee up towards ceiling
6. Lower right knee
7. Repeat 10 times

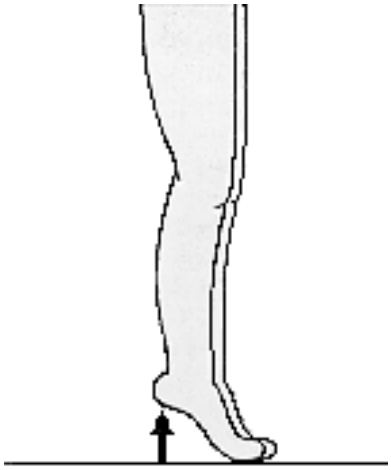


With permission from M. Gottschalk, MS, PT (Yale FICSIT).

Special Appendix XII: Balance Exercises (Level II)

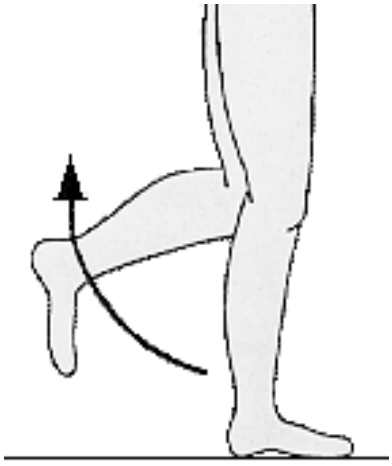
The Sink Toe Stand II

1. Stand facing sink
2. Hold on with one hand
3. Go up on your toes
4. Hold for count of 5
5. Then come down
6. Repeat 10 times



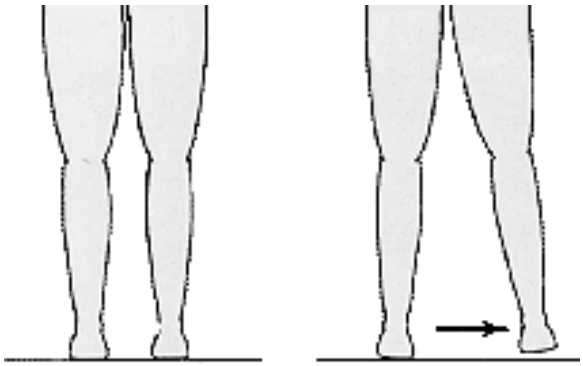
One Leg Sink Stand II

1. Stand facing sink
2. Hold on with one hand
3. Stand on your left leg for count of 5
4. Stand on your right leg for count of 5
5. Do each leg 10 times



Sink Side Step II

1. Stand facing sink
2. Hold on with both hands
3. Move hands along sink as you step to left 5 steps
4. Step with both feet to right 5 steps
5. Repeat 5 times



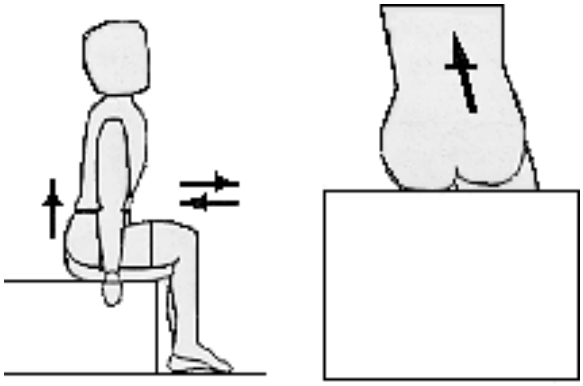
With permission from M. Gottschalk, MS, PT (Yale FICSIT).

Special Appendix XII: Balance Exercises (Level II *continued)*

Do the exercises marked by your doctor TWICE a day.

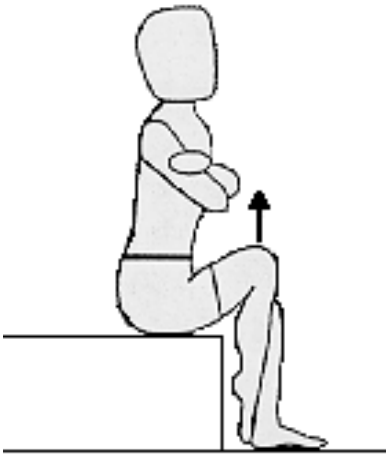
The Bedwalk II

1. Sit on the edge of bed
2. Feet flat on floor
3. Raise arms out to side
4. Shift weight side to side "walking" your bottom forward a few inches
5. Walk your bottom back to starting position
6. Repeat 5 times



