Hologic is Pleased to Present

Bone Densitometry

Des Moines University

November 8, 2012
Agenda

Osteoporosis Facts
Your DXA-Discovery A
Radiation Dose
Why DXA?
Who is at risk?
BMD & VFA (Vertebral Fracture Risk Assessments)
Osteoporosis, BMD and T-scores
FRAX™
New Treatment Recommendations
Obesity
Pediatrics
No one looks forward to osteoporosis

No one should have to suffer

No one should have to die
Introduction – Osteoporosis Facts

• 44 Million Americans are affected by Osteoporosis, or 55% of the People >50Yrs
  80% are Women and 20% are Men

• Every 20 seconds someone in the US suffers from an osteoporotic fracture.

• Every Year Osteoporosis Related Fractures Cause:
  432,000 Hospital Admissions
  2,500,000 Office Visits
  180,000 Nursing Home Admissions

• 50% of Your Female Patients, 50 Yrs and Older, Will Suffer an Osteoporotic Fracture
  During their Remaining Years  (Men: One in Four)

• 20% of Your Female Patients Suffering a Hip Fracture Will Die Within 2 Yrs

• 25% of those who were ambulatory before their hip fracture, require long-term care afterward

• 6 months after a hip fracture, only 15% of those suffering the fracture can walk across a room
  unaided

• There are More Deaths from Osteoporosis than Breast, Uterine and
  Cervical Cancer Combined
Discovery A

Discovery A Offers BMD Measurements:

AP Spine & Supine Lateral Spine
Hip (Right/Left)
Dual Hips
Forearm
Whole Body/Body Composition
Supine Lateral HD IVA (Vertebral Fracture Risk Assessments) L4-T4
216 High Resolution Digital Detector Array
10 Second AP Spine and Hip BMD Studies
Why Offer Bone Density Measurements?
Why Do DXA?

- **Diagnose**
  Allows the diagnosis of osteoporosis in asymptomatic individuals (prior to the first fracture!)

- **Estimate Fracture Risk**
  As women age, BMD goes down and fracture risk goes up.

- **Monitor**
 Radiation Dose

Fan Beam DXA: 1-5 uSv per exam
Fan Beam Scatter: Less than 1 mRem/Hr at a Distance of 1m from the Beam

• Natural Background: 5-8 uSv per day

• LA-NY-LA Flight: 60 uSv
Osteoporotic Fracture

Also called a fragility fracture or low-trauma fracture

An osteoporotic fracture occurs with minimal trauma, such as a force equal to or less than falling from a standing height.
WHO is at Risk?

- **AGE** - Although osteoporosis can affect people of all ages, it is more common in older people
- **GENDER** – One out of two women over the age of 50 will suffer an osteoporotic fracture
  
  *A woman's risk of hip fracture is equal to her combined risk of breast, uterine and ovarian cancer.*
- **GENDER** – One in four men will also suffer an osteoporotic fx.
- **FAMILY HISTORY**- If one of your parents had osteoporosis or broke a bone, you are more likely to get osteoporosis too
- **SMALL STATURE** - < 127 Pounds
- **ESTROGEN DEFICIENCY** – When estrogen levels drop, many women lose bone density
- **TESTOSTERONE** – Low levels of testosterone in men can lead to osteoporosis
Medications that May Cause Bone Loss

- Aluminum-containing antacids
- Antiseizure medications (only some) such as Dilantin® or Phenobarbital
- Aromatase inhibitors such as Arimidex®, Aromasin® and Femara®
- Cancer chemotherapeutic drugs
- Cyclosporine A and FK506 (Tacrolimus)
- Glucocorticoids such as cortisone and prednisone
- Gonadotropin releasing hormone (GnRH) such as Lupron® and Zoladex®
- Heparin
- Lithium
Medications that May Cause Bone Loss

- Medroxyprogesterone acetate for contraception (Depo-Provera®)
- Methotrexate
- Proton pump inhibitors (PPIs) such as Nexium®, Prilosec® andPrevacid® (High Doses or > 1 year)
- Selective serotonin reuptake inhibitors (SSRIs) such asLexapro®, Prozac® and Zoloft®
- Tamoxifen® (premenopausal use)
- Thiazolidinediones (Actos® and Avandia®)
- Thyroid hormones in excess

This list may not include all medications that cause bone loss.
Medical Conditions that Cause Bone Loss

