Use of DXA / Bone Density in the Care of Your Patients

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Important Websites Resources for Clinicians and Patients

- www.NOF.org
- www.iofbonehealth.org
- www.sheffield.ac.uk/FRAX/
- www.surgeongeneral.gov/library/bonehealth/content.html
- www.ISCD.org
Dual-Energy X-ray Absorptiometry

Preferred current abbreviation “DXA”

Some people will always use “DEXA”
A bone density scan is a low-dose x-ray which checks an area of the body such as the hip, hand or foot for signs of mineral loss and bone thinning.
DXA Technology

X-ray Source
(produces 2 photon energies with different attenuation profiles)

Collimator
(pinhole for pencil beam, slit for fan beam)

Patient

Detector (detects 2 tissue types - bone and soft tissue)

Very low radiation to patient.

Very little scatter radiation to technologist

Photons
What do our bones do??

- Give us structure and strength
- Protect against injury
- Help us be mobile
- Store release minerals (calcium/phosphate)
On a city bus, an angry bus passenger grows irritated with Peter’s music and threatens to break every bone in his body. Peter quickly wishes that he was boneless and collapses into a fleshy heap.
Bone: Normal Osteoporotic
IOF reports:
ONE in THREE women over age 50 and
ONE in FIVE men over age 50 will
experience osteoporotic fractures....
OUCH!
Why Should We Care About Osteoporosis?

- Osteoporosis is serious - Osteoporotic fractures cause increased morbidity and mortality
- Good treatments are available- Fracture risk can be reduced by about 50%
- Osteoporosis is easy to diagnose - Bone density testing can detect osteoporosis BEFORE the first fracture occurs
You have probably told your patients this advice:

- **EAT RIGHT:**
  Get your daily recommended amounts of Calcium and Vitamin D.

- **EXERCISE:**
  Engage in regular weight-bearing and muscle strengthening exercise.

- **MAINTAIN A HEALTHY LIFESTYLE:**
  Avoid smoking and excessive alcohol consumption.
Two other items of advice from the National Osteoporosis Foundation

- **TALK TO YOUR HEALTHCARE PROVIDER:**
  Talk to your healthcare provider about bone health.

- **GET TESTED:**
  Have a bone density test and take medication when appropriate.
Why Measure BMD (bone mineral density)?

- BMD is a strong independent predictor of fracture risk.
- Clear relation of BMD and fracture risk on older women---For each standard deviation drop in BMD (in spine 10 to 12% loss), fracture risk increases 1.5 to 2.5 times
Why Measure BMD?

- Conventional radiographs—good for fracture detection, insensitive for bone density loss detection
- Estimated that it takes about a 30% loss of bone density to show, and technique can make someone with normal BMD look like low BMD
Do you have criteria for who should have a DXA??

- **DXA**—measures the BMD
  
  (Somebody must have liked alphabet soup as a kid to come up with all these initials......)
U.S. Preventive Services Task Force

- recommends screening for osteoporosis in women aged 65 years or older and in younger women whose fracture risk is equal to or greater than that of a 65-year-old white woman who has no additional risk factors.
U.S. Preventive Services Task Force

- concludes that the current evidence is insufficient to assess the balance of benefits and harms of screening for osteoporosis in men.
Fracture probability is age- and BMD-specific

Adapted from Kanis et al., Osteoporos Int. 2001
Fracture probability is age- and gender-specific

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10-year hip fracture probability (%) vs. Age (years)

Women

Men

Adapted from Kanis et al., Osteoporos Int. 2000
Who should have BMD tested?

- Those with clinical “red flags”
- ISCD has recommendations (generally correspond to the “red flags”)

“Red Flags”

- History of fractures related to mild or moderate trauma (e.g., a fall from standing height or less)
- Family history of bone disease
- Low body weight
- Weight loss of more than 1 percent per year in the elderly
- Late onset of sexual development
- Unusual cessation of menstrual periods
“Red Flags”

- Anorexia nervosa (often related to marked weight reduction)
- Athletic amenorrhea syndrome (related to intense physical activity)
- Patients being treated with drugs that affect bone metabolism (e.g., glucocorticoids)
- Patients with diseases linked to secondary osteoporosis
“Red Flags”

- High levels of serum calcium or alkaline phosphatase in otherwise healthy patients
- Hyperparathyroidism, hyperthyroidism, or treatment with high doses of thyroid hormone
- Height loss or progressive spinal curvature
National Osteoporosis Foundation

Clinician’s Guide to Prevention and Treatment of Osteoporosis

Developed by the National Osteoporosis Foundation

BoneXSource
Bone Health and Osteoporosis: A Report of the Surgeon General

Chapter 8: Assessing the Risk of Bone Disease and Fracture
FRAX is a computer-based algorithm which uses easily obtained clinical risk factors to estimate an individual’s 10-year fracture probability.

