Geriatric Fragility Fractures

Laura Phieffer, MD
Director of Orthopaedic Trauma
Clinical Co-Director of
The Fragility Fracture Program at
The Ohio State University Medical Center

Fragility Fracture

• Fractures that are a result of minimal trauma (i.e. from a fall from a standing height)
1.5 Million Fragility Fractures Annually

Vertebral Fractures: 700,000+
Wrist Fractures: 200,000+
Hip Fractures: 300,000+
Other Fractures: 300,000+

Source: National Osteoporosis Foundation, 2000

Fragility Fractures Due to Osteoporosis are Common

- 1 in 2 women and 1 in 5 men over age 50 will suffer a fracture in their remaining lifetime\(^1\)
- 55% of persons over age 50 are at increased risk of fracture due to low bone mass
- At age 50, a woman’s **lifetime risk of fracture exceeds** combined risk of breast, ovarian & uterine cancer
- At age 50, a man’s **lifetime risk of fracture exceeds** risk of prostate cancer

---

Osteoporosis-fracture Occurrences vs Other Diseases

![Chart showing annual incidence of common diseases]

Consequences of Hip Fracture

<table>
<thead>
<tr>
<th>Patients (%)</th>
<th>One year after hip fracture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unable to carry out at least one independent activity of daily living</td>
</tr>
<tr>
<td>Death within one year</td>
<td>24%</td>
</tr>
<tr>
<td>Permanent disability</td>
<td>30%</td>
</tr>
<tr>
<td>Unable to walk independently</td>
<td>40%</td>
</tr>
<tr>
<td>80%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Morbidity and Mortality of Fractures in Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Men account for 30% of hip fractures</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Morbidity and Mortality of Fractures in Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Men account for 30% of hip fractures</td>
</tr>
<tr>
<td>• Annual number of fractures in men should increase as U.S. population ages</td>
</tr>
</tbody>
</table>
# Morbidity and Mortality of Fractures in Men

- Men account for 30% of hip fractures
- Annual number of fractures in men should increase as U.S. population ages
- Mortality is higher for men following hip and vertebral fractures

---

# Osteoporosis Underdiagnosed

- Fewer than 5% of patients with fractures are referred for evaluation and treatment
Osteoporosis Underdiagnosed

- Fewer than 5% of patients with fractures are referred for evaluation and treatment
- Most older women with hip, wrist, or vertebral fracture received no drug treatment within 1 year

- At hospital discharge, 4.5% of men with hip fracture and 27% of women with hip fracture had treatment for osteoporosis
Definition of Osteoporosis

A skeletal disorder characterized by...

- Excessive osteoclast-mediated bone resorption
- Compromised bone strength
- Increased risk of fracture at all skeletal sites

"Osteoporosis is one of the most common and debilitating chronic diseases, and a global healthcare problem."

International Osteoporosis Foundation

"Osteoporosis has financial, physical, and psychosocial consequences, all of which significantly affect the individual, the family, and the community."

NIH Consensus Statement

Skeletal Form and Function

- The skeleton is a dynamic organ comprised of over 200 discrete bones with mechanical, protective, and metabolic functions
- Composed of two types of bone:
  - Cortical bone: Outer dense shell
  - Trabecular bone: Network of connecting plates inside the cortical shell
  - Bone remodeling (formation and resorption “bone turnover”) occurs throughout life
**Skeletal Form and Function**


**The Life Cycle of Bone**

- When bone turnover is increased, bone loss dominates

Bone Mass Is Lost in Age-Related Remodeling


Pathophysiology: Bone Strength

- Factors that influence bone strength
  - Bone mass (measured by BMD)
  - Remodeling frequency (bone turnover)
  - Bone size
  - Bone area
  - Microarchitecture
  - Degree of bone mineralization
Cortical Bone Geometry Changes With Age

Biomechanical Strength of Bone Decreases With Age

<table>
<thead>
<tr>
<th>Property</th>
<th>Loss/Decade, %</th>
<th>Loss from 20–80, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulus</td>
<td>–1.5</td>
<td>–7.5</td>
</tr>
<tr>
<td>Strength</td>
<td>–2.1</td>
<td>–11.0</td>
</tr>
<tr>
<td>Energy-to-failure</td>
<td>–6.8</td>
<td>–34.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Property</th>
<th>Loss/Decade, %</th>
<th>Loss from 20–80, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulus</td>
<td>–12.8</td>
<td>–64.0</td>
</tr>
<tr>
<td>Strength</td>
<td>–13.5</td>
<td>–67.5</td>
</tr>
<tr>
<td>Energy-to-failure</td>
<td>–14.0</td>
<td>–70.0</td>
</tr>
</tbody>
</table>

Who Has Osteoporosis and Low Bone Mass?

