**Standard of Care: Osteoporosis**

**Case Type / Diagnosis:** Osteoporosis 730.2, Vertebral Fracture closed 805.8

**Definition:** Osteoporosis is characterized by the presence of both low bone mass and a disruption of normal bone architecture which results in loss of bone strength. According to the World Health Organization (WHO) the operational definition is a bone density measure >2.5SD below the mean of young healthy adults of similar race and gender. Osteoporosis can also be categorized as primary or secondary. Primary refers to the bone loss that results either from normal aging, hormone alterations associated with menopause, or is idiopathic. Secondary osteoporosis refers to bone loss occurring as a result of another disorder such as endocrine dysfunction, neoplasia, GI dysfunction, or as a side effect of certain drugs such as corticosteroids. Secondary osteoporosis can also be the result of immobilization.

**Epidemiology:** Osteoporosis affects greater than 10 million people in the US. An estimated 30% of post-menopausal females have osteoporosis. There are 1.3 million osteoporotic fractures yearly in the US. About 50% of these fractures occur in the vertebra and the other half mostly consist of fractures in the hip and wrist (Colle’s fractures). Osteoporosis is associated with a four-fold increase in fracture rate. Risk factors are outlined in the table below.

<table>
<thead>
<tr>
<th>Non-modifiable risks</th>
<th>Potentially modifiable risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>previous fracture as an adult</td>
<td>current cigarette smoking</td>
</tr>
<tr>
<td>history of fractures in a first-degree relative</td>
<td>low body weight (&lt;58kg)</td>
</tr>
<tr>
<td>female sex</td>
<td>estrogen deficiency</td>
</tr>
<tr>
<td>advanced age</td>
<td>low calcium intake</td>
</tr>
<tr>
<td>Caucasian race</td>
<td>alcoholism</td>
</tr>
<tr>
<td>dementia</td>
<td>impaired eyesight</td>
</tr>
<tr>
<td>recurrent falls</td>
<td>inadequate physical activity</td>
</tr>
<tr>
<td></td>
<td>poor health/frailty</td>
</tr>
</tbody>
</table>

**Pathogenesis:** Total bone mass peaks during young adulthood and is influenced by physical activity, genetic factors and nutrition. The cycle of bone activation, resorption and formation lasts 3-4 months. Osteoporosis occurs when a mismatch exists between bone formation and bone resorption. Bone loss can occur as a result of increased osteoclast activity and/or decreased osteoblast activity. Age related bone loss begins in the 4th or 5th decades and results in slow loss (0.7% yearly) of cortical and cancellous bone in both sexes. For females, bone loss is accelerated by estrogen deficiency, which can occur with menopause and amenorrhea. During menopause, loss of bone occurs at a rate of 2% of cortical bone and 9% of cancellous bone.
yearly. This continues for about 10 years at which time the rate of bone loss returns to the rate occurring with normal aging, which is about 0.7% and equal for males and females.\textsuperscript{11}

Osteoporosis may also be the result of glucocorticoid use which is common in the treatment of chronic lung disorders, rheumatoid arthritis and other connective tissue diseases, inflammatory bowel disease and post-transplantation. Bone loss is more rapid during the early months with fractures increasing within 3 months of treatment. It affects trabecular bone more than cortical bone.\textsuperscript{7}

**General Medical Management:**

Non-pharmacologic recommendations: diet: adequate calorie intake, calcium, vitamin D; weight-bearing exercise several times per week.

Pharmacologic: Estrogen/progestin treatment initially was the pharmacologic treatment of choice however with its cancer and cardiovascular risks other drugs have taken a more prominent position.\textsuperscript{10}

Over the last ten years drug treatment has come to include the following:

- Bisphosphonates such as alendronate and risedronate (ie Fosamax\textsuperscript{®} and Actonel\textsuperscript{®} respectively): these drugs impair osteoclastic function and also reduce the number of osteoclasts. Furthermore they seem to have increased skeletal retention (about 10 years for alendronate) allowing long term effects whereas the beneficial effects of estrogen decline after the drug is stopped. Bisphosphonates are also the only drug to demonstrate reduction in fracture risk in large clinical trials for patients on glucocorticoids.\textsuperscript{3,7}

- Selective estrogen receptor modulators (SERMs) such as Raloxifene (Evista\textsuperscript{®}): the estrogen drugs act to reduce bone turnover by inhibiting osteoclasts directly. SERMs act similarly however they have increased tissue selectivity and therefore can be tailored to individual needs. The exact physiological mechanism is unknown and is an area of ongoing investigation. Studies show that women who take estrogen have a 50% reduction of osteoporotic fractures.\textsuperscript{7,10}