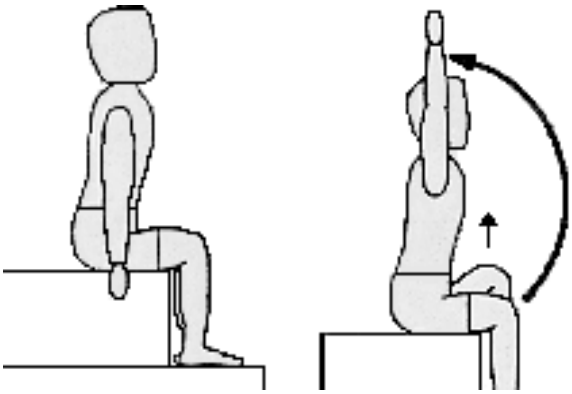
Sitting Knee Lifts II

1. Sit on bed
2. Put arms across chest
3. Lift left knee up towards ceiling
4. Lower left knee
5. Lift right knee up towards ceiling
6. Lower right knee
7. Repeat 10 times



Sitting March II

1. Sit on bed
2. Arms by side
3. Keep knees bent
4. Lift right leg and left arm
5. Lower knee and arm
6. Lift left leg and right arm
7. Lower knee and arm
8. Repeat 10 times

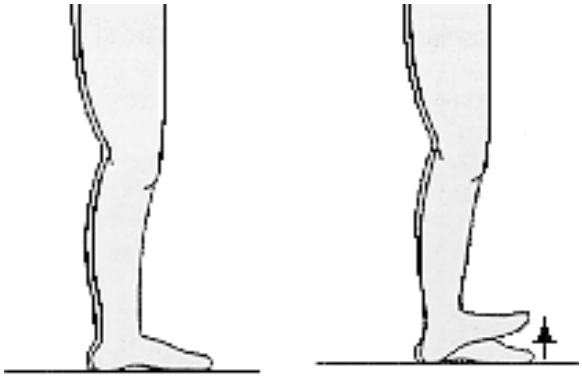


With permission from M. Gottschalk, MS, PT (Yale FICSIT).

Special Appendix XII: Balance Exercises (Level III)

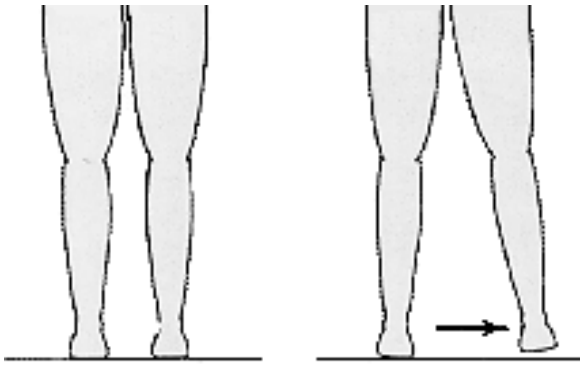
Heel Stand II

1. Stand facing sink
2. Hold on with both hands
3. Rock back on heels raising toes off the floor
4. Hold this position for count of 5
5. Return to normal standing position
6. Repeat 5 times



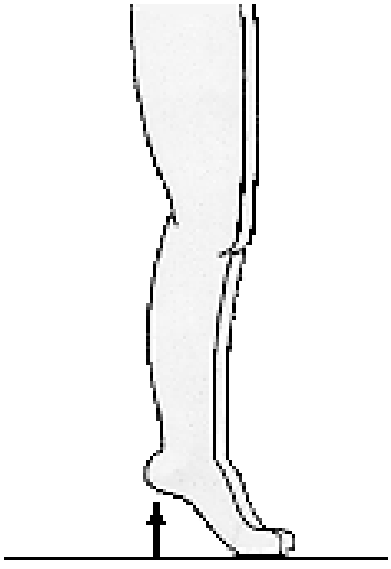
Sink Side Step III

1. Stand facing sink
2. Hold on with one hand
3. Move hand along sink as you step to left 5 steps
4. Step to right 5 steps



Sink Toe Stand III

1. Stand facing sink
2. Do not hold onto the sink
3. Go up on four toes
4. Hold for count of 5
5. Then come down
6. Repeat 10 times

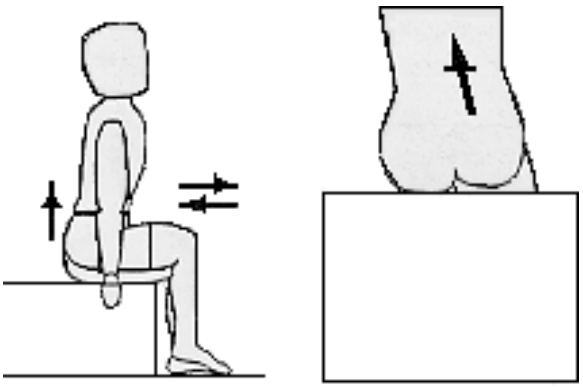


With permission from M. Gottschalk, MS, PT (Yale FICSIT).