- More than 44 million Americans
- 1 in 2 women over 50 years old
Who Has Osteoporosis and Low Bone Mass?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 44 million Americans</td>
<td></td>
</tr>
<tr>
<td>1 in 2 women over 50 years old</td>
<td></td>
</tr>
<tr>
<td>1 in 4 men over 50 years old</td>
<td></td>
</tr>
</tbody>
</table>

Who Has Osteoporosis and Low Bone Mass?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 44 million Americans</td>
<td></td>
</tr>
<tr>
<td>1 in 2 women over 50 years old</td>
<td></td>
</tr>
<tr>
<td>1 in 4 men over 50 years old</td>
<td></td>
</tr>
<tr>
<td>Associated Costs</td>
<td></td>
</tr>
<tr>
<td>– $15 billion for care of fractures</td>
<td></td>
</tr>
</tbody>
</table>
Who Has Osteoporosis and Low Bone Mass?

• More than 44 million Americans
• 1 in 2 women over 50 years old
• 1 in 4 men over 50 years old
• Associated Costs
  – $15 billion for care of fractures
• 62 million in U.S. by 2020

U.S. Surgeon General 2004

“According to the Surgeon General, an estimated 10 million Americans over the age of 50 have osteoporosis while another 34 million have osteopenia or low-bone mass. This problem affects men and women of all ethnicities. Due to the aging of baby boomers, we will have many more people at risk over the next two decades.

It is vital that Americans know how to prevent and treat bone disease and take action that can lead to better bone health.”
2000–2010: National Bone and Joint Decade

• Goals
  – Raise awareness of the growing burden of musculoskeletal disorders on society
  – Empower patients to participate in decisions on their care
  – Promote cost-effective prevention and treatment
  – Advance understanding of musculoskeletal disorders through research to improve prevention and treatment

“The musculoskeletal system gives us support and the power to move. When things go wrong, people are in pain and their lives become limited. The goal of the Bone and Joint Decade...is to keep people moving, to enjoy fuller lives.”

Stuart L. Weinstein, MD; Bone and Joint Decade

The Fragility Fracture Program

• Improve processes and outcomes for older adults undergoing surgery for fragility fractures

“Multi-disciplinary approach with standardized protocols”

Fragility Fracture Program

Hospital
  In-patient

Clinic
  Out-patient
**Benefits of Inpatient Program**

- Streamlined admission process
- Standardized protocols decrease variability/delays to surgery
- Optimal fracture surgery within 24 hours of admission
- Daily evaluation to ensure earlier mobility and faster recovery
- Co-management with frequent communication to avoid errors and reduce adverse events

<table>
<thead>
<tr>
<th>Benefits of Inpatient Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Improved communication with patients, family and entire team</td>
</tr>
<tr>
<td>• Initiation of research and education</td>
</tr>
<tr>
<td>• Earlier initiation of rehabilitation and more effective use of discharge planning resources</td>
</tr>
<tr>
<td>• Screening for osteoporosis and plan management</td>
</tr>
</tbody>
</table>
Potential Impact

- Decreased time to surgical intervention =>
  - Decreased patient morbidity$^{1,2}$
  - Decreased patient mortality$^{1,2}$
  - Shorter length of stay$^{1,2}$
  - Increased likelihood to return to pre-injury status

2 Fisher AA J Orthop Trauma 2006

Potential Impact

- Cost savings$^{1}$
  - Estimate savings of $3879 /case
  - Assuming 350,000 hip fxs per year in the US => 1.36 billion dollars cost savings per year

2 Fisher AA J Orthop Trauma 2006
Increase awareness and treatment of osteoporosis

- Fewer than 5% of patients with fractures receive evaluation and treatment of osteoporosis, the underlying cause of most fragility fractures\textsuperscript{1,2}

- A prior fracture increases the risk of a new fracture 2- to 5-fold

- At hospital discharge, 4.5% of men with hip fracture and 27% of women with hip fracture had treatment for osteoporosis

1. Eastell et al. QJM 2001; 94:575-59

Increase awareness and treatment of osteoporosis

- Awareness and knowledge about osteoporosis is low among fracture patients

- Our response to a fragility fracture must include a determined attempt to prevent another one
  - Needs a system that achieves this automatically

1. Eastell et al. QJM 2001; 94:575-59
Fragility Fracture Program

- Hospital In-patient
- Clinic Out-patient

Step 1
Fragility Fracture Program

Hospital
In-patient

Clinic
Out-patient

Step 1
Identify at-risk individuals who require further evaluation

Step 2
**Step 1** Identify at-risk individuals who require further evaluation

**Step 2** Measure BMD for individuals at risk for osteoporosis

**Risk Factors - Osteoporosis**

- Female sex
- Thin or small frame
- Low body weight
- Hispanic or Caucasian race
- Low calcium intake
- Alcoholism (> 2 drinks/day)
Risk Factors - Osteoporosis