- Parathyroid hormone (Forteo\textsuperscript{®}): responsible for calcium homeostasis. Chronic elevation is associated with bone loss but mild, intermittent elevations help maintain trabecular bone mass by affecting osteoblasts. This permits an increase in bone thickness as well as a restoration of the microarchitecture.\textsuperscript{7}

- Calcitonin (Miacalcin\textsuperscript{®}) and/or vitamin D: calcitonin appears to suppress osteoclasts through a direct effect on the calcitonin receptor of the cell. While it is associated with small increments in bone mass it is not indicated for prevention of osteoporosis. One of it’s greatest uses is for the analgesic effect it has on bone pain.\textsuperscript{7}

**Indications for Treatment:** Patients with osteoporosis may present to physical therapy at various stages of the disease and under a variety of circumstances. Often they are referred to physical therapy after sustaining a fracture, after kyphoplasty or vertebroplasty. In less severe cases they may present with musculoskeletal dysfunction, postural dysfunction, decreased balance, altered gait, pain, and/or impaired function (ADLs, walking, recreational activity intolerance). Furthermore, patients may present to physical therapy for management of a different condition but have risk factors for osteoporosis or may have been diagnosed but are currently asymptomatic. In cases where osteoporosis is encountered as a comorbid condition it
must be taken into consideration as a secondary rehabilitation diagnosis as it may impact
evaluation and intervention such as positioning and exercise prescription.

Contraindications / Precautions for Treatment:

2. Joint mobilization

There is limited research investigating the risks associated with spinal mobilization. In a rare study by Sran et al the authors investigate the safety of spinal mobilization as it relates to failure loads in the thoracic spine. The study seeks to quantify failure loads in cadaveric thoracic spines (in vitro) and compare it to the force applied by physical therapists during posteroanterior (PA) joint mobilizations on human volunteers (in vivo). They find a significant difference between the in vitro and in vivo forces for most specimens. However, the lowest in vitro fracture thresholds are about the same amount of force as the upper range of applied loads by the physical therapists. Out of 12 subjects one cadaveric thoracic spine failed at a level of force below the maximum force generated by the therapist on human volunteers. Furthermore, all fractures occurred at the spinous process, therefore vertebral body injury was an unlikely sequelae of PA mobilization. The study also concludes that bone mineral density of the whole vertebra is not a good predictor of PA failure load and should not be relied on to assess fracture risk.

Examination:

Medical History: Note history of fractures, falls, and surgeries; inquire regarding other diagnoses associated with increased risk of osteoporosis (ie endocrine, nutritional/GI, rheumatologic, hematologic disorders or hypogonadal states). Note the presence of any of the risk factors documented previously and consider whether they are modifiable or not.

Imaging: Several imaging techniques are useful for assessing the skeleton. Radiographs are commonly used however are not reliable for detecting osteoporosis until 30-40% bone loss has occurred. Bone mass density (BMD) can be measured by dual energy x-ray absorptiometry (DXA), single x-ray absorptiometry (SXA), peripheral densitometry, quantitative CT or ultrasound. DXA uses x-rays at two energy levels to determine bone mineral content. Peripheral densitometry scans are becoming more common and may involve ultrasonography of the heel or DXA that measures the calcaneus, radius and ulna, or phalanges. CT scans measure the spine, or peripherally, the forearm or tibia. CT is valuable as it can provide the true density (bone mass per unit volume due to its three dimensional nature), however it is expensive, less reproducible, and involves increased radiation exposure. Ultrasound measures bone mass by calculating the speed at which the sound wave passes through the bone but it is unclear whether ultrasound can assess bone quality.

As DXA seems to be the most commonly used and the report is easily accessed through LMR it will be reviewed more in depth here. Sites typically measured are the first four lumbar vertebra and the proximal femur. Once the data is obtained from the scan it is compared to reference data (which is scanner specific) and the results are expressed as the T score and Z score.
The T score compares the bone density with that of the mean value in young adult white women and is expressed in standard deviations from the mean.

The WHO has established diagnostic categories according to T score: Normal: 0 to -0.99, Osteopenia: –1 to –2.499, osteoporosis: <= -2.5, Severe Osteoporosis <=-2.5 with fracture. It should be noted that the original intent of these categories was to assess prevalence of the disease and not to be used as thresholds for intervention.

The Z score compares bone mineral density with that of the mean value in a population of similar age, sex, and height. This score is useful in determining likelihood of secondary osteoporosis that may occur with malignancy, for example.

The DXA report generally includes the patient’s scores, percent change from previous tests, risk factors, diagnosis based on WHO criteria, relative risk for fracture, and recommendations for treatment.