Special Appendix XII: Balance Exercise (Level III, *continued*)

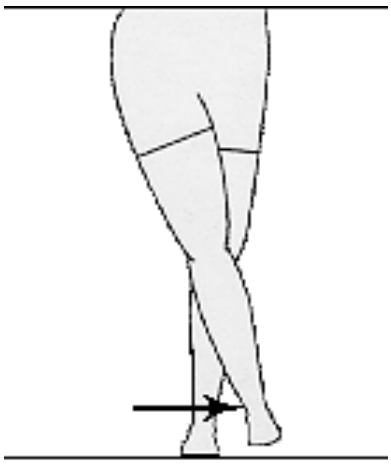
Do the exercises marked by your doctor TWICE a day.

The Bedwalk III



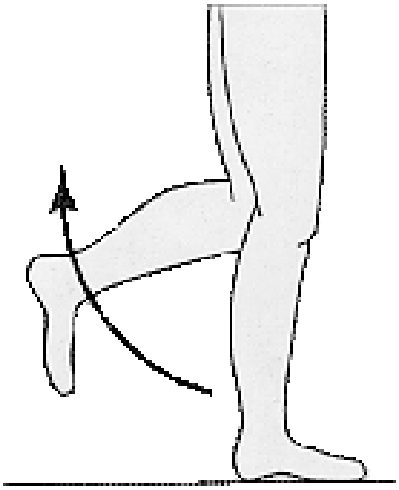
1. Sit on the edge of bed
2. Feet flat on floor
3. Fold arms across chest
4. Shift weight side to side "walking" your bottom forward a few inches
5. Walk your bottom back to starting position
6. Repeat 5 times

Sink Leg Cross III



1. Stand facing sink
2. Hold on with both hands
3. Move hands along sink as you step
4. Cross left foot in front of right foot
5. Cross right foot behind left foot
6. Repeat steps 4 & 5 three times
7. Now, cross right foot in front of left foot (reverse directions)
8. Cross left foot behind right foot
9. Repeat steps 7 & 8 three times

One Leg Sink Stand III

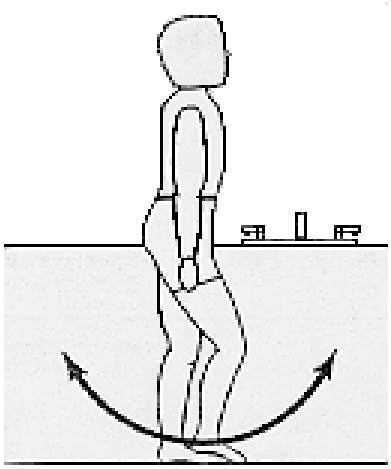


1. Stand facing sink
2. Do not hold onto the sink
3. Stand on your left leg for count of 5
4. Stand on your right leg for count of 5
5. Do each leg 10 times

With permission from M. Gottschalk, MS, PT (Yale FICSIT).

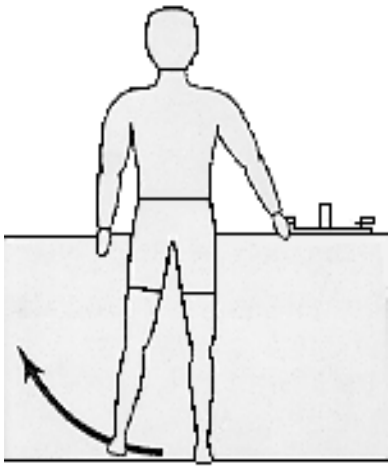
Sink Leg Swing III

1. Stand with left side toward sink
2. Hold on with left hand
3. Gently swing right leg forward and backward as far as safe
4. Repeat 10 times
5. Turn around
6. Hold on with right hand
7. Swing left leg
8. Repeat 10 times



Sink Leg Lift III

1. Stand with left side toward sink
2. Hold on with left hand
3. Lift right leg out to side and back
4. Repeat 10 times, turn around
5. Hold on with right hand
6. Lift left leg out to side and back
7. Repeat 10 times



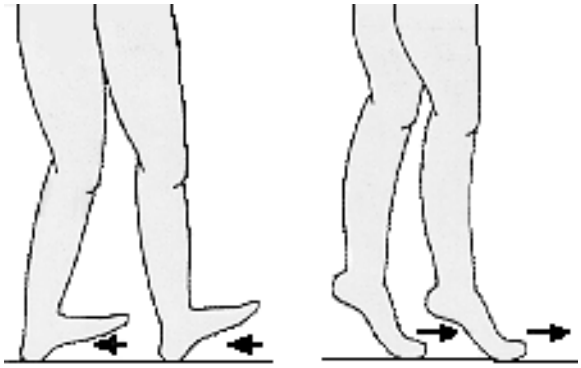
With permission from M. Gottschalk, MS, PT (Yale FICSIT).