- AIDS/HIV
- Anorexia Nervosa and Other Eating Disorders
- Ankylosing spondylitis
- Blood and bone marrow disorders
- Breast cancer
- Celiac Disease
- Cushing’s syndrome
- Depression
- Emphysema
- Female athlete triad
- Gastrectomy
- Gastrointestinal bypass procedures
- Hyperparathyroidism
- Hyperthyroidism
- Idiopathic scoliosis
- Inflammatory bowel disease
- Diabetes mellitus
- Kidney disease
- Lupus
- Lymphoma and leukemia
Medical Conditions that Cause Bone Loss

- Malabsorption syndromes (examples are Celiac disease and Crohn’s disease)
- Multiple myeloma
- Multiple sclerosis
- Organ transplants
- Parkinson’s disease
- Poor diet
- Post-polio syndrome
- Premature menopause
- Prostate cancer
- Rheumatoid arthritis
- Severe liver disease (including biliary cirrhosis)
- Spinal cord injuries
- Stroke (CVA)
- Thalassemia
- Thyrotoxicosis
- Weight loss

The list may not include all conditions that cause bone loss
Osteoporosis

Old definition
A reduced amount of bone that is qualitatively normal

Modern definition
“A systemic skeletal disease characterized by low bone mass and microarchitectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fracture.”

Modern definition
“Osteoporosis is a skeletal disorder characterized by compromised bone strength predisposing to an increased risk of fracture. Bone strength reflects the integration of two main features: bone density and bone quality.”
Osteoporosis Definition (1991)

• “A systemic skeletal disease characterized by low bone mass and microarchitectural deterioration, with a consequent increase in bone fragility with susceptibility to fracture.”*

1994

- In 1994, the World Health Organization took bone densitometry from research to the clinical world, with the introduction of T-scores.

- T-scores are based on female, Caucasian, postmenopausal fracture date from DXA measurements of the AP Spine, Hip and Forearm.

- T-Scores were NOT meant for:
  - Healthy premenopausal women
  - Ethnicities other than Caucasian
  - Males
  - QCT
  - Ultrasound
  - Children
WHO Classification for Postmenopausal Osteoporosis

(World Health Organization 1994)

The T-score compares an individual’s BMD with the mean value for young normals, and expresses the difference as a standard deviation score.

Normal: T-score of –1.0 and above

Low Bone Mass (“osteopenia”): T-score between –1.0 and –2.5

Osteoporosis: T-score of -2.5 and below

Severe Osteoporosis: Fragility Fracture and T-score <-2.5

Note: According to ISCD Guidelines, words like mild, moderate, severe, borderline…are not to be used in conjunction with the term “osteopenia.”
Why the WHO Chose $T = -2.5$

“Such a cutoff value identifies approximately 30% of postmenopausal women as having osteoporosis using measurements made at the spine, hip or forearm. This is approximately equivalent to the lifetime risk of fracture at these sites.”

T and Z-scores

- **T-score**: \( \frac{(BMD_{\text{patient}} - BMD_{\text{young-normal reference}})}{SD_{\text{young-normal reference}}} \)
- **Z-score**: \( \frac{(BMD_{\text{patient}} - BMD_{\text{age-matched reference}})}{SD_{\text{age-matched reference}}} \)

Note: If a T-score is low, it does not mean that one has lost bone. It may actually be peak bone mass for that particular patient!

Note: A Z-score of -2.0 or lower is defined as “below the expected range for age.”
A Z-score above -2.0 is “within the expected range for age.”
Children

- Use Z-scores for children

- Diagnosis of Osteoporosis:
  
  Z-score < -2.0 and
  2+ Fractures
Males

• **United States**
  T and Z-scores are based on male reference data
  In men < 50, can’t diagnose osteoporosis based on BMD only

• **Europe**
  The Rotterdam study says that men and women fracture at the hip at the same BMD.
  Other studies say that men fracture at the spine at a higher absolute BMD than women
Vertebral Fractures

If someone comes in with a heart attack, they expect you to start testing and do something! Most vertebral fractures are asymptomatic. If someone presents with back pain, they say, “I’m just getting old…”
VFA

• VFA is low radiation imaging of the spine (L4-T4), useful for detecting prevalent or incident vertebral fractures at the time of the BMD measurement.

• A visual technique—different than the quantitative methodology of DXA for measurement of BMD.

