A short guide to DXA and BMD

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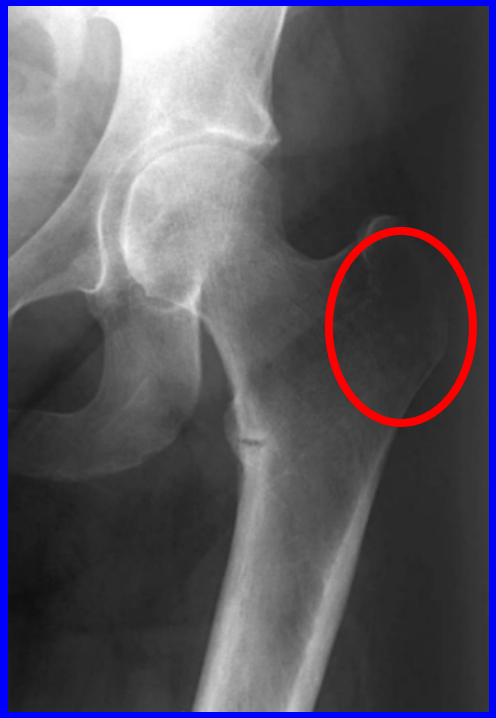
How does it work?

Patient pathways

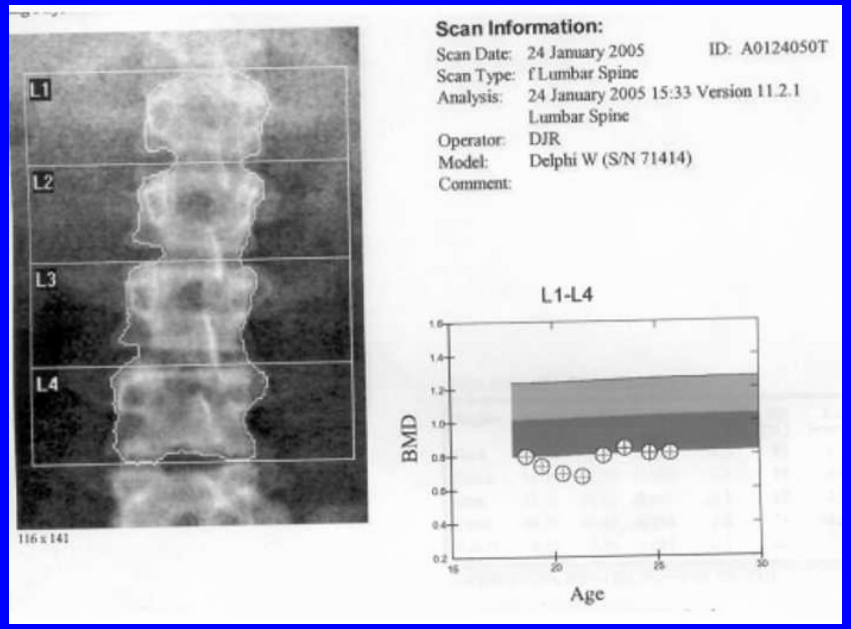
What's new?

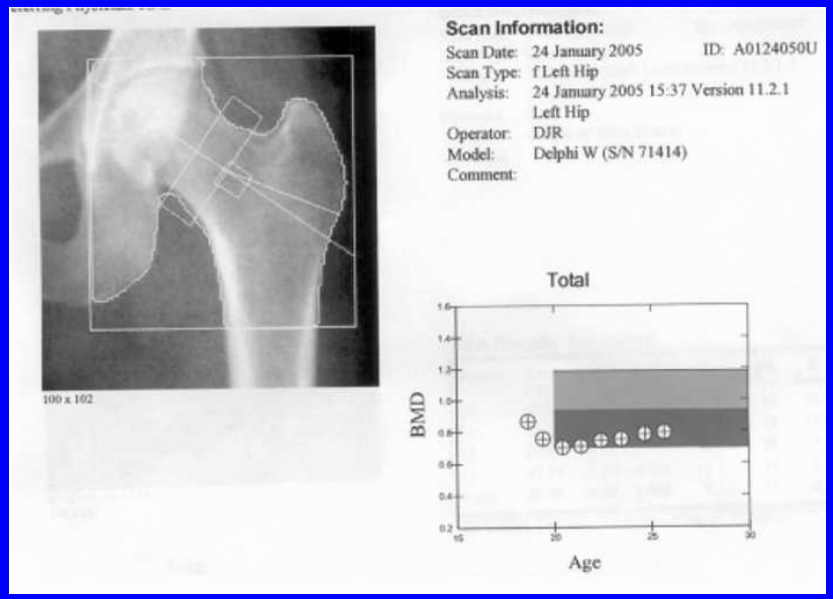
x-rays can suggest deficiency in bone mineral..