Special Appendix XII: Balance Exercises (Level IV*)*

Do these exercises marked by your doctor TWICE a day.

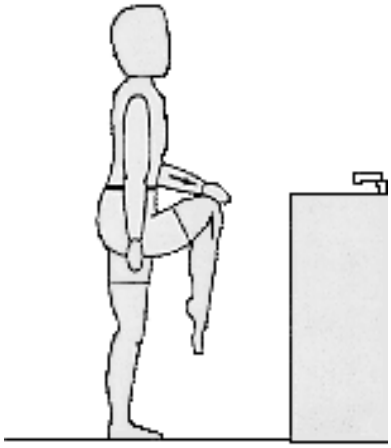
Heel Toe Walk IV

1. Stand facing sink
2. Hold on with both hands
3. Do not let go of sink while moving
4. Walk backwards on heels 4 small steps
5. Walk forwards to sink on toes 4 small steps
6. Repeat 10 times



Standing Arm and Leg March IV

1. Stand facing sink
2. Raise right knee up
3. Touch right knee with left hands
4. Lower right knee
5. Now raise left knee up
6. Touch left knee with right hand
7. Lower left knee
8. Repeat 10 times



With permission from M. Gottschalk, MS, PT (Yale FICSIT).

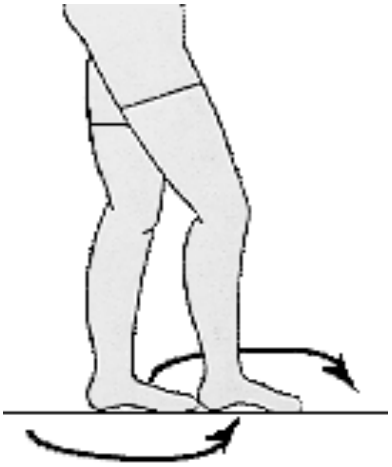
Special Appendix XII: Balance Exercises (Level IV, continued)

Tandem Walking IV

1. Stand with left side toward sink
2. Hold on with left hand
3. Move hand along sink as you step
4. Place right heel directly in front of toes of left foot
5. Now place left heel directly in front of toes of right foot
6. Repeat steps 4 and 5 three times
7. Turn around
8. Hold with right hand
9. Repeat steps 4 and 5 three times

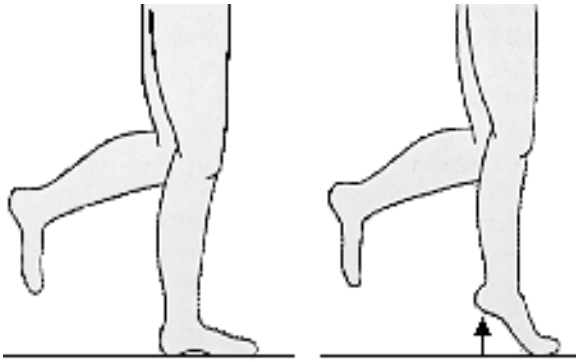
Cross-Over Walk IV

1. Stand with left side toward sink
2. Hold on with left hand
3. Move hand along sink as you step forward
4. Cross left foot over right foot
5. Cross right foot over left foot
6. Repeat steps 4 and 5 three times
7. Turn around
8. Hold on with right hand
9. Repeat steps 4 and 5 three times



One Leg Sink Toe Stand IV

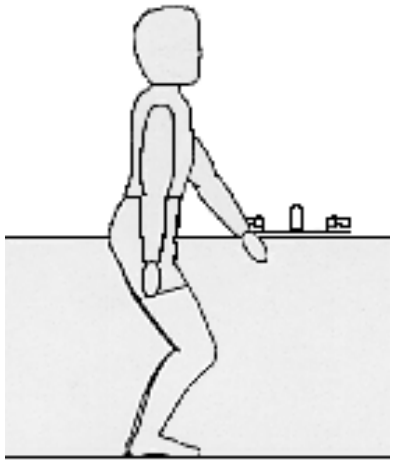
1. Stand facing sink
2. Hold on with both hands
3. Stand on right leg
4. Push up on toes of right foot
5. Hold for count of 5
6. Then come down
7. Repeat 5 times
8. Stand on left leg
9. Push up on toes of left foot
10. Hold for count of 5
11. Then come down
12. Repeat 5 times



With permission from M. Gottschalk, MS, PT (Yale FICSIT).