• Genant’s semi-quantitative approach
  Mild: 20-25% Deformity
  Moderate: 25-40% Deformity
  Severe: 40%+

• Can be a standalone procedure.
  Has a separate CPT code
  Use a separate diagnosis code(s)*
  Requires a separate report

* Height Loss seems to be the best chance for getting VFA covered
AP and Lateral IVA - Standard of Care to Accurately Assess Fracture Status

- Lateral IVA - 15 Second Scan
- AP IVA - 15 Second Scan
- Lateral IVA does not show all fractures
  - Without an AP scan this fracture would have been missed
  - Without the AP this patient would have been mis-diagnosed
**IVA**

*Instant Vertebral Assessment*

Improved Risk Assessment: BMD and IVA
BMD and IVA

- Improved Risk Assessment
- Identifies significant (30%) of “Missed Patients”
- Used to effect treatment decisions, ex. Osteopenia
- Improves patient understanding
- Improves acceptance and compliance
- Reduces osteoporotic fractures

When do luminaries recommend IVA?

- It’s good medicine
- > 60-65 years of age
- Height Loss
- When knowing the presence of a fracture would affect treatment decision
- When x-rays are unavailable

Note: Billed when medically necessary
ISCD Guidelines for VFA-Women

Consider VFA when the results may influence clinical management.

Postmenopausal women with low bone mass (osteopenia) by BMD, PLUS any one of the following:

- Age greater than or equal to 70 years
- Historical height loss greater than 4 cm.
- Prospective height loss greater than 2 cm
- Self-reported vertebral fracture (not previously documented)

Two or more of the following:

- Age 60 to 69 years
- Self-reported prior non-vertebral fracture
- Historical height loss of 2 to 4 cm
- Chronic systemic diseases associated with increased risk of vertebral fractures (Example: Crohn’s Disease, Rheumatoid Arthritis)
ISCD Guidelines for VFA-Men

Consider VFA when the results may influence clinical management.

Men with low bone mass (osteopenia) by BMD criteria, PLUS any one of the following:

- Age 80 years or older
- Historical height loss greater than 6 cm
- Prospective height loss greater than 3 cm
- Self-reported vertebral fracture (not previously documented)

Two or more of the following:

- Age 70 to 79 years
- Self-reported prior non-vertebral fracture
- Historical height loss of 3-6 cms.
- On pharmacologic androgen deprivation therapy or following orchiectomy
- Chronic systemic diseases associated with increased risk of vertebral fractures

ISCD Guidelines 2007
ISCD Guidelines for VFA
Men and Women

Women or men on chronic glucocorticoid therapy (equivalent to 5mg or more of prednisone daily for three months or longer).

Postmenopausal women or men with osteoporosis by BMD criteria, if documentation of one or more vertebral fractures will alter clinical management.

ISCD Guidelines 2007
Clinical Risk Factors for Low Bone Density

- Loss of Height
- Low body Weight
- Advanced Age
- Late age at menarche
- Menopausal
- Time since menopause
- Smoking
- Dietary calcium
- Alcohol intake

*Note: Age and BMI account for identifying the largest number of individuals with low bone mass*
Independent Risk Factors for Vertebral Fractures

- **Low BMD**
  Decreasing BMD by 1 SD increases fracture risk 1.7-2.6 times

- **Advancing Age**
  Each decade of aging past age 50 approximately doubles the fracture risk

- **Prior Fracture**
  One prior vertebral fracture increases the risk of subsequent vertebral fracture approximately 4-fold
  (Klotzbuecher CM et al. J Bone Miner Res. 2000; 15: 1721)
Clinical Risk Factors that Increase Hip Fracture that Are Generally Independent of Bone Density

- Prior Fracture after age 50
- Parental history of hip fracture
- Current smoking
- Ever use of glucocorticoids
- Alcohol intake more than 2 units daily
- Rheumatoid arthritis
Problem: Treatment decisions based only on T-scores will miss over half of those who will fracture.

WHO 2008 Fracture Risk Assessment Tool
Frax™
10 Year Absolute Fracture Risk Calculator
www.sheffield.ac.uk/FRAX

Hint: Google, Welcome to FRAX
FRAX™

• Does not apply to premenopausal women

• Does not apply to treated patients

• Country Specific Cost-Effective Intervention (Treatment) Thresholds
  NOF 2008 model for USA
  (www.nof.org)
Please answer the questions below to calculate the ten year probability of fracture with BMD.

