


**To Treat Or Not To Treat : Understanding and Utilizing the FRAX Score**

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- Who is at risk for osteoporosis
- When to screen with Dual energy X ray Absorptiometry
- What information can be interpreted from DXA
- When to use FRAX as a useful tool in deciding when to treat osteoporosis

**Current Definition of Osteoporosis: NIH Consensus Conference**

- 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
  - bone quality

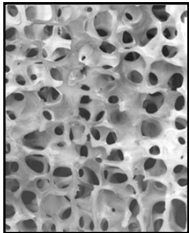
NIH Consensus Development Panel. *JAMA*. 2001;285:785.

**Bone Strength**

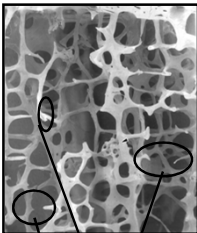
- **Bone Density** – measurable
  - DXA (aBMD=g/cm<sup>2</sup>)
  - QCT (vBMD=g/cm<sup>3</sup>)
- Areal bone density takes into account the size of bone and is actually better correlated with bone strength than volumetric bone density
- Example – a man's bones, with the same volumetric bone density as a woman's, has stronger bone because it is larger
- **Bone Quality** – **not well-defined**, includes
  - Architecture, Turnover, Damage accumulation, Mineralization and Collagen quality

**Microarchitectural Changes in Osteoporosis: Important for Bone Quality But Cannot Measure**

Normal



Osteoporotic



Horizontal Disconnections

Dempster 2000

**Osteoporosis is Due to :**

- Low peak bone mass
- Bone loss
- Both low peak bone mass and bone loss

### Peak Bone Mass

- Maximum bone mass or density achieved during a lifetime
- It is reached when the growth in the size of bones and accumulation of bone mineral has stabilized (consolidation)
- Different skeletal sites peak at different times
  - Trochanter BMD: Mid teens
  - Femoral Neck BMD: Late teens
  - Spine BMD: Early 20's

LinY-C et al., Bone 2003;32:546

### Why is Osteoporosis Important?

- Common
- Serious
  - Morbidity and mortality
  - Societal cost
- Preventable and Treatable

### Osteoporosis is Common

- Most common bone disease
  - 10 million Americans have osteoporosis and 33.6 million have low bone density at the hip
  - Over 200 million worldwide
- Approximately 50% of Caucasian women and 20% of men will experience an osteoporotic fracture

National Osteoporosis Foundation Clinician's Guide 2008

[www.iofbonehealth.org/health-professionals/about-osteoporosis/epidemiology](http://www.iofbonehealth.org/health-professionals/about-osteoporosis/epidemiology)

### WHO Classification of Postmenopausal Osteoporosis

	T- score
Normal	Equal to -1.0 or higher
Low Bone Mass (Osteopenia)	Between -1.0 and -2.5
Osteoporosis	Equal to -2.5 or lower
Severe Osteoporosis	Equal to -2.5 or lower with fracture

World Health Organization. Technical Report Series 843 WHO, Geneva.1994.

### BMD Testing Should be Performed...

NOF guidelines 2014

- In women age 65 and older and men age 70 and older
- In women and men age 50-69, based on risk factor profile
- Recommend BMD testing and vertebral imaging to those who have had a fracture, to determine degree of disease severity
- BMD testing should be performed at DXA facilities using accepted quality assurance measures

USPTF recommendations for screening 2011

- All women ≥ 65
- Younger postmenopausal women whose fracture risk is equal to an average 65 y/o without risk factors
- No recommendation for men "balance of evidence is insufficient to assess the balance of benefits and harms of the service"

National Osteoporosis Foundation Clinicians Guide 2013 [www.NOFOrg](http://www.NOFOrg)

### Clinical Utility of Bone Densitometry

- Diagnosis
- Prognosis/Fracture risk assessment
- Monitoring

### Using T and Z-scores

- T-scores
  - Used for diagnosis
  - Only applicable to postmenopausal women or men over 50
- Z-scores
  - Used to compare to age-matched controls i.e. to determine if BMD is what you would expect at that age
  - Appropriate for children and healthy adults under the age of 50