…but DXA provides both an image and a numerical assessment of bone density

The function of the image is to ensure the appropriate region of interest is measured every time…





Good precision depends critically on ROI placement …

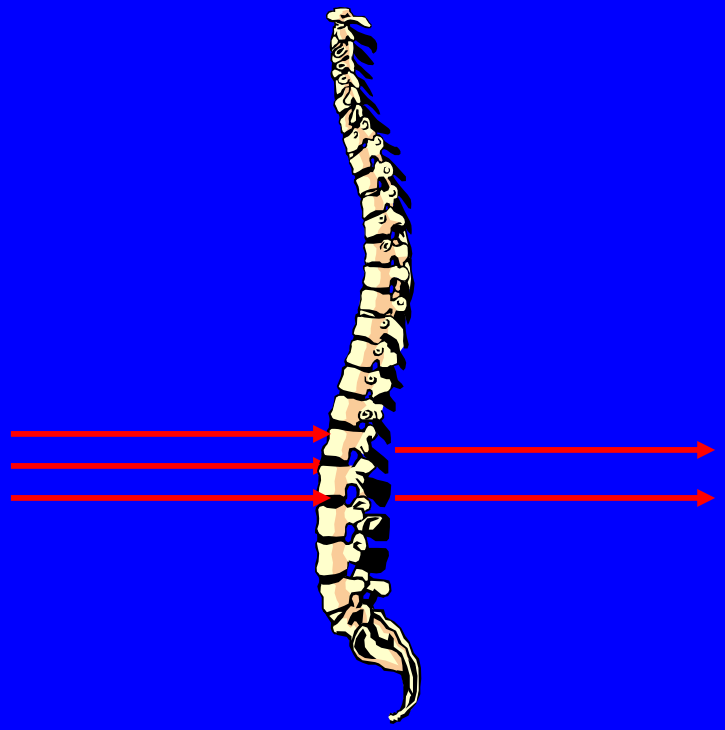
In bone densitometry, the gold standard is the ash weight of the skeletal site being tested. BMD testing is very precise and accurate compared to other tests commonly used in clinical practice, but precision and accuracy will vary according to the instrument used, the skeletal site being measured, *and the skill of the technologist.*

www.iscd.org

So image quality is an important factor ensuring precision

…but how does it work out the numbers?

DXA works by measuring a narrow beam of x rays transmitted through bone



I_0

X Rays in

$I = < I_0$

X Rays out

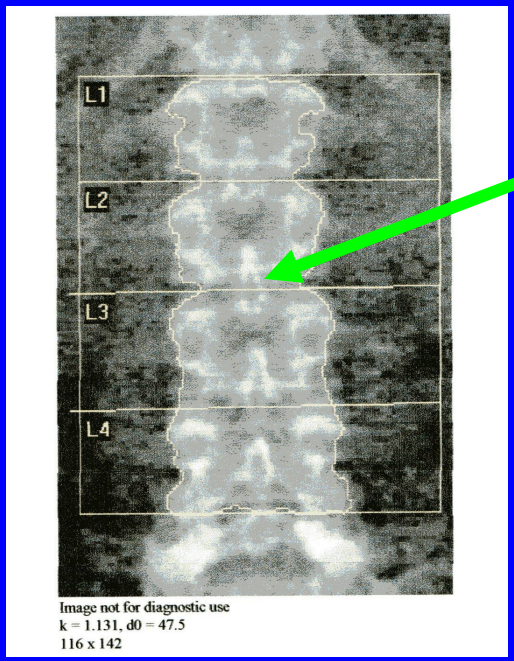
Narrow x-ray beams obey a well defined exponential law of absorption