It may be utilized by clinicians to assist in the identification of patients at high risk for fractures.
2010 Official Positions of the ISCD/IOF on the Interpretation and Use of FRAX in Clinical Practice
Garbage In----Garbage Out

- Change in a single answer on the FRAX questionnaire may shift the 10 year fracture risk from “medical treatment advised” to “routine follow-up”
- VERY important for primary health care provider to understand FRAX
- At Scott & White, we do not put FRAX results on the actual DXA report
Accumulation of risk factors increases fracture probability

At age 65 years, BMI = 24 kg/m², US Caucasian

Men

Women

- No Clinical Factors
- Prior Fracture
- + Glucocorticoids
- + Family History

FRAX® 2009
DXA

- “Gold-standard” for BMD measurement
- Measures “central” or “axial” skeletal sites: spine and hip
- May measure other sites: total body and forearm
- Extensive epidemiologic data
- Correlation with bone strength in-vitro
- Validated in many clinical trials
- Widely available (over 10,000 DXA machines in USA—still increasing until 3/2012—attrition due to 50% cut in amount Medicare pays)
Which Skeletal Sites Should Be Measured?

Every Patient
- Spine
  - L1-L4
- Hip
  - Total Proximal Femur
  - Femoral Neck
  - Trochanter

Some Patients
- Forearm (33% Radius)
  - If hip or spine cannot be measured
  - Hyperparathyroidism
  - Very obese

Use lowest T-score of these sites
What DXA Really Measures: Bone Mineral Content (BMC) In Grams and Area In cm$^2$

- “Areal” BMD is calculated in g/cm$^2$
- “T-score” compares the patient’s BMD with the young-normal mean BMD and expresses the difference as a standard deviation (SD) score
T-score

Example:

\[
T\text{-score} = \frac{0.7 \text{ g/cm}^2 - 1.0 \text{ g/cm}^2}{0.1 \text{ g/cm}^2} = -3.0
\]
Reference Database for T-Scores

- Use a uniform Caucasian (non-race adjusted) female normative database for women of all ethnic groups.*
- Use a uniform Caucasian (non-race adjusted) male normative database for men of all ethnic groups.*---Some places use only one standard for females & males...
- The NHANES III database should be used for T-score derivation at the hip regions.

*Note: Application of recommendation may vary according to local requirements.
Central DXA for Diagnosis

- The WHO international reference standard for osteoporosis diagnosis is a T-score of -2.5 or less at the femoral neck.
  - The reference standard from which the T-score is calculated is the female, white, age 20-29 years, NHANES III database.
Central DXA for Diagnosis

- Osteoporosis may be diagnosed in postmenopausal women and in men age 50 and older if the T-score of the lumbar spine, total hip, or femoral neck is -2.5 or less:*
  - In certain circumstances the 33% radius (also called 1/3 radius) may be utilized

*Note: Other hip regions of interest, including Ward's area and the greater trochanter, should not be used for diagnosis. Application of recommendation may vary according to local requirements.
Central DXA for Diagnosis

- Skeletal sites to measure
  - Measure BMD at both the PA spine and hip in all patients
  - Forearm BMD should be measured under the following circumstances:
    - Hip and/or spine cannot be measured or interpreted.
    - Hyperparathyroidism
    - Very obese patients (over the weight limit for DXA table)
Central DXA for Diagnosis

- Spine Region of Interest (ROI)
  - Use PA L1-L4 for spine BMD measurement
  - Use all evaluable vertebrae and only exclude vertebrae that are affected by local structural change or artifact. Use three vertebrae if four cannot be used and two if three cannot be used.
  - BMD based diagnostic classification should not be made using a single vertebra.
  - If only one evaluable vertebra remains after excluding other vertebrae, diagnosis should be based on a different valid skeletal site.
Central DXA for Diagnosis