### Do NOT Use T-scores in:

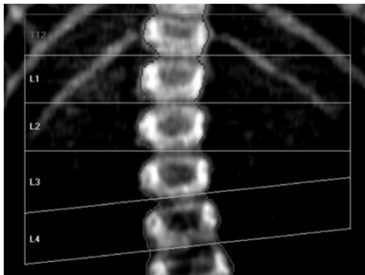
- Premenopausal Women
- Men Under Age 50
- Children

T-score use is inappropriate in these populations as a low value would imply increased fracture risk

Even with low BMD, young healthy people are at low fracture risk (perhaps because they do not have the microarchitectural deterioration that occurs with age and menopause)

### Your Patient Has a T-score of -6.6

Is Osteoporosis Treatment Needed?



NO, the patient is a five year old boy!

### ISCD Official Position:

**Apply the WHO Criteria for Diagnosis Using the Lowest T-score of the Lumbar Spine, Total Hip, Femoral Neck or 1/3rd Radius**

- Other sites (eg trochanter, ultradistal radius) and other technologies (eg CT, ultrasound) CANNOT be used for diagnosis as T-scores from these sites and techniques were not included in the initial WHO criteria and do not correlate with T-scores on the accepted sites
- Report an overall diagnosis, not a site-specific diagnosis e.g. if T-score at the spine is -2.8, femoral neck -1.9 and total hip -2.3, the diagnosis is simply osteoporosis by WHO criteria

Baim, et al. *J Clin Densitom.* 2008;11:75-91

### When Should Follow-up DXA be Performed?

- "It depends"
- Not more frequently than yearly
- Initiation of steroids is an exception (6 months)
- ISCD position; measure one year after initiation of Rx to document response (stability or increase)
- Medicare has defined monitoring interval as no more frequently than every 24 months

Remember that stable BMD on Rx = Success

### What is a Real Change on Follow-up DXA?

- Necessary to perform an *in-vivo* precision assessment
  - ◊ This is facility, technician and patient population dependent
- At one facility, the L1-L4 spine LSC is 0.040 grams/cm<sup>2</sup> and 0.020 grams/cm<sup>2</sup> at the mean total femur
  - ◊ These values vary between facilities and technologists
  - ◊ For example, the L1-L4 LSC at another facility in the same city is 0.053 grams/cm<sup>2</sup>

## Practical DXA Interpretation

### Components of DXA Printouts

- Image
- Demographics
- Data
  - BMD
  - T-Score
  - Z-score
- Graph

**Demographics**

**Image**

**Results T- and Z-scores**

**Graph**

Region	Area (cm <sup>2</sup> )	BMD (g/cm <sup>3</sup> )	BMC (g)	T-score	Z-score	ANZ (%)
L1	11.79	0.85	10.01	-2.8	-0.8	76
L2	11.83	0.88	10.45	-3.3	-0.2	73
L3	13.68	0.88	12.02	-2.7	-1.6	88
L4	14.48	0.88	12.78	-3.5	-2.4	74
Total	50.68	0.794	40.3	-3.7	-2.8	74

**DXA Results Summary**

Region	Area (cm <sup>2</sup> )	BMD (g/cm <sup>3</sup> )	BMC (g)	T-score	Z-score	ANZ (%)
Radius	4.89	0.50	2.45	-1.3	-0.1	74
Ulna	3.28	0.48	1.58	-0.8	0.0	88
Both	8.17	0.49	4.03	-1.4	0.2	80
Total	26.26	0.84	21.7	-1.2	-0.2	82
Both 33%	1.03	0.83	0.85	-3.1	-0.1	58

### Forearm Example

Remember only the 33% or 1/3 radius T-score can be used for diagnosis using the WHO criteria

Region	BMD (g/cm <sup>3</sup> )	Young-Adult (%)	T-score	Age-Matched (%)	Z-score	BMC (g)	Area (cm <sup>2</sup> )
Radius UD	0.607	130	3.1	151	4.5	2.41	3.96
Ulna UD	0.490	-	-	-	1.16	2.37	-
Radius 33%	0.929	105	0.5	122	1.9	2.46	2.65
Ulna 33%	1.069	-	-	-	2.25	2.11	-
Both UD	0.563	-	-	-	3.57	6.33	-
Both 33%	0.991	-	-	-	4.72	4.76	-
Radius Total	0.769	113	1.4	129	2.9	12.40	16.14
Ulna Total	0.796	-	-	-	8.53	10.72	-
Both Total	0.779	-	-	-	20.93	26.86	-