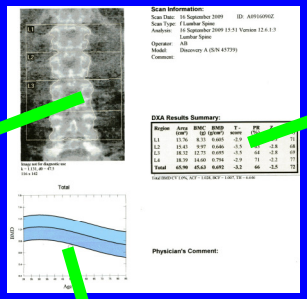
For narrow beam x-rays passing through a person …

- Absorption depends upon the bone mineral density (BMD) (g/cm^2) which is what we want to know
- It also depends upon soft tissue thickness and fat content which varies within and between patients.
- DXA uses two x-ray energies at each point
- Changes in absorption with energy are much greater for bone than soft tissue
- The difference in the two signals at each point when compared to soft tissue baseline gives BMD

The report shows……

1) A skeletal image (lumbar spine or proximal hip)
2) Bone mineral densities (g/cm^2)
3) The patient result plotted against a normal population

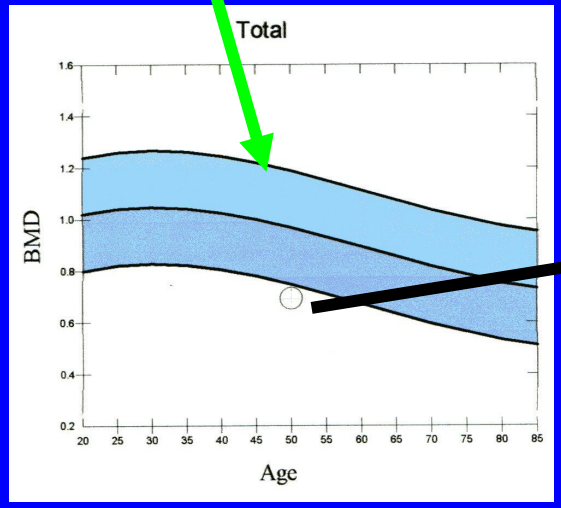




DXA Results Summary:

Region	Area (cm²)	BMC (g)	BMD (g/cm²)	T - score	PR (%)	Z - score	AM (%)
L1	13.76	8.33	0.605	-2.9	65	-2.3	71
L2	15.43	9.97	0.646	-3.5	63	-2.8	68
L3	18.32	12.73	0.695	-3.5	64	-2.8	69
L4	18.39	14.60	0.794	-2.9	71	-2.2	77
Total	**65.90**	**45.63**	**0.692**	**-3.2**	**66**	**-2.5**	**72**