Limitations of DXA: the placement and sizing of the region must be consistent on subsequent scans. In fact, the area must be within 2% of original scan to make the comparison valid. The reference data is based on normal anatomy. The modification or absence of anatomical structures (such as is the case of bone spurs from osteoarthritis or of laminectomy) can alter the accuracy of the DXA. Each scanner uses its own reference data so it is important to use the same scanner on subsequent tests to ensure accuracy and consistency of the test.\textsuperscript{7,9}

**History of Present Illness:** Chief complaint or mechanism of injury, date of injury or duration of symptoms (of particular importance with Medicare patients), treatment to date, reason for referral, prior level of function, previous PT and any exercise program. Also inquire about patient’s own goals.

**Social History:** Home environment including lighting, rugs and ambulatory hazards, rails, stairs, bathtub arrangement; family/social support, hobbies, sports.

**Medications:** Patients with osteoporosis may be managed with Fosamax®, Actonel®, Miacalcin®, Evista®, estrogen replacement therapy, and parathyroid hormone. Estrogens are mainly used by post-menopausal women for fracture prevention. Biphosphonates are typically used for women with established osteoporosis as well as to treat steroid-induced osteoporosis. They are effective also in women who already have fractures. Calcitonin is not indicated for prevention and does not appear to be powerful enough to prevent bone loss. If the patient has had a fracture an anti-resorptive drug is needed, such as bisphosphonates, calcitonin, and/or estrogens. The use of glucocorticoids, heparin, lithium, and anticonvulsants is associated with increased risk of osteoporosis.\textsuperscript{7} Also note dietary supplements.

**Examination:** (Physical / Cognitive / applicable tests and measures / other)
This section is intended to capture the minimum data set and identify specific circumstance(s) that might require additional tests and measures.
**Pain:** Per Visual Analog Scale (VAS) scale, aggravating/alleviating factors, location, quality, frequency, duration. Vertebral fractures can be asymptomatic, in fact only about 25-30% present with acute onset back pain.  

**Posture:** May be at extremes of forward head and rounded shoulders, have a dowager’s hump, altered scapular position, thoracic kyphosis, and/or scoliosis. Note if the patient is able to correct the faulty posture and sustain it. Identify if patient is frequently in a sitting posture and observe this. Inquire about sleeping positions including number of pillows under head and/or pillow arrangement used for comfort, elevation, or support. Also inquire about the patient’s awareness of any loss in height.

**ROM:** Select areas to test based on patient’s history and involved area, but may include any of the following: cervical, thoracic and lumbar spine; shoulders; elbow; wrist; hips; or other areas as indicated by examination. If patient is s/p fracture or vertebroplasty observe MD/surgeon orders and precautions.

**Muscle length:** Hip flexors, hamstrings, and gastrocnemius because of these muscles’ influence on posture and balance. If there is thoracic or shoulder involvement, periscapular muscle length, such as rhomboids, middle trapezius, serratus, and pectorals may need to be investigated. For cervical issues examine muscle length of cervical flexors and extensors.

**Strength:** MMT of UE, LE and core strength including gluteus medius, gluteus maximus, and the abdominals. Precaution must be taken in applying resistance in patients with severe osteoporosis. MMT also may not be indicated in patients who are post-operative, and therefore proceed according to MD orders.

**Balance:** Depending on the functional level of the patient as well as their history the physical therapist should select the measure best suited to the patient’s activity tolerance and level of function. This may include any of the following: single-leg stance, tandem stance, weight shifting, Romberg, functional reach, Berg, Timed Up and Go, Tinetti.

**Function:** Bed mobility, transfers, stairs

**Gait:** Pattern/deviations, need for assistive device, appropriateness of current device, footwear

**Evaluation / Assessment:**

Establish Diagnosis and Need for Skilled Services

**Problem List** (Identify Impairment(s) and/or dysfunction(s))

- Pain
- Impaired posture
- Impaired ROM
- Impaired strength
- Impaired functional mobility/gait
- Impaired balance
- Impaired knowledge of condition and of symptom management

**Standard of Care:** Osteoporosis

Copyright © 2007 The Brigham and Women's Hospital, Inc. Department of Rehabilitation Services. All rights reserved.
**Prognosis:** Variable as outcomes will be affected by age, prior function, comorbidities, fracture and fall history, social support.