### Examples of Issues That Can Affect Interpretation Of Bone Density Results

- Patient positioning
  - Spine not centered
  - Hip abducted or rotated improperly
- Placement of regions of interest
  - Different placement of the femoral neck box
- Artifacts
  - Hardware including prosthetic joints
  - Contrast
  - Osteoarthritis
  - Laminectomy
  - Fractures

**Take-Home Lesson:**  
Review DXA images to ensure appropriate interpretation

### Spine Artifacts Often falsely Elevate Measured BMD

Vertebral fracture: Eliminate L2

Severe Scoliosis: Uninterpretable

### Contrast Can Falsely Elevate Measured Density

L1-L4 BMD = 1.268 g/cm<sup>2</sup>  
T-score = +0.7

2 weeks Later  
L1-L4 BMD = 0.929 g/cm<sup>2</sup>  
T-score = -2.1

### Patient CD

- 72 y/o Caucasian female: routine DXA
- DXA T-scores
  - LS -1.9
  - FN -1.2
- Diagnosis = Osteopenia

### Patient CD

Region	BMD	T-score
L1	0.516	-3.7
L2	0.739	-2.6
L3	0.871	-1.9
L4	1.122	-0.1
L1-L4	0.834	-1.9
L1-L3	0.721	-2.7

Diagnosis = Osteoporosis

### Patient CD

Diagnosis = Osteoporosis

### Patient CD: Teaching Points

- Accurate DXA interpretation requires looking at scan data including the image
- This patient's diagnosis changed from
  - Osteopenia (T-score = -1.9 at L1-L4) to
  - Osteoporosis (T-score = -2.7 at L1-L3) to
  - Osteoporosis = osteoporosis with fracture
- Spine imaging is important

### 2014 NOF Guide

- Practical clinical guide that includes recommendations on
  - When to do DXA
  - How to treat
  - Secondary causes to consider
  - Treatment options

2014 update available on-line at [www.NOF.org](http://www.NOF.org)

## NOF Guidelines Who Should Be Treated?


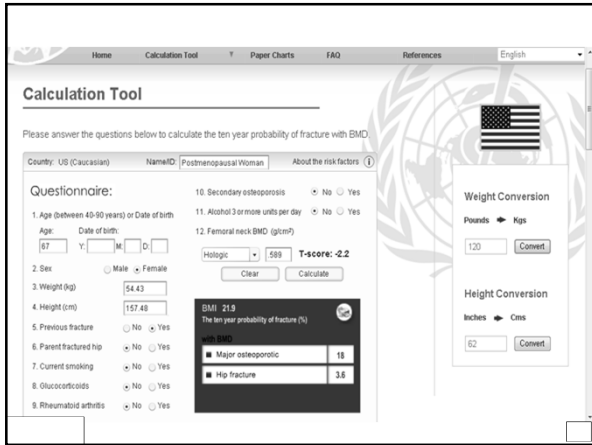
- Fragility fracture hip or spine
- T-score  $\leq -2.5$
- T-score -1.0 to -2.5 (osteopenia) and
  - 10-year hip fracture probability  $\geq 3\%$  or a 10-year major osteoporosis-related fracture probability of  $\geq 20\%$

[www.nof.org](http://www.nof.org)

## FRAX<sup>tm</sup>: The WHO Fracture Risk Assessment Tool


[www.shef.ac.uk/FRAX/](http://www.shef.ac.uk/FRAX/)

- Assesses 10-year risk of hip fracture and all osteoporotic fractures
- Based on risk factors plus or minus femoral neck BMD
- Fracture probability calculated from 12 worldwide cohorts (59,232 individuals, 250K person-years), validated in 11 independent cohorts


## Answering FRAX Questions

- What does untreated mean?
  - No ET/HT, SERM, calcitonin, PTH, DMAB, for the past 1 year
  - No bisphos for the past 2 years
    - ◊ Unless it is an oral taken for <2 months
- Age
  - Model accepts ages between 40 and 90
  - If patients are younger or older the program will compute probabilities at 40 and 90 years respectively