- Sedentary life style
- History of smoking
- Estrogen deficiency at an early age (< 45 years)
- Family history or personal history of fractures or osteoporosis
- Use of medications associated with accelerated bone loss (oral corticosteroids > 3 mo)

Osteoporosis in Men

- Gradual bone loss begins in men in their 30’s
- Unlike women, no universal reduction in hormone levels resulting in accelerated bone loss
- Men with hypogonadism may experience rapid bone loss
Ethnicity & Osteoporosis

• Hispanic women at highest risk
• Hispanic women tend to consume less calcium than the RDA
• Caucasian & Asian-American women also high risk

Ethnicity & Osteoporosis

• The average calcium intake among Asian-American women is about half that of their Caucasian counterparts
• While Asian-American women generally have lower incidence of hip fractures than Caucasian women, the prevalence of vertebral fractures is about equal between the two populations.
Ethnicity & Osteoporosis

• African-American women generally have higher bone density and are at somewhat lower risk than their Asian-American and Caucasian counterparts, this should not be taken to mean that there is no cause for concern among this population.

Ethnicity & Osteoporosis

• 10% of African-American women over 50 have Osteoporosis
• 80-95% of all fractures sustained by African-Americans 64+ are osteoporotic
• African-American women more likely to die from hip fractures than White women
# BMD Screening Recommendations for Postmenopausal Women

- National Osteoporosis Foundation¹

---


---

## BMD Screening Recommendations for Postmenopausal Women

- National Osteoporosis Foundation¹  
  - All women aged 65 and older regardless of risk factors

---

BMD Screening Recommendations for Postmenopausal Women

- National Osteoporosis Foundation¹
  - All women aged 65 and older regardless of risk factors
  - Younger postmenopausal women with 1 or more risk factors, other than being white, postmenopausal, and female

Patients Eligible for Medicare Coverage of BMD Testing

- Estrogen-deficient women at clinical risk for osteoporosis
- Individuals with vertebral abnormalities
- Individuals receiving, or planning to receive, long-term glucocorticoid therapy
- Individuals with primary hyperparathyroidism
- Individuals being monitored to assess the response or efficacy of osteoporosis therapy


WHO Definition of Low Bone Density and Osteoporosis Based on BMD
WHO Definition of Low Bone Density and Osteoporosis Based on BMD

- BMD value within 1 S.D. of young-adult mean (T-score at or above -1)

Normal
### WHO Definition of Low Bone Density and Osteoporosis Based on BMD

<table>
<thead>
<tr>
<th>Osteoporosis</th>
<th>Osteopenia/Low Bone Mass</th>
<th>Normal Bone</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.5 to -3</td>
<td>-2.0 to -1.5</td>
<td>-1.0 to -0.5</td>
</tr>
<tr>
<td>-1.5 to -2</td>
<td>-1.0 to -0.5</td>
<td>-0.5 to 0</td>
</tr>
<tr>
<td>-1.0</td>
<td>-0.5 to 0</td>
<td>Normal</td>
</tr>
</tbody>
</table>

**Normal**
- BMD value within 1 S.D. of young-adult mean (T-score at or above -1)

**Osteopenia**
- BMD value between -1 S.D. and -2.5 S.D. below young-adult mean (T-score between -1 and -2.5)
WHO Definition of Low Bone Density and Osteoporosis Based on BMD

<table>
<thead>
<tr>
<th>Osteoporosis</th>
<th>Osteopenia/Low Bone Mass</th>
<th>Normal Bone</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.5</td>
<td>-1.5</td>
<td>0</td>
</tr>
<tr>
<td>-1.5</td>
<td>-1.0</td>
<td>-0.5</td>
</tr>
<tr>
<td>-1.0</td>
<td>-0.5</td>
<td>-1.0</td>
</tr>
<tr>
<td>-0.5</td>
<td>-2.0</td>
<td>-1.5</td>
</tr>
</tbody>
</table>

**Normal**
BMD value within 1 S.D. of young-adult mean (T-score at or above -1)

**Osteopenia**
BMD value between -1 S.D. and -2.5 S.D. below young-adult mean (T-score between -1 and -2.5)

**Osteoporosis**
BMD value at least -2.5 S.D. below young adult mean (T-score at or below -2.5)
WHO Definition of Low Bone Density and Osteoporosis Based on BMD

- **Normal**
  - BMD value within 1 S.D. of young-adult mean (T-score at or above -1)

- **Osteopenia**
  - BMD value between -1 S.D. and -2.5 S.D. below young-adult mean (T-score between -1 and -2.5)

- **Osteoporosis**
  - BMD value at least -2.5 S.D. below young adult mean (T-score at or below -2.5)

- **Severe Osteoporosis**
  - BMD value at least -2.5 S.D. below young adult mean and presence of fracture
Relationship Between BMD and Fracture Risk