- Anatomically abnormal vertebrae may be excluded from analysis if:
  - They are clearly abnormal and non-assessable within the resolution of the system; or
  - There is more than a 1.0 T-score difference between the vertebra in question and adjacent vertebrae
- When vertebrae are excluded, the BMD of the remaining vertebrae is used to derive the T-score
- The lateral spine should not be used for diagnosis, but may have a role in monitoring
Fracture Risk Doubles With Every SD Decrease in BMD
Z-score

Patient’s BMD – Age-Matched Mean BMD

1 SD of Age-Matched Mean BMD in g/cm²

Low Z-score (less than -2.0) may suggest increased likelihood of secondary osteoporosis, however . . .

- This is not validated in clinical trials
- High index of suspicion for secondary causes of osteoporosis is suggested in all patients
Z-Score Reference Database

- Z-scores should be population specific where adequate reference data exist. For the purpose of Z-score calculation, the patient's self-reported ethnicity should be used.
# Diagnostic Classification

<table>
<thead>
<tr>
<th>Classification</th>
<th>T-score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>-1 or greater</td>
</tr>
<tr>
<td>Osteopenia</td>
<td>Between -1 and -2.5</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>-2.5 or less</td>
</tr>
<tr>
<td>Severe Osteoporosis</td>
<td>-2.5 or less and fragility fracture</td>
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</table>
ISCD Official Positions 2007: Use of the Term “Osteopenia”

- The term “osteopenia” is retained, but “low bone mass” or “low bone density” is preferred.
- People with low bone mass or density are not necessarily at high fracture risk.
Diagnosis Caveats

- T-score -2.5 or less does not always mean osteoporosis
  - Example: osteomalacia
- Clinical diagnosis of osteoporosis may be made with T-score greater than -2.5
  - Example: atraumatic vertebral fracture with T-score equals -1.9
- Low T-score does not identify the cause
  - Medical evaluation should be considered
  - Example: celiac disease with malabsorption
BMD Reporting in Postmenopausal Women and in Men Age 50 and Older

- The WHO densitometric classification is applicable.
- T-scores are preferred.
BMD Reporting in Females Prior to Menopause and in Males Younger Than Age 50

- Z-scores, not T-scores, are preferred. This is particularly important in children.
- A Z-score of -2.0 or lower is defined as “below the expected range for age”, and a Z-score above -2.0 is “within the expected range for age.”
- Osteoporosis cannot be diagnosed in men under age 50 on the basis of BMD alone
- The WHO diagnostic criteria many be applied to women in the menopausal transition
DXA L-Spine Image
Image Dual Femur
DXA IMAGE Forearm
Sample BMD results

- Postmenopausal Patient
- L1-L4
  - 1.103 g/cm²  T-score -0.2
- Right Femoral Neck
  - 1.050 g/cm²  T-score 0.1
- Left Femoral Neck
  - 0.978 g/cm²  T-score -0.4

- Do you treat??
Sample BMD results

- Postmenopausal Patient
- L1-L4
  - 1.103 g/cm²  T-score -0.2
- Right Femoral Neck
  - 1.050 g/cm²  T-score 0.1
- Left Femoral Neck
  - 0.978 g/cm²  T-score -0.4

- When do you request a follow-up DXA?
Bone-Density Testing Interval and Transition to Osteoporosis in Older Women

Margaret L. Gourlay, M.D., M.P.H., Jason P. Fine, Sc.D., John S. Preisser, Ph.D., Ryan C. May, Ph.D., Chenxi Li, Ph.D., Li-Yung Lui, M.S., David F. Ransohoff, M.D., Jane A. Cauley, Dr.P.H., and Kristine E. Ensrud, M.D., M.P.H. for the Study of Osteoporotic Fractures Research Group

Background: Although bone mineral density (BMD) testing to screen for osteoporosis (BMD T-score, −2.50 or lower) is recommended for women 65 years of age or older, there are few data to guide decisions about the interval between BMD tests.
Bone-Density Testing Interval and Transition to Osteoporosis in Older Women

- **Methods**

  - We studied 4957 women, 67 years of age or older, with normal BMD (T-score at the femoral neck and total hip, −1.00 or higher) or osteopenia (T-score, −1.01 to −2.49) and with no history of hip or clinical vertebral fracture or of treatment for osteoporosis, followed prospectively for up to 15 years.
Bone-Density Testing Interval and Transition to Osteoporosis in Older Women