## Answering FRAX Questions

- Previous fracture
  - Fracture in adult life occurring spontaneously or from trauma which, in a healthy person, would not have resulted in a fracture
- Parent fractured hip
  - Does not allow for other types of fracture
- Current smoking
  - Not past smoking
- Glucocorticoids
  - EVER oral glucocorticoids for more than 3 months at a dose of prednisone 5mg daily or more



## Answering FRAX Questions

- Secondary Osteoporosis
  - Disorder strongly associated with Osteoporosis
  - Type 1 DM, OI in adults, untreated/longstanding hyperthyroidism, hypogonadism, premature menopause, chronic malnutrition, Malabsorption, chronic liver disease
  - Dummy risk factor if BMD entered
- ETOH 3 or more units daily
  - 1 unit = 1.5 oz liquor, 10 oz beer, 4 oz wine



**FRAX Limitations**

- Do not use in premenopausal females, men under age 50 and kids
- Tx will change fracture risk but this is difficult to quantitate
- All populations are not included
- Risk may be under or overestimated
  - BMD input only for FN
  - “dose effect” not considered with smoking, steroids, alcohol or RA
  - Does not include falls, rate of bone loss, bone turnover, FH of fx other than hip



**Patient DF**

- 72 y/o Caucasian Female
- Mother with hip fracture
- FN T-score = -2.0
- FRAX = 20.0% / 7.6%
- Would you treat?



**Patient DF: Using FRAX Teaching Points**

- FRAX can help with treatment decisions
- NOF guide recommends consideration of pharmacologic therapy in patients with osteopenia when 10 year probability of major osteoporotic fracture  $\geq 20\%$  or  $\geq 3\%$  for hip fracture

**Patient SF**

- 65 y/o Caucasian Female falls in her garden and fractured her wrist
- She has previous history of rib fracture with coughing at age 62 and ankle fracture after twisting injury at age 58
- DXA: LS T-score = -1.7, FN = -2.0
- FRAX= 16% / 2.7%
- What is the diagnosis?
- Would you treat?



**Patient SF: Teaching Points**

- Treatment decisions should be individualized
- NOF guide does not consider wrist fracture alone to be indication of treatment
- FRAX includes prior fragility fracture but does not distinguish type, severity or number of fractures
- FRAX underestimates fracture risk with multiple fractures

**Patient HL**

- 65 y/o Caucasian Male, H/O back pain, maternal h/o hip fracture, no personal h/o fracture
- LS T-score = +1.2, FN = -2.0
- You are uncertain whether or not to recommend treatment and he is uncertain whether he is willing to take treatment
- FRAX = 15% / 2.2%
- What do you recommend?



### Patient HL Teaching Points

- FRAX suggests no treatment needed but...
- Consider VFA or other vertebral imaging when knowledge of fracture would make a difference in clinical management
- Knowledge of vertebral fracture may change diagnostic classification, assessment of fracture risk, treatment recommendations and patient's motivation to take treatment



### Patient HL Post VFA

- VFA shows compression fracture
- Repeat FRAX calculation = 25% / 3.7%
- How does your management change?

### Patient AL

- Healthy 30 y/o Caucasian female has free heel QUS at a health fair
- T-score = -1.1
- PCP orders DXA
- FN T-score = -2.5 and Z-score = -2.4
- Images reviewed are of good quality
- What is the diagnosis?
- Would you treat?



### Patient AL: Teaching Points

- Use Z-scores not T-scores in premenopausal woman
- Diagnosis: BMD is below the expected range for age
- Low peak bone mass is common cause of low BMD in healthy premenopausal woman
- Fracture risk is low
- BMD is likely to remain stable until perimenopause or menopause
- Pharmacologic therapy is rarely if ever indicated
- FRAX is not validated under age 40
- NOF guidelines do not apply to perimenopausal women
- Evaluation may be needed depending on clinical history

### DOCTORS



What my friends think I do



What my Mom thinks I do



What society thinks I do



What the government thinks I do



What I think I do



What I really do