Geriatric Fragility Fractures

Suzanne Stanek, CNP
Clinical Co-Director of
The Fragility Fracture Program at
The Ohio State University Medical Center
Fragility Fracture Clinic

Fragility Fracture Program

Hospital
In-patient

Clinic
Out-patient

Fragility Fracture Clinic
Objectives

- To identify patients at increased risk of fragility fracture
- To offer appropriate information to patients regarding osteoporosis management and fall prevention
- To provide advice to PCPs on suitable interventions
- To provide interventions to reduce risk of fragility fracture
Prevention & Treatment of Osteoporosis

Lifestyle Changes
(Nutrition, Physical Activity and Fall Prevention)

Address Secondary Factors
(Drugs and Diseases)

Pharmacotherapy
(Antiresorptives and Anabolics)


Secondary Causes of Osteoporosis

Lifestyle Changes
(Nutrition, Physical Activity and Fall Prevention)

Address Secondary Factors
(Drugs and Diseases)

Pharmacotherapy
(Antiresorptives and Anabolics)

# Secondary Causes of Osteoporosis

<table>
<thead>
<tr>
<th>Genetic Disorders</th>
<th>Hemochromatosis</th>
<th>Homocystinuria</th>
<th>Hypophosphastasia</th>
<th>Idiopathic hypercalciuria</th>
<th>Marfan’s syndrome</th>
<th>Menke’s steely hair syndrome</th>
<th>Osteogenesis imperfecta</th>
<th>Porphyria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cystic fibrosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ehlers-Danlos</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glycogen storage diseases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaucher’s disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riley-Day syndrome</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypogonadal States</td>
<td>Hyperprolactinemia</td>
<td>Panhypopituitarism</td>
<td>Athletic amenorrhoea</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Androgen insensitivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anorexia nervosa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premature ovarian failure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endocrine Disorders</td>
<td>Cushing’s syndrome</td>
<td>Diabetes mellitus (Type 1)</td>
<td>Hyperparathyroidism</td>
<td>Thyrotoxicosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acromegaly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adrenal insufficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastrointestinal Diseases</td>
<td>Malabsorption</td>
<td>Celiac disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastrectomy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflammatory bowel disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hematologic Disorders</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemophilia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leukemias and lymphomas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rheumatic and Auto-Immune Diseases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ankylosing spondylitis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcoholism</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amyloidosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic metabolic acidosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anticoagulants (heparin)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anticonvulsants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cytotoxic drugs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glucorticoids and adrenocorticopin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thyroxine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tamoxifen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total parenteral nutrition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

# Additional Secondary Causes

<table>
<thead>
<tr>
<th>Hematologic Disorders</th>
<th>Multiple myeloma</th>
<th>Sickle cell disease</th>
<th>Systemic mastocytosis</th>
<th>Thalassemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leukemias and lymphomas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rheumatic and Auto-Immune Diseases</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ankylosing spondylitis</td>
<td>Lupus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcoholism</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amyloidosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic metabolic acidosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anticoagulants (heparin)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anticonvulsants</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cytotoxic drugs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glucorticoids and adrenocorticopin</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thyroxine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tamoxifen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total parenteral nutrition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# AACE-Recommended Laboratory Tests

<table>
<thead>
<tr>
<th>Complete Blood Count and Sed Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum Chemistry Studies</td>
</tr>
<tr>
<td>Calcium</td>
</tr>
<tr>
<td>Phosphorus</td>
</tr>
<tr>
<td>Pre-albumin</td>
</tr>
<tr>
<td>Alkaline phosphatase</td>
</tr>
<tr>
<td>Liver enzymes</td>
</tr>
</tbody>
</table>

# Lifestyle Changes

- Pharmacotherapy (Antiresorptives and Anabolics)
- Address Secondary Factors (Drugs and Diseases)
- Lifestyle Changes (Nutrition, Physical Activity and Fall Prevention)
Modifiable Risk Factors for Osteoporosis

- Inadequate calcium and vitamin D intake
- Physical inactivity
- Excessive alcohol
- Cigarette smoking
- Low body weight (127 lbs)

How Much Calcium?