- **Methods**
- The BMD testing interval was defined as the estimated time for 10% of women to make the transition to osteoporosis before having a hip or clinical vertebral fracture, with adjustment for estrogen use and clinical risk factors.
Bone-Density Testing Interval and Transition to Osteoporosis in Older Women

- **Methods**
  - Transitions from normal BMD and from three subgroups of osteopenia (mild, moderate, and advanced) were analyzed with the use of parametric cumulative incidence models.
Bone-Density Testing Interval and Transition to Osteoporosis in Older Women

- **Methods**
  - Incident hip and clinical vertebral fractures and initiation of treatment with bisphosphonates, calcitonin, or raloxifene were treated as competing risks.
Bone-Density Testing Interval and Transition to Osteoporosis in Older Women

- **Results**
  - The estimated BMD testing interval was 16.8 years (95% confidence interval [CI], 11.5 to 24.6) for women with normal BMD, 17.3 years (95% CI, 13.9 to 21.5) for women with mild osteopenia, 4.7 years (95% CI, 4.2 to 5.2) for women with moderate osteopenia, and 1.1 years (95% CI, 1.0 to 1.3) for women with advanced osteopenia.
Bone-Density Testing Interval and Transition to Osteoporosis in Older Women

Conclusions

Our data indicate that osteoporosis would develop in less than 10% of older, postmenopausal women during rescreening intervals of approximately 15 years for women with normal bone density or mild osteopenia, 5 years for women with moderate osteopenia, and 1 year for women with advanced osteopenia. (Funded by the National Institutes of Health.)
In other words

- Normal or “mild osteopenia” on initial DXA—could follow-up in approx 15 years
- “Moderate osteopenia” on initial DXA—could follow-up in 5 years
- “Advanced osteopenia” could follow-up in 1 year
TECHNICAL INFORMATION:
Temple studies are performed on Lunar Prodigy DF+16037 with enCORE version 9.1 software
Mobile studies are performed on Lunar Prodigy DPXMT+150915 with enCORE version 11.40 software

Least significant change data:
L1-L4 0.043g/cm²
Left Femoral Neck 0.038g/cm²
Sample BMD results

- Postmenopausal Patient
- L1-L4
  - 1.183 g/cm²  T-score 0.0
- Right Femoral Neck
  - 0.850 g/cm²  T-score -1.4
- Left Femoral Neck
  - 0.833 g/cm²  T-score -1.5
Sample BMD Results

- Postmenopausal Patient
- L1-L4
  - 1.183 g/cm²  T-score  0.0
- Right Femoral Neck
  - 0.850 g/cm²  T-score  -1.4
- Left Femoral Neck
  - 0.833 g/cm²  T-score  -1.5

- Pt age 90 or age 50? Takes steroids? Heavy smoker?
- Now do you treat??
Accumulation of risk factors increases fracture probability

At age 65 years, BMI = 24 kg/m², US Caucasian

FRAX® 2009
Age 75

1. Have you ever had a fracture from minimal trauma or a spontaneous fracture without known trauma? [ ] Yes [ ] No [ ] Don't Know

2. Have either of your parents had a hip fracture? [ ] Yes [ ] No [ ] Don't Know

3. Do you currently smoke tobacco? [ ] Yes [ ] No

4. Do you take or have you taken oral glucocorticoid or steroid medication (such as prednisolone) for 3 months or more? [ ] Yes [ ] No [ ] Don't Know

5. Do you have an official diagnosis of RHEUMATOID arthritis (not osteoarthritis)? [ ] Yes [ ] No [ ] Don't Know

6. Do you drink 3 or more units of alcohol per day? (A unit is a standard glass of beer or a medium glass of wine or 30ml of spirits) [ ] Yes [ ] No [ ] Don't Know

7. Please mark any of these conditions you know you have had:
   a. [ ] Type 1 Insulin Dependent Diabetes
   b. [ ] Hyperthyroidism, especially that you believe was present a long time before you were treated
   c. [ ] If female, Premature Menopause (before age 45)
   d. [ ] If male, Hypogonadism, or low testosterone
   e. [ ] Chronic liver disease
   f. [ ] Malabsorption or Inflammatory bowel disease
   g. [ ] Cystic fibrosis
   h. [ ] Low bone density or osteoporosis treated with a prescription medicine (such as Fosamax for example). Over the counter calcium supplements do NOT count for this question
   i. [ ] Hyperparathyroid Disease (Parathyroid Gland). This is not a disease of the thyroid gland.