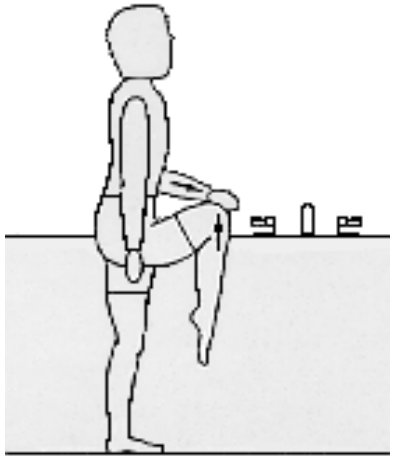
Special Appendix XII: Balance Exercises (Level V)

Two Leg Sink Lunge V



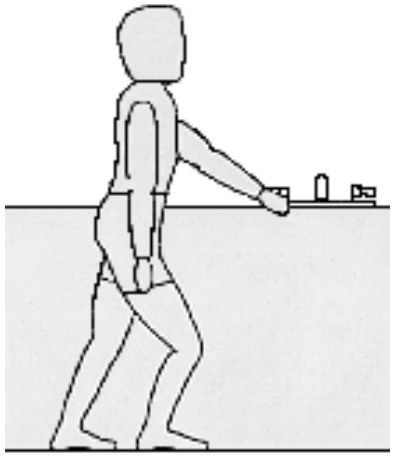
1. Stand facing kitchen/bathroom sink
2. Stand with feet together
3. Hold on with _____ hand(s)
4. Lunge right to the side
5. Return to standing position with feet together
6. Lunge left to the side
7. Return to stand position with feet together

Knee Lifts V



1. Stand facing sink
2. Raise right knee up
3. Touch right knee with left hand
4. Lower right knee
5. Now raise left knee up
6. Touch left knee with right hand
   Repeat _____ times

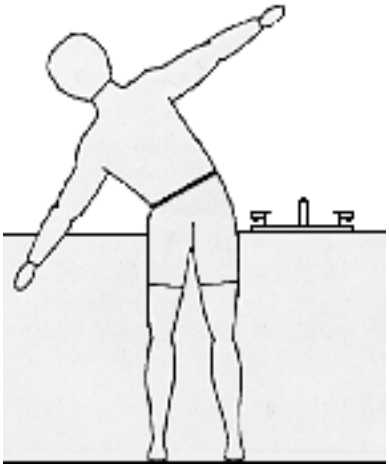
Forward Lunge V



1. Stand with side to sink
2. Hold on with _____ hand
3. Lunge forward with right foot
4. Return to start position
5. Lunge forward with left foot
6. Return to start position
   Repeat _____ times

With permission from M. Gottschalk, MS, PT (Yale FICSIT).

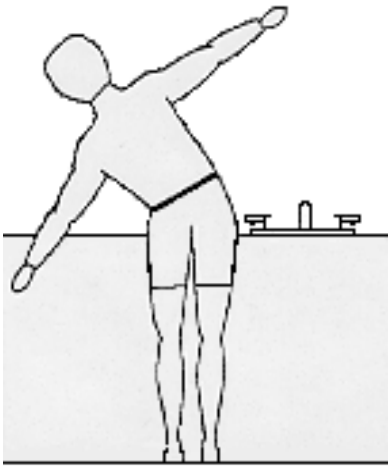
Side Bend, Feet Apart V



1. Stand near sink
2. Stand with feet one foot apart
3. Arms out to side at shoulder height
4. Tip left arm down
5. Return to upright position
6. Tip right arm down
7. Return to upright position

Repeat _____ times

Side Bend, Feet Together V

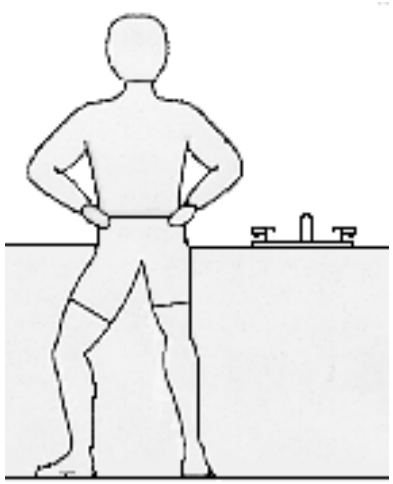


1. Stand near sink
2. Stand with feet together
3. Arms out to side at shoulder height
4. Tip left arm down
5. Return to upright position
6. Tip right arm down
7. Return to upright position

Repeat _____ times

With permission from M. Gottschalk, MS, PT (Yale FICSIT).