Adult Women and Men 50+ years
1200-1500 mg
In 2 divided doses

Maximum 2,000 – 2,500 mg/day
### Calcium: Food Sources

<table>
<thead>
<tr>
<th>Dairy products</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Skim milk, 1 glass</td>
<td>300 mg</td>
</tr>
<tr>
<td>Yogurt, 6 oz fruit</td>
<td>200 mg</td>
</tr>
<tr>
<td>Cheese, 1 slice</td>
<td>204 mg</td>
</tr>
<tr>
<td>Cottage cheese, 1 cup</td>
<td>150 mg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fortified foods</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fortified cereal (Total ¾ c)</td>
<td>1,000 mg</td>
</tr>
<tr>
<td>Fortified orange juice, 1 c</td>
<td>300 mg</td>
</tr>
</tbody>
</table>

### Calcium Supplements

<table>
<thead>
<tr>
<th>USP approved</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Choices</td>
<td></td>
</tr>
<tr>
<td><strong>Calcium carbonate</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Calcium citrate</strong></td>
<td></td>
</tr>
</tbody>
</table>
**Calcium Carbonate**

- Requires acid for absorption
  - Take with meals
  - Don’t use if taking medication to reduce stomach acid
  - Aging?
- Low cost
- Constipation or upset?
- Tums, Oscal, Viactive Chews

---

**Calcium Citrate**

- Acid not required for absorption
  - Can take any time of day
  - Ok with medication to reduce stomach acid
- Costs more
- No constipation or upset
- 2 tablets twice a day
Risks of Calcium?

- Calcium Stones
  - Evaluate risk
  - Prevention strategies
    - Diet; hydration; thiazides
    - Calcium rich food sources
- Cardiovascular
  - Evaluate risk
  - Prevention strategies
    - Vitamin D supplements
    - Calcium rich food sources

### Synthesis and Metabolism of Vitamin D

- Cholesterol $\rightarrow$ 7-Dehydrocholesterol
  - UVB Radiation; Heat
- Previtamin D3
- Diet (D2 and D3) $\rightarrow$ Vitamin D3 (cholecalciferol) $\rightarrow$ Fat Cell
- Circulation
  - Liver
  - 25(OH)D (major metabolite)
  - Kidneys
  - 1,25(OH)2D (calcitriol, active form)
## Role of Vitamin D

- Regulate mineral metabolism
  - Calcium and phosphorous homeostasis
- Bone metabolism
- Muscle strength; fall reduction
- Parathyroid regulation
- Inhibit cell proliferation (psoriasis); promote cell differentiation
- Insulin secretion
- Possible reduction of risk for some chronic diseases

## Vitamin D Protection

- **Fall reduction**
  - Nursing home residents taking 800 IU vitamin D/day plus calcium had 26% reduction in risk of falls compared with placebo group
- **Anti-fracture efficacy**
  - Women consistent in taking calcium and 700-800 IU D3 had 29% reduction in hip fx (Women's Health Initiative)
- **Optimal protection**
  - only in trials providing 700-800 IU D3 / day or when serum 25(OH)D rose to 40ng/mL

Holick, Michael. N Engl J Med 357:3; 266-281
### Dietary Sources of Vitamin D

<table>
<thead>
<tr>
<th>Food</th>
<th>Amount (IU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cod liver oil, 1 Tbsp</td>
<td>1360</td>
</tr>
<tr>
<td>Salmon, 3 ½ oz cooked</td>
<td>360</td>
</tr>
<tr>
<td>Mackerel, 3 ½ oz cooked</td>
<td>345</td>
</tr>
<tr>
<td>Tuna fish, canned in oil, 3 oz</td>
<td>200</td>
</tr>
<tr>
<td>Sardines, canned in oil, drained, 1½ oz</td>
<td>250</td>
</tr>
<tr>
<td>Nonfat, reduced fat, and whole milk, vitamin D fortified, 1 cup</td>
<td>98</td>
</tr>
<tr>
<td>Margarine, fortified, 1 Tbsp</td>
<td>60</td>
</tr>
<tr>
<td>Pudding, prepared from mix and made with vitamin D fortified milk,</td>
<td>60</td>
</tr>
<tr>
<td>¼ cup</td>
<td></td>
</tr>
<tr>
<td>Ready-to-eat cereals fortified with 10% of the DV for vitamin D</td>
<td>40</td>
</tr>
<tr>
<td>(servings vary according to the brand)</td>
<td></td>
</tr>
<tr>
<td>Egg, 1 whole (vitamin D is found in egg yolk)</td>
<td>20</td>
</tr>
<tr>
<td>Liver, beef, cooked, 3½ oz</td>
<td>15</td>
</tr>
<tr>
<td>Cheese, Swiss, 1 oz</td>
<td>12</td>
</tr>
</tbody>
</table>

Source: NHANES III

### Who May Be D-Deficient?

Latitudes above 42°N may not provide adequate vitamin D levels in winter.

Source: NHANES III
Who May Be D-Deficient?