8. Have you had a gastric bypass? [ ] Yes [ ] No [ ] Don't Know

9. Have you had a renal or liver transplantation? [ ] Yes [ ] No [ ] Don't Know

10. If you are a female, have you gone through menopause (change of life, stopped having regular periods)? [ ] Yes [ ] No [ ] Don't Know

   If Yes, age of menopause: [ ]

   [ ]
Age 65

Weight: 139
Height: 5'9"

1. Have you ever had a fracture from minimal trauma or a spontaneous fracture without known trauma? Yes, No, Don't Know

2. Have either of your parents had a hip fracture? Yes, No, Don't Know

3. Do you currently smoke tobacco? Yes, No

4. Do you take or have you taken oral glucocorticoid or steroid medication (such as prednisone) for 3 months or more? Yes, No, Don't Know

5. Do you have an official diagnosis of RHEUMATOID arthritis (not osteoarthritis)? Yes, No, Don't Know

6. Do you drink 3 or more units of alcohol per day? (A unit is a standard glass of beer or a medium glass of wine or 30ml of spirits.) Yes, No, Don't Know

7. Please mark any of these conditions you know you have had:
   a. Type 1 Insulin Dependent Diabetes
   b. Hyperthyroidism, especially if you believe was present a long time before you were treated
   c. Premature Menopause (before age 45)
   d. Male hypogonadism or low testosterone
   e. Chronic liver disease
   f. Malabsorption or inflammatory bowel disease
   g. Cystic fibrosis
   h. Low bone density or osteoporosis treated with a prescription medication (such as Fosamax for example). Over the counter calcium supplements do NOT count for this question
   i. Hyperparathyroid Disease (Parathyroid Gland) This is not a disease of the thyroid gland.

8. Have you had a gastric bypass? Yes, No, Don't Know

9. Have you had a renal or liver transplantation? Yes, No, Don't Know

10. If you are a female, have you gone through menopause (change of life, stopped having regular periods)? Yes, No, Don't Know
    If Yes, age of menopause: 20 [Handwritten]
Male, age 76

1. Have you ever had a fracture from minimal trauma or a spontaneous fracture without known trauma? **Yes** _No_ _Don't Know_

2. Have either of your parents had a hip fracture? **Yes** _No_ _Don't Know_

3. Do you currently smoke tobacco? **Yes** _No_ _Don't Know_

4. Do you take or have you taken oral glucocorticoid or steroid medication (such as prednisone) for 3 months or more? **Yes** _No_ _Don't Know_

5. Do you have an official diagnosis of RHEUMATOID arthritis (not osteoarthritis)? **Yes** _No_ _Don't Know_

6. Do you drink 3 or more units of alcohol per day? (A unit is a standard glass of beer or a medium glass of wine or 30ml of spirits). **Yes** _No_ _Don't Know_

7. Please mark any of these conditions you know you have had:
   a. **Type 1** (diabetes dependent diabetes)
   b. **Hyperthyroidism**, especially that you believe was present a long time before you were treated
   c. **If female, Premature Menopause** (before age 45)
   d. **If male, hypogonadism or low testosterone**
   e. **Chronic liver disease**
   f. **Malabsorption or inflammatory bowel disease**
   g. **Cystic fibrosis**
   h. **Low bone density or osteoporosis treated with a prescription medicine (such as Fosamax for example). Over the counter calcium supplements do NOT count for this question**
   i. **Hyperparathyroid Disease (Parathyroid Gland) This is not a disease of the thyroid gland**

8. Have you had a gastric bypass? **Yes** _No_ _Don't Know_

9. Have you had a renal or liver transplantation? **Yes** _No_ _Don't Know_

10. If you are a female, have you gone through menopause (change of life, stopped having regular periods)? **Yes** _No_ _Don't Know_.

   If Yes, age of menopause: _N/A_
FRAX is a useful tool....