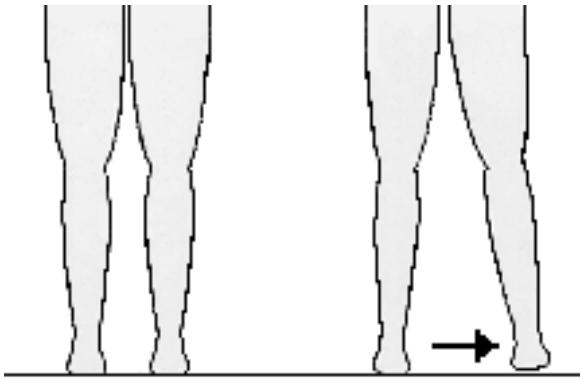
Side Lunge, Hands on Hips V



1. Stand near sink
2. Hands on hips
3. Lunge forward on left foot
4. Return to upright position
5. Lunge to side on left foot
6. Return to upright position
7. Lunge forward on right foot
8. Return to upright position
9. Lunge to side on right
10. Return to upright position

Repeat _____ times

Side Step V



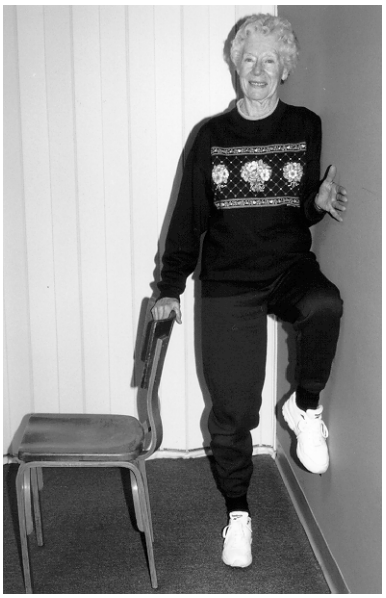
1. Stand facing sink
2. Arms at side
3. Side step 4 steps to right
4. Side step 4 steps to left

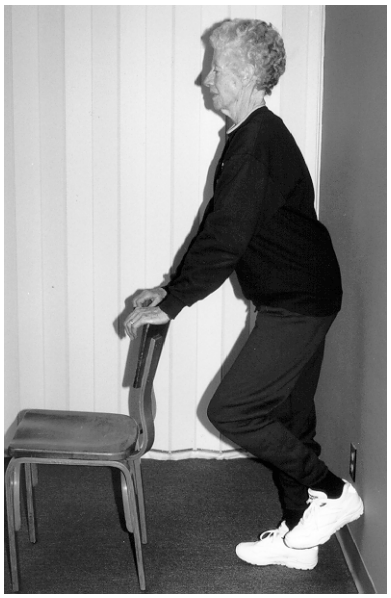
Repeat _____ times

With permission from M. Gottschalk, MS, PT (Yale FICSIT).

Special Appendix XIII: Wall Push Exercise

The wall push is an exercise that will help improve lower extremity strength and balance. The patient stands sideways against a wall, holding onto a chair to provide stability. The elbow, hip and knee nearest the wall are all flexed to about 90 degrees. The patient pushes against the wall while trying to maintain balance. The instructions are to breathe and hold for 3-10 seconds. Exercise both sides. One formula is to do 6 repetitions of 6 second holds twice a day. The patient may or may not do this with a "small foot." Good posture should be emphasized.