**Screen:**
- Adults > 50 years
- Homebound; institutionalized
- Limited sun exposure; sunscreen, protective clothing
- Darkly pigmented skin
- Live north of the Carolinas
- Inadequate intake of vitamin D; malabsorption
- Chronic liver & kidney disease
- Drugs: anticonvulsants, glucocorticoids; antirejection meds

Source: NHANES III

Reference Range for Serum 25(OH)D

<table>
<thead>
<tr>
<th>Hypovitaminosis D</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Severe deficiency</td>
<td>&lt; 10 ng/ml</td>
</tr>
<tr>
<td>- Mild to moderate deficiency</td>
<td>10-20 ng/ml</td>
</tr>
<tr>
<td>- Insufficiency</td>
<td>21-29 ng/ml</td>
</tr>
<tr>
<td>Sufficient</td>
<td>30-80 ng/ml</td>
</tr>
<tr>
<td>Possible toxicity</td>
<td>&gt; 80 ng/ml</td>
</tr>
</tbody>
</table>

Vitamin D Recommendations

• Deficiency (<20ng/mL):
  – Vitamin D2 (ergocalciferol): 50,000 IU once a week for up to 2 - 3 months, or 3x/week for one month. Re-check levels; adjust dose for individual requirements.

• Maintenance or Insufficiency:
  – Vitamin D3 (cholecalciferol): 800 – 2,000 IU/day for older adults, or individuals who are chronically ill, housebound, or institutionalized.

• May take any time of the day. May continue smart sun exposure.

Exercise
Exercise: 20 Minutes A Day

Strengthening of muscles
Improving muscle function

Falls

Bone mass

Fractures

Quality of life

Exercise

Best to do
Weight-bearing exercises
AND
Strength-training-exercises
AND
Balance-exercises
Tai-chi Reduces Fall Risk


Basic Balance Training

**One foot...5 seconds**
Stand facing a counter or table top.
Hold on with both hands, stand on one leg.
Hold for 5 seconds.
Repeat with the other foot.

Repeat sequence holding on with one hand.
Repeat holding on with fingertip.
Repeat sequence without holding on.
Repeat from beginning but close eyes when balancing on the one leg.
Fall Prevention
The “F” Word

*###* does happen…

We can prevent most falls!!!

Risk Factors for Falling:
Intrinsic Factors

- Frailty and associated deconditioning
- Problems with gait, balance and mobility
- Cognitive impairment or depression
- Poor visual acuity: depth perception & contrast
- Impaired hearing
- Low vitamin D levels
- Previous falls
- “Blackouts”

*Woof et al. BMJ 2003; 327:89-95*
### Personal Hazards
- Use of sedatives; SSRI
- Inappropriate footwear and clothing
- Not using personal assistive devices

### Hazards outdoors
- Uneven pavement, streets and paths
- Lack of safety equipment

### Hazards indoors
- Snow and icy conditions
- Traffic and public transportation
- Dim lighting
- Steep stairs; lack of handrails
- Slippery floors; loose rugs
- Pets; grandchildren’s toys
- Cords for telephone and electrical appliances

---

### Fall Risk Assessment
- History of circumstances of the fall
- Medical: drugs; acute or chronic medical problems
- Cognitive: mental status
- Cardiovascular: heart rate and rhythm; postural hypotension
- Vision: depth perception and contrast sensitivity
- Mobility, gait and balance
- Neurological: leg strength, reflexes, proprioception, foot sensitivity; tests of cortical, cerebellar and extrapyramidal function

Woolf et al. BMJ 2003; 327:89-95
**Timed Get Up and Go Test (TUG)**

87% sensitive and 87% specific in predicting falls in community dwelling older adults

Performed with patient wearing regular footwear, using usual walking aid if needed, and sitting back in a chair with arm rest.

Observe patient for postural stability, steppage, stride length and sway.

Instruct the patient to:
- Rise from chair
- Stand still momentarily
- Walk short distance (~ 10 feet)
- Turn around
- Walk back to chair
- Sit down

Get Up and Go Test: Interpretation

Low scores correlate with good functional independence; high scores correlate with poor functional independence and higher risk of falls.

Completes task in:

<table>
<thead>
<tr>
<th>Time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10 seconds</td>
<td>Normal</td>
</tr>
<tr>
<td>&lt; 20 seconds</td>
<td>Adequate for independent transfers and mobility; &gt; 13.5 fall risk</td>
</tr>
<tr>
<td>&gt; 20 seconds</td>
<td>Abnormal</td>
</tr>
<tr>
<td>&gt; 30 seconds</td>
<td>Higher dependence and risk of falls</td>
</tr>
</tbody>
</table>
AACE Recommendations for Fall Prevention

**PCP**
- Gait and balance training
- Adjust dosage of drugs with sedative effects

**Home**
- Avoid loose rugs
- Remove clutter
- Keep loose wires behind furniture
- Use nonskid mats
- Install handrails in bathrooms, halls, and stairs
- Light hallways, stairs, and entrances
- Wear sturdy, low-heeled shoes


Treatment Guidelines (NOF)

Postmenopausal women and men >= age 50 who present with

- Hip or vertebral fragility fracture
- T-score <= -2.5 after exclude secondary causes
- Osteopenia and positive FRAX