**Questionnaire:**

1. Age (between 40-90 years) or Date of birth
   - Age: 57
   - Date of birth: 1950
2. Sex
   - Male
3. Weight (kg)
   - 63.50
4. Height (cm)
   - 152.4
5. Previous fracture
   - No
6. Parent fractured hip
   - No
7. Current smoking
   - No
8. Glucocorticoids
   - No
9. Rheumatoid arthritis
   - No
10. Secondary osteoporosis
    - No
11. Alcohol 3 more units per day
    - No
12. Femoral neck BMD
    - T-score: 0.758

**RMI 27.3**

The ten year probability of fracture (%) with BMD

- Major osteoporotic: 6.9
- Hip fracture: 0.1

http://www.shef.ac.uk/FRAX/tool.jsp
FRAX Risk Factors

Age  The model accepts ages between 40 and 90 years. If ages below or above are entered, the programme will compute probabilities at 40 and 90 year, respectively.

Sex  Male or female. Enter as appropriate.

Weight  This should be entered in kg.

Height  This should be entered in cm.

Previous fracture  A previous fracture denotes more accurately a previous fracture in adult life occurring spontaneously, or a fracture arising from trauma which, in a healthy individual, would not have resulted in a fracture. Enter yes or no (see also notes on risk factors).

Parent fractured hip  This enquires for a history of hip fracture in the patient’s mother or father. Enter yes or no.

Current smoking  Enter yes or no depending on whether the patient currently smokes tobacco (see also notes on risk factors).

Glucocorticoids  Enter yes if the patient is exposed to oral glucocorticoids or has been exposed to oral glucocorticoids for more than 3 months at a dose of prednisolone of 5mg daily or more (or equivalent doses of other glucocorticoids) (see also notes on risk factors).

Rheumatoid arthritis  Enter yes where the patient has a confirmed diagnosis of rheumatoid arthritis. Otherwise enter no (see also notes on risk factors).
FRAX Risk Factors

Secondary osteoporosis Enter yes if the patient has a disorder strongly associated with osteoporosis. These include type I (insulin dependent) diabetes, osteogenesis imperfecta in adults, untreated long-standing hyperthyroidism, hypogonadism or premature menopause (<45 years), chronic malnutrition, or malabsorption and chronic liver disease.

Alcohol 3 or more units/day Enter yes if the patient takes 3 or more units of alcohol daily. A unit of alcohol varies slightly in different countries from 8-10g of alcohol. This is equivalent to a standard glass of beer (285ml), a single measure of spirits (30ml), a medium-sized glass of wine (120ml), or 1 measure of an aperitif (60ml) (see also notes on risk factors).

Bone mineral density (BMD) Please select the make of DXA scanning equipment used and then enter the actual femoral neck BMD (in g/cm²). In patients without a BMD test, the field should be left blank (see also notes on risk factors) (provided by Oregon Osteoporosis Center).
WHO 10 year Fracture Risk

To produce:

- 10 Year Risk of Hip fracture (%)
  - Threshold is 3% for US

- 10 Year Risk of any clinical fracture (%)
  - Threshold is 20% for US

- NOF Created new physician guidelines

Each country will set a % fracture risk at which intervention is recommended, based on health economic and/or social willingness to pay.
Integrated FRAX™ Report

Risk Factors
- 61 yr Caucasian female
- T-score = -1.7
- Previous Fracture
- Smoking
  - Major Osteoporotic Fracture 21%
  - Hip Fracture 3.6%

10-year Fracture Risk

<table>
<thead>
<tr>
<th>Risk Type</th>
<th>10-year Fracture Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Osteoporotic Fracture</td>
<td>21%</td>
</tr>
<tr>
<td>Hip Fracture</td>
<td>3.6%</td>
</tr>
</tbody>
</table>

Reported Risk Factors:
US (Caucasian), T-score(WHO)= -1.7, BMI=22.1, previous fracture, smoking

FRAX™ Version 1.00. Fracture probability calculated for an untreated patient. Fracture probability may be lower if the patient has received treatment.
FRAX Limitations

- Doesn’t take into account the number of previous fractures
- Doesn’t ask where the fracture occurred
- Steroids - No distinction between long term and short term use or dose
Postmenopausal Women and Men Age 50 and Older Presenting with the Following Should Be Treated:

- A hip or vertebral (clinical or morphometric) fracture

Other prior fractures and low bone mass (T-score between −1 and −2.5 at the femoral neck, total hip or spine)

T-score ≤ -2.5 at the femoral neck, total hip or spine after appropriate evaluation to exclude secondary causes

NOF Guidelines
Treatment Recommendations Continued

- Low bone mass (T-score between –1.0 and –2.5 at the femoral neck, total hip or spine) and secondary causes associated with high risk of fracture (such as glucocorticoid use or total immobilization)

Low bone mass (T-score between –1.0 and –2.5 at the femoral neck, total hip or spine) and 10 year probability of hip fracture >/=3%, or a 10 year probability of any major osteoporosis-related fracture >/= 20% based on the US adapted WHO algorithm.