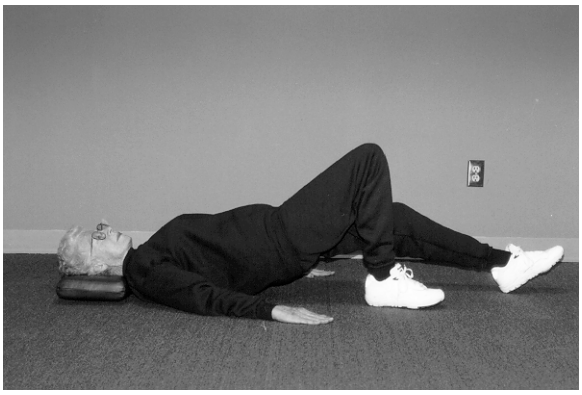




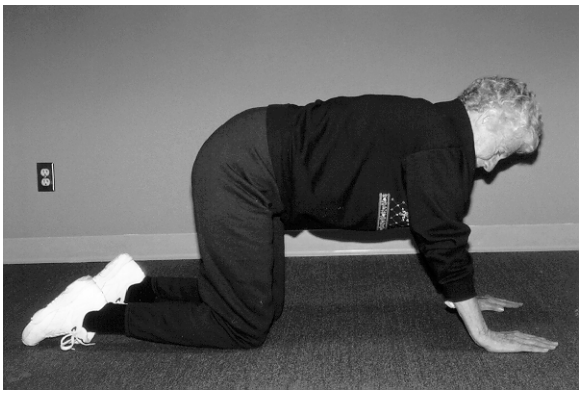
Special Appendix XIV: Floor Exercises

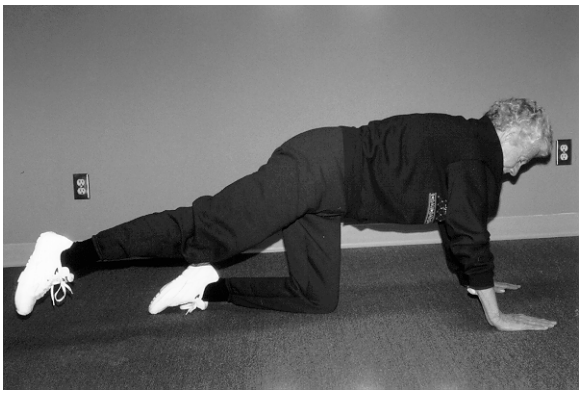
The Bridge

This exercise will target the gluteal muscles and the quadriceps. One result will be greater unconscious control in protecting and stabilizing the low back. The patient should find a comfortable "neutral" pelvis, stabilize it by gently contracting the abdomen, and then slowly lift his/her buttock off the floor. Be careful not to allow the patient to arch into hyperextension. If this can be done easily, the exercise can be made sequentially more challenging by lifting one heel off the ground, by lifting one foot, by extending one leg, or by drawing both heels closer to the buttocks and starting this sequence over again. The patient should hold the position for several seconds or until s/he starts to shake, the pelvis tips from the horizontal, or until neutral pelvis or the abdominal bracing is lost. When this occurs, the patient should repeat the exercise at a simpler level. Work up to 10 repetitions. (For more information, see the protocol Lumbar Stabilization, The Bridge Track.)



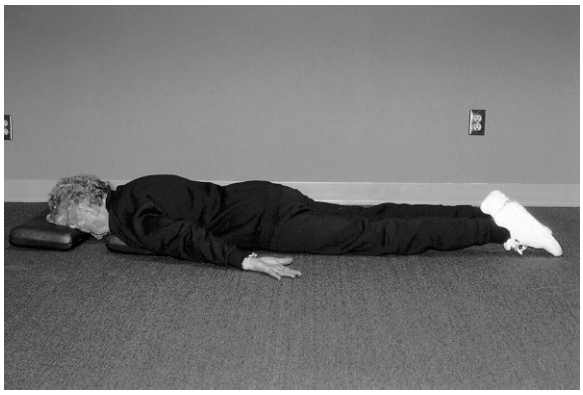
The Quadruped Leg Kick



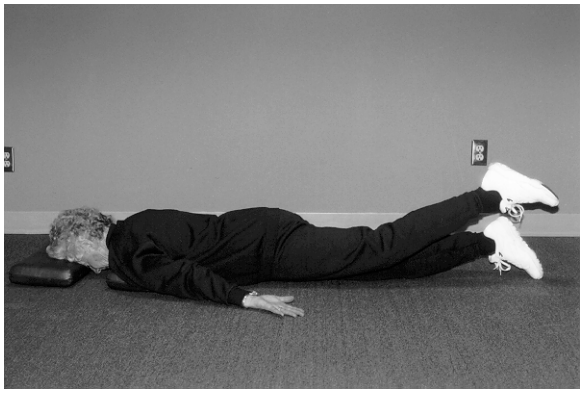


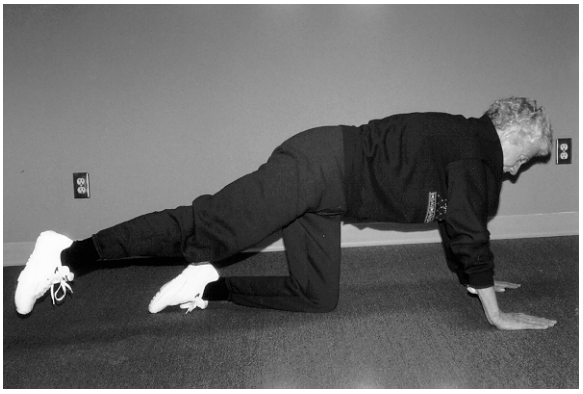
Special Appendix XIV: Floor Exercises, continued…