- Consultation (general recommendations)
- Basic treatment (calcium + vitamin D)
- Fall evaluation and prevention
- Special pharmacotherapy

**FRAX Score: Osteopenia**

- WHO computer-based algorithm
- Identifies osteopenic patients who may benefit from treatment
- 10 year fracture risk based on specific risk factors and BMD
- Country and race specific
- Suggest treatment if:
  - 10 yr probability of hip fx >= 3%
  - 10 yr probability of major osteoporosis-related fx >= 20%

---

**Monitoring Therapy**  
**Postmenopausal Women**

- Serial BMD
  - BMD changes slowly
  - Assessment is required every 2 years to measure change
  - Look for maintenance or improvement in BMD
  - Should be performed on the same machine if possible
- **Bone turnover markers**
  - Evolving method of clinical assessment
  - Large changes in biochemical markers associated with fracture reduction
Pharmacotherapy

1. **Antiresorptive agents**
   - Bisphosphonates
   - **SERMs** (Selective estrogen receptor modulators)
   - Hormones: Estrogen; Androgen
   - Calcitonin

2. **Anabolic agents**
   - r-PTH

3. **RANKL inhibitor (new)**
## Pharmacotherapy: Bisphosphonates

<table>
<thead>
<tr>
<th>Bisphosphonate</th>
<th>Labeled Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prevention</td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
</tr>
<tr>
<td><strong>Alendronate</strong></td>
<td>Postmenopausal osteoporosis</td>
</tr>
<tr>
<td></td>
<td>Postmenopausal osteoporosis</td>
</tr>
<tr>
<td></td>
<td>Men with osteoporosis</td>
</tr>
<tr>
<td></td>
<td>Glucocorticoid-induced osteoporosis</td>
</tr>
<tr>
<td><strong>Ibandronate</strong></td>
<td>Postmenopausal osteoporosis</td>
</tr>
<tr>
<td></td>
<td>Postmenopausal osteoporosis</td>
</tr>
<tr>
<td><strong>Risedronate</strong></td>
<td>Postmenopausal osteoporosis</td>
</tr>
<tr>
<td></td>
<td>Glucocorticoid-induced osteoporosis</td>
</tr>
<tr>
<td></td>
<td>Postmenopausal osteoporosis</td>
</tr>
<tr>
<td></td>
<td>Glucocorticoid-induced osteoporosis</td>
</tr>
<tr>
<td></td>
<td>Men with osteoporosis</td>
</tr>
<tr>
<td><strong>Zoledronic acid (IV)</strong></td>
<td>Postmenopausal osteoporosis</td>
</tr>
</tbody>
</table>

## Efficacy of Bisphosphonates

30-50% Risk Reduction v.s. Placebo

<table>
<thead>
<tr>
<th>Bisphosphonate</th>
<th>Risk Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hip</td>
</tr>
<tr>
<td></td>
<td>Spine</td>
</tr>
<tr>
<td><strong>Alendronate</strong></td>
<td>51-56%</td>
</tr>
<tr>
<td></td>
<td>44-48%</td>
</tr>
<tr>
<td><strong>Ibandronate</strong></td>
<td>34%</td>
</tr>
<tr>
<td></td>
<td>(post hoc analysis)</td>
</tr>
<tr>
<td></td>
<td>48-49%</td>
</tr>
<tr>
<td><strong>Risedronate</strong></td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>41-49%</td>
</tr>
<tr>
<td><strong>Zoledronic acid (IV)</strong></td>
<td>41%</td>
</tr>
<tr>
<td></td>
<td>46-77%</td>
</tr>
</tbody>
</table>

Osteoporosis Int 2010; 21: 1793-1802
Bisphosphonates

- Contraindicated for poor renal function, hypocalcemia and pregnancy
- Caution in patients with abnormalities of the esophagus, reflux or stomach ulcers
- Use PPI if taking ASA
- Caution for oral surgery & poor dental hygiene
- Strict dosing instructions
- Consider drug holiday after 5 years therapy
- IV Reclast: pretreat with acetomenophen

Pharmacotherapy: SERMS

<table>
<thead>
<tr>
<th>Serms</th>
<th>Labeled Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prevention</td>
</tr>
<tr>
<td>Raloxifene</td>
<td>Postmenopausal osteoporosis</td>
</tr>
<tr>
<td></td>
<td>Decrease risk of invasive breast cancer</td>
</tr>
</tbody>
</table>
**Pharmacotherapy: HRT Clinical Studies**

- WHI confirmed the effects of hormone therapy on fracture reduction
  - Hip and vertebral fractures decreased by one-third
  - Total fractures decreased by 24% to 30%
- WHI found HT provides no cardioprotective benefits and increases breast cancer risk
- Other adverse effects (increased risk of stroke, cognitive impairment, deep vein thrombosis)
- May be 1st line therapy for women < 60 years with menopausal symptoms at low dose; women should discuss benefits and risks with their health care provider (FDA)