**Goals** (with measurable parameters and specific timelines):
1. Decrease pain and increase independence with symptom management
2. Increase ROM and improve self correction of posture
3. Increase strength
4. Independent with transfers
5. Independent with ambulation with least device
6. Improve balance
7. Demonstrates knowledge of joint protection techniques, fall and fracture prevention
8. Independent with home exercise program

**Age Specific Considerations:** Bone mass naturally decreases with age so patients with osteoporosis are often elderly and may present with multiple comorbid conditions. Take into account the effects of these conditions in assessment and intervention.

**Treatment Planning / Interventions**

<table>
<thead>
<tr>
<th>Established Pathway</th>
<th>___ Yes, see attached.</th>
<th><em>x</em>_ No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Established Protocol</td>
<td>___ Yes, see attached.</td>
<td><em>x</em>_ No</td>
</tr>
</tbody>
</table>

**Interventions** most commonly used for this case type/diagnosis:

- Posture training: cervical, shoulders, thoracic etc in positions indicated (sitting, standing, sleeping etc). May benefit from positioning supports such as pillows, wedges, rolls as well as corsets and braces as comfort measures.
- Stretching: correct any muscle length imbalances of hamstrings, iliopsoas, rectus femoris, gastroc/soleus, periscapular muscles, cervical muscles
- Strengthening: target areas (spine vs extremity) as identified during assessment, implement free weights, theraband, and emphasize weight bearing exercise as tolerated.
- Balance training: single-leg stance on firm and soft surfaces, weight shifting, reaching outside BOS, tandem stance, braiding, beam exercises, etc
- Transfer/gait training with assistive device
- Aerobic exercise: e.g. treadmill walking

*Type: A meta-analysis of 18 randomized trials reported aerobics, weight bearing exercise, and resistance exercises all appear to be effective on bone mass density (BMD) of the spine in postmenopausal women. Walking is shown to be effective on BMD of the spine and the hip. These findings are limited however due to poor quality of allocation concealment and blinding in many of the trials.*

**Standard of Care: Osteoporosis**

Copyright © 2007 The Brigham and Women's Hospital, Inc. Department of Rehabilitation Services. All rights reserved.
**Frequency/duration:** A prospective cohort study of 61,000 postmenopausal women found that women who walked >= 4 hours/week had a 41% lower risk of hip fracture than those who walked <=1 hour/week.4

**Intensity:** There is not convincing evidence to suggest that high-intensity exercise (such as running) is of greater benefit than lower intensity exercise (such as walking). In older women, except for very vigorous regimens, the beneficial effect of any weight bearing exercise on bone density is small; rather the decrease in fractures is attributed to increased muscular strength.5

Also it cannot be concluded that exercise programs provide any lasting effect once they are discontinued.2,4

Additional research is needed to more precisely define the optimal treatment regime. The studies to date provide mixed results and the quality of the methodology is low in many of them.2,13

- Patient education regarding body mechanics, joint protection techniques including potential benefit of hip protector pads, home exercise program and exercise progression, proper footwear, positioning, posture awareness, symptom management and use of heat/cold. Also may want to refer patient to the National Osteoporosis Foundation website ([www.nof.org](http://www.nof.org)) for additional resources and support.
- Modalities as indicated for pain relief, musculoskeletal complaints

**Frequency & Duration:** Variable, about 1-2x/wk for 4-8 weeks

**Patient / family education:**
Pathology, home safety, body mechanics, benefit of regular, long-term exercise, home exercise program (HEP). HEP will vary as it is individually tailored to patients. Once short term goals are achieved optimal discharge home program includes 30 minutes 3x/week of moderate intensity weight bearing exercise.

**Recommendations and referrals** to other providers:
- orthotist for bracing needs (ie s/p compression fx),
- pain management
- endocrinologist
- rheumatologist
- nutritionist

**Re-evaluation / assessment**

- Standard Time Frame: 30 days
- Other Possible Triggers: significant change in symptoms and/or pain pattern, fall, change in posture, or successful completion of short term goals.

**Discharge Planning**

- Commonly expected outcomes at discharge are

---

**Standard of Care: Osteoporosis**

Copyright © 2007 The Brigham and Women's Hospital, Inc. Department of Rehabilitation Services. All rights reserved.
independence with HEP, safety with functional mobility, demonstration of good understanding of patient education regarding joint protection techniques.

Patient’s discharge instructions include a HEP, body mechanics, and home safety modifications, if applicable.

Written by: Diana Bodily 1/2005
Reviewed: Marie-Josee Paris 2/2005
Janice McInnes 3/2005

Bibliography / Reference List


Standard of Care: Osteoporosis
Copyright © 2007 The Brigham and Women's Hospital, Inc. Department of Rehabilitation Services. All rights reserved.


© 2005, Department of Rehabilitation Services, Brigham & Women’s Hospital, Boston, MA