Prone Leg Lift



This exercise targets the gluteal maximus muscles. The patient lies on his/her stomach. Rolled up towels underneath the forehead and pelvis should make this position more comfortable. The pelvis should be held in a pain-free, neutral range, and stabilized by gently contracting the abdomen. The leg is slowly lifted off the floor. Be careful not to allow the patient to arch into hyperextension. The patient should hold the position for several seconds or until s/he starts to shake, or until neutral pelvis or the abdominal bracing is lost. When this occurs, the patient should lower the leg and relax for a moment. Work up to 10 repetitions. (For more information, see the protocol Lumbar Stabilization, The Prone Track.)





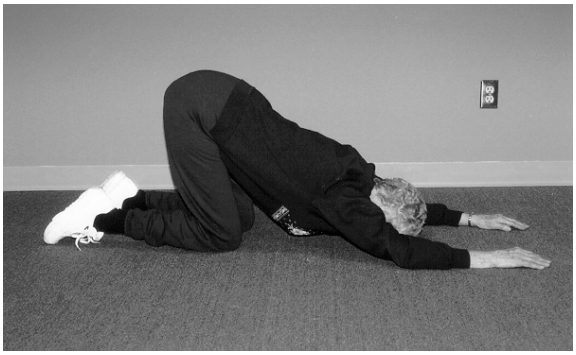
Special Appendix XV: Extension Flexibility Exercises

In this stretching exercise, the patient places his/her arms against a wall and, allowing his/her body to sag forward, decreases the upper thoracic kyphosis. This should be done in a deliberate, relaxed way. In the standing version, the arms are extended straight up the wall, providing a stretch to the pec muscles. The feet must not be too close to the wall or there will not be adequate upper back extension. In the seated version, the arms are folded and placed against the wall just above the patient's head. This exercise is also useful for patients who have post-vertebral fracture pain and kyphosis.

Wall Arch

Cat Stretch

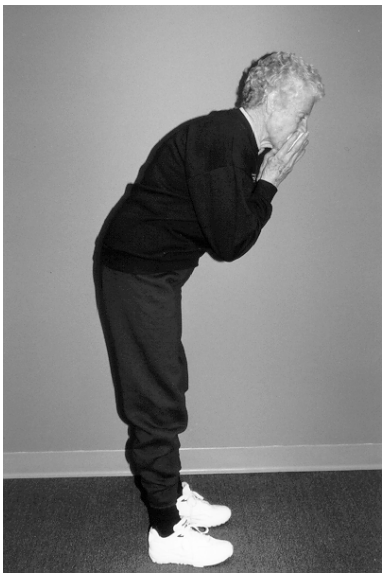
This stretch will also increase extension flexibility. The patient reaches her arms far out in front of her, drops her buttock towards her heels, and allows her sternum to sag to the floor. By adjusting the length of her reach and how far she drops back toward her heels, the "fulcrum" can be moved until it is felt in the upper thoracic area. Again, this should be done as a slow, relaxation exercise.

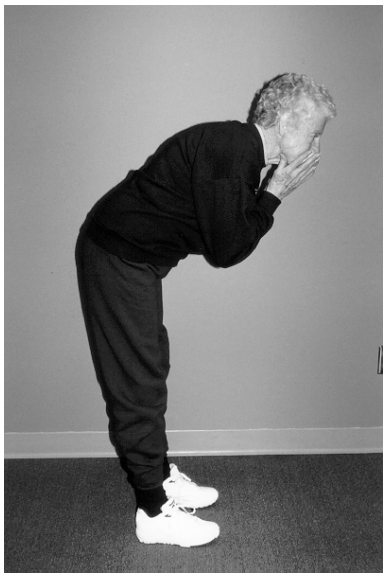


Special Appendix XVI: Avoiding Stress to Bones and Joints When Coughing

Even coughing or sneezing can sometimes cause fractures in osteoporotic patients. The patient should be taught to support the back whenever coughing or sneezing. This can be done by placing the hand in the small of the back and gently leaning backwards over it or by bracing the upper body with a hand on the thigh. Once patients have been taught one of these methods, they should be demonstrated on subsequent visits to see that they are being done correctly. The practitioner should reinforce that these protective poses must become part of an automatic behavior pattern.

Wrong Way





Better Ways