NOF Guidelines
Obesity Is an Epidemic

• Prevalence
  – Globally an estimated 1.8 billion Adults
  – 58.6 Million American Adults
  – More than 1/3 American School Age Children

• Obesity is an Independent Risk Factor for:
  – Cardiovascular Diseases and Conditions
    • Type 11 Diabetes
    • Hypertension
    • Heart Disease
    • Stroke
    • Some Cancers
U.S. Adults Obesity Trends* 2005

(*BMI ≥30, or ~ 30 lbs overweight for 5’ 4” person)

No Data          <10%           10%–14% 15%–19%           20%–24%          25%–29%          ≥30%
Why is DXA Body Composition Important?

• DXA is the Gold Standard
• Measures the amount of lean tissue compared to fat
  – Scale not a good tool
• Provides a foundation for research studies
• Identifies pediatric growth and nutrition deficiencies
• Body Composition Analysis can quantify muscle, fat or level of exercise or intervention needed
Obesity and Cancer

Increases risk by 25-33%:

- Breast (post-menopausal)
- Colon
- Endometrial
- Esophageal
- Kidney
- Prostate
Obesity Assessment

- BCA Report
  - Android/Gynoid
  - Detailed fat and lean indices
  - Compartmental Trending
- Reflection™
- Rotation of Subregions
- Rulers
- Adjustable Room Size
Body Composition Report
### DXA Report

#### Fat and Lean Indices

<table>
<thead>
<tr>
<th>Adipose Indices</th>
<th>Measure</th>
<th>Result</th>
<th>T-score</th>
<th>Z-score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Body % Fat</td>
<td>26.3</td>
<td>0.2</td>
<td>-0.3</td>
</tr>
<tr>
<td></td>
<td>Fat Mass/Height² (kg/m²)</td>
<td>6.07</td>
<td>-0.1</td>
<td>-0.7</td>
</tr>
<tr>
<td></td>
<td>Android/Gynoid Ratio</td>
<td>0.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Fat Trunk/% Fat Legs</td>
<td>0.86</td>
<td>-0.5</td>
<td>-1.3</td>
</tr>
<tr>
<td></td>
<td>Trunk/Limb Fat Mass Ratio</td>
<td>0.89</td>
<td>-0.6</td>
<td>-1.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lean Mass Indices</th>
<th>Measure</th>
<th>Result</th>
<th>T-score</th>
<th>Z-score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lean Mass/Height² (kg/m²)</td>
<td>17.0</td>
<td>-1.0</td>
<td>-1.4</td>
</tr>
<tr>
<td></td>
<td>Appen. Lean Mass/Height² (kg/m²)</td>
<td>7.69</td>
<td>-1.1</td>
<td>-1.2</td>
</tr>
</tbody>
</table>
Fast Facts on Childhood Obesity

• 1 in 5 ages 6-17 (9.2 million)
  – 30% of school age overweight
  – 15% of school age obese
• Doubled in 30 years: NHANES III
• 1996 US Surgeon General’s Report: 50% of 12-21 year olds have no vigorous exercise
• 300 NIH pediatric studies (24 months to 17 years)
• 9 NIH infant studies (newborn to 23 months)
Visceral Adipose Tissue (VAT)

- VAT (fat in and around abdominal organs) has been shown to be a risk factor for all-cause mortality in men\(^1\)

- VAT is a unique, pathogenic fat depot\(^2\) associated with metabolic risk factors (triglycerides, cholesterol, fasting glucose, hypertension) and CVD


Visceral Adipose Tissue
Region of Interest

Visceral cavity

Inner abdominal muscle wall

Subcutaneous fat
Pediatric

- Infant Total Body
- Pediatric
  - Spine
  - Femur
  - Total Body/BCA
- CDC Growth Curves
- Reference Data
- Rapid Acquisition
- Low Dose
NHANES Published Data

- Longest running public health study
- Largest body composition data
- Ages: 8-85
- Data collected SOLELY on Hologic equipment
- Pending FDA approval
- Coordinates with CDC growth centiles
Thank You

Questions?