FRAX does not replace your clinical judgment
FRAX

- WHO fracture risk assessment tool
- 10 year probability of fracture
- Uses BMD but also looks at multiple other risk factors
- Age (40 to 90 years), gender, country
- ONLY ON UNTREATED PEOPLE
2010 Official Positions of the ISCD/IOF on the Interpretation and Use of FRAX in Clinical Practice
13 clinical statements regarding FRAX:

Impaired functional status in patients with rheumatoid arthritis may be a risk factor for clinical fractures. FRAX may underestimate fracture probability in such patients.
There is no consistent evidence that non-glucocorticoid medications for rheumatoid arthritis alter fracture risk.
While there is evidence that duration and dose of tobacco smoking may impact on fracture risk, quantification of this risk is not possible.
13 clinical statements regarding FRAX:

Falls are a risk factor for fractures but are not accommodated as an entry variable in the current FRAX model. Fracture probability may be underestimated in individuals with a history of frequent falls, but quantification of this risk is not currently possible.
13 clinical statements regarding FRAX:

There is a relationship between number of prior fractures and subsequent fracture risk. FRAX underestimates fracture probability in persons with a history of multiple fractures.
13 clinical statements regarding FRAX:

There is a relationship between severity of prior vertebral fractures and subsequent fracture risk. FRAX may underestimate fracture probability in individuals with prevalent severe vertebral fractures.
13 clinical statements regarding FRAX:

While there is evidence that hip, vertebral, and humeral fractures appear to confer greater risk of subsequent fracture than fractures at other sites, quantification of this incremental risk in FRAX is not possible.
13 clinical statements regarding FRAX:

A parental history of non-hip fragility fracture may be a risk factor for fracture. FRAX may underestimate fracture probability in individuals with a parental history of non-hip fragility fracture.
13 clinical statements regarding FRAX:

Evidence that bone turnover markers predict fracture risk independent of Bone Mineral Density (BMD) is inconclusive. Therefore, bone turnover markers are not included as risk factors in FRAX.
13 clinical statements regarding FRAX:

There is a dose relationship between glucocorticoid use of greater than 3 months and fracture risk. The average dose exposure captured within FRAX is likely to be a prednisone dose of 2.5-7.5 mg/day or its equivalent. Fracture probability is under-estimated when prednisone dose is greater than 7.5 mg/day and is over-estimated when prednisone dose is less than 2.5 mg/day.
13 clinical statements regarding FRAX:

Frequent intermittent use of higher doses of glucocorticoids increases fracture risk. Because of variability in the dose and dosing schedule, quantification of this risk is not possible.
13 clinical statements regarding FRAX:

High dose inhaled glucocorticoids may be a risk factor for fracture. FRAX may underestimate fracture probability in users of high dose inhaled glucocorticoids.
13 clinical statements regarding FRAX:

Appropriate glucocorticoid replacement in individuals with adrenal insufficiency has not been shown to increase fracture risk. In such patients, use of glucocorticoids should not be included in FRAX calculations.
FRAX BMD STATEMENTS

Measurements other than BMD or T-score at the femoral neck by Dual-energy X-ray Absorptiometry (DXA) are not recommended for use in FRAX.

FRAX may underestimate or overestimate major osteoporotic fracture risk when lumbar spine T-score is much lower or higher (>1 Standard Deviation discrepancy) than femoral neck T-score.
FRAX BMD STATEMENTS
A procedure based upon the difference (off set) between the Lumbar Spine and Femoral Neck T-scores can enhance fracture prediction in the current version of FRAX.
FRAX BMD STATEMENTS

The ISCD 2007 PDC Statements on fracture risk prediction and application of heel Quantitative Ultrasounds (QUS) are supported by a higher level of evidence in men and women than was available in 2007.
Currently validated heel QUS devices, using criteria defined in the 2007 ISCD PDC, predict fracture risk similarly.
FRAX BMD STATEMENTS

FRAX with BMD predicts fracture risk better than clinical risk factors or BMD alone. Use of FRAX without BMD is appropriate when BMD is not readily available or to identify individuals who may benefit from a BMD measurement.
FRAX BMD STATEMENTS

It is not appropriate to use FRAX to monitor treatment response.
Evidence that rate of bone loss may be an independent risk factor for fracture is conflicting. Therefore, rate of bone loss is not included as a FRAX risk factor.
Thank you
--- and may all your DXA decisions be wise.