---

**Pharmacotherapy: Testosterone Clinical Studies**

**Testosterone**

- Hypogonadism: testosterone replacement increases BMD; fracture prevention is unknown
- BMD did not increase in men with normal pretreatment levels
- May not be appropriate in elderly men, because of potential for undiagnosed prostate cancer

---

AACE Position Statement on HRT and Cardiovascular risk, 2008
## Pharmacotherapy: Calcitonin

<table>
<thead>
<tr>
<th>Calcitonin</th>
<th>Labeled Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention</td>
<td>Treatment</td>
</tr>
<tr>
<td>Calcitonin</td>
<td>Postmenopausal osteoporosis of spine</td>
</tr>
<tr>
<td></td>
<td>Analgesia for vertebral fractures</td>
</tr>
</tbody>
</table>

## Anabolic Agents Pharmacotherapy: rPTH

<table>
<thead>
<tr>
<th>rPTH</th>
<th>Labeled Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention</td>
<td>Treatment</td>
</tr>
<tr>
<td>Teraparatide</td>
<td>Postmenopausal osteoporosis</td>
</tr>
<tr>
<td></td>
<td>Men with osteoporosis</td>
</tr>
<tr>
<td></td>
<td>Glucocorticoid-induced osteoporosis</td>
</tr>
<tr>
<td></td>
<td>May increase rate of healing fractures</td>
</tr>
</tbody>
</table>
Pharmacotherapy: RANKL Inhibitor

<table>
<thead>
<tr>
<th>RANKL Inhibitor</th>
<th>Labeled Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denosumab</td>
<td>Severe postmenopausal osteoporosis</td>
</tr>
</tbody>
</table>

Combining Therapies

Combining Antiresorptive Therapies
- Clinical studies have not shown combinations of HT or Raloxifene with bisphosphonates to increase BMD or reduce fracture risk more than each agent alone

Combining Antiresorptive & Anabolic Therapies
- PTH followed by Alendronate: vertebral BMD increased substantially
- PTH followed by Raloxifene: effective
- Alendronate and PTH used together—less effective
- Alendronate followed by PTH: reduced response
- Raloxifene followed by PTH: complete response to PTH
- Zolendronic acid and PTH: BMD increased
Multiple Factors May Mitigate Fracture Risk

<table>
<thead>
<tr>
<th>Lifestyle Modifications</th>
<th>Therapeutic Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimizing factors that contribute to falls</td>
<td>Slowing/stopping bone loss</td>
</tr>
<tr>
<td>Modification of risk factors (diet, exercise)</td>
<td>Maintaining or increasing bone density and strength</td>
</tr>
<tr>
<td></td>
<td>Maintaining or improving bone microarchitecture</td>
</tr>
<tr>
<td></td>
<td>Improving medication adherence</td>
</tr>
</tbody>
</table>


Adherence Encompasses Both Persistence and Compliance

- **Adherence**
  Reflects a combination of behaviors determining the extent to which patients take medications as prescribed
- **Persistence**
  The length of time on therapy
- **Compliance**
  The consistency and accuracy with which a prescribed regimen is followed

Poor Adherence Is Associated With Increased Fracture Risk

![Fracture Risk by Adherence Level](image)

- Poor adherence is associated with increased fracture risk.
- Data on 38,000 women in a managed care database.

Improving Adherence Has Been Associated With Decreased Fracture Rates in Postmenopausal Osteoporosis

- 100% compliance is associated with a fracture rate of ~ 8%.
- Data on 35,537 patients from 2 claims databases.
Osteoporosis Therapy and Patient Adherence

Less than 25% of patients adhere to their therapy for more than 1 year

Factors Affecting Adherence

- Side effects
- Safety concerns
- Health problems
- Lack of results

Patients Initiating Therapy

Factors Affecting Adherence

Lack of motivation

Cost

Inconvenient dosing

Withdrawn by others

Patients Continuing Therapy


Fragility Fracture Clinic Prevention and Treatment

- Assessment
  - Lab work: calcium, vitamin D, secondary causes
  - Tests: DEXA, FRAX
  - Cognitive & mood assessment
  - Nutritional assessment
  - Risk assessment
  - Medication review

- Fall Prevention
  - Exam: orthostatic hypotension, vision, feet,
  - Gait assessment
  - Balance assessment
  - Home assessment for environmental risks

- Evidence based interventions
- Letter to Primary Care Provider
- Follow-up
Prevention & Treatment of Osteoporosis

Pharmacotherapy
(Antiresorptives and Anabolics)

Address Secondary Factors
(Drugs and Diseases)

Lifestyle Changes
(Nutrition, Physical Activity and Fall Prevention)


Thank You!