Total BMD CV 1.0%, ACF = 1.028, BCF = 1.007, TH = 6.646



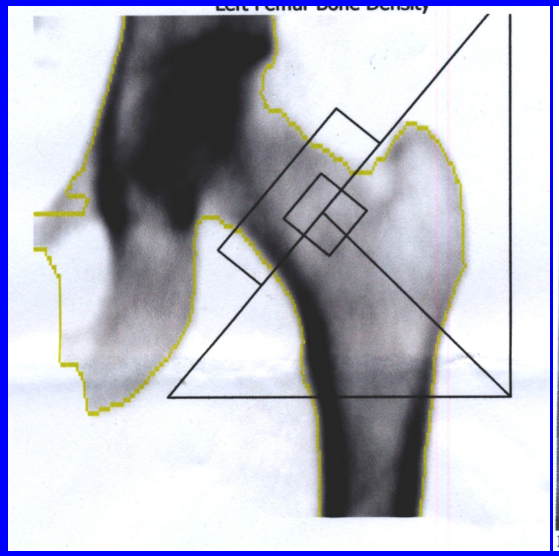
Z= -2.5

T= -3.2

Same patient two years apart…

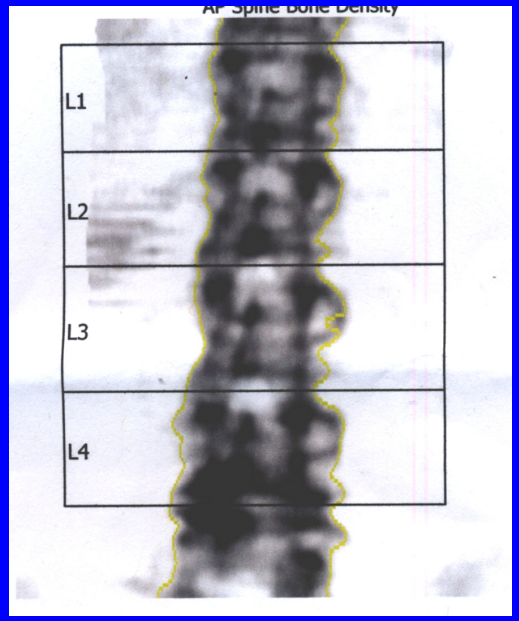
Lunar

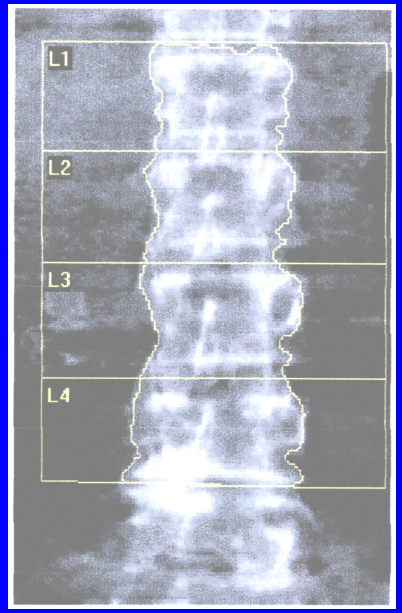
Bravo



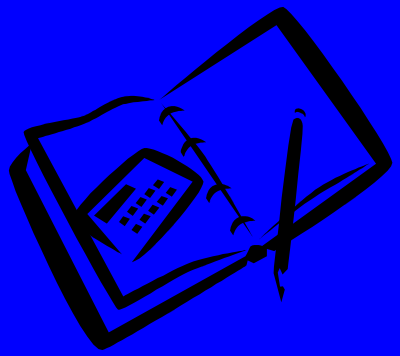
Hologic

Discovery





Specifications DXA



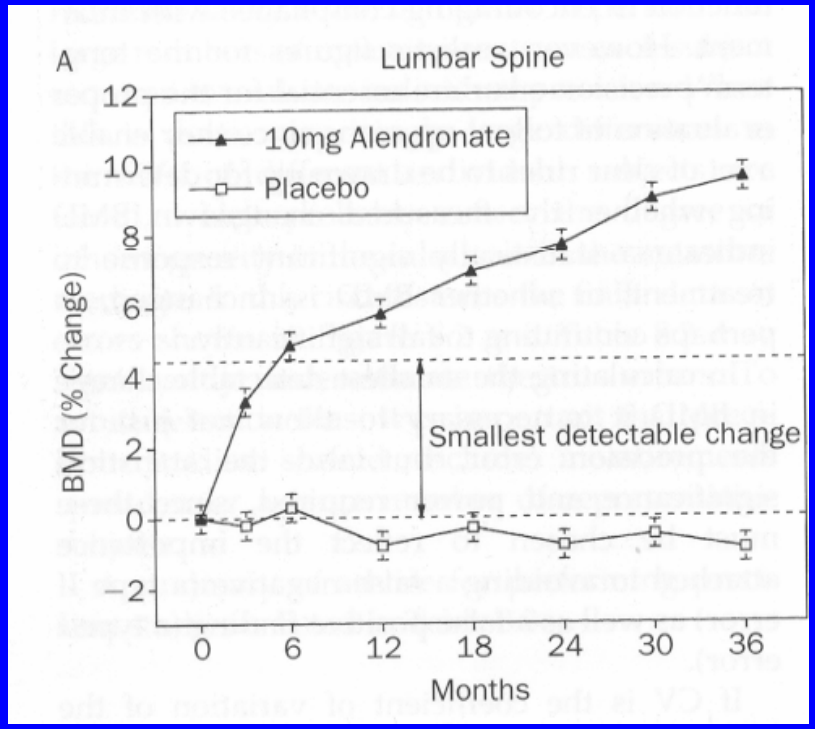
- Long term precision about 2-3% in vivo
- Scan time 30secs per region
- Patient appointment time 15 mins
- Low radiation dose (8 microSievert)

Monitoring using DEXA

Least significant change =2√2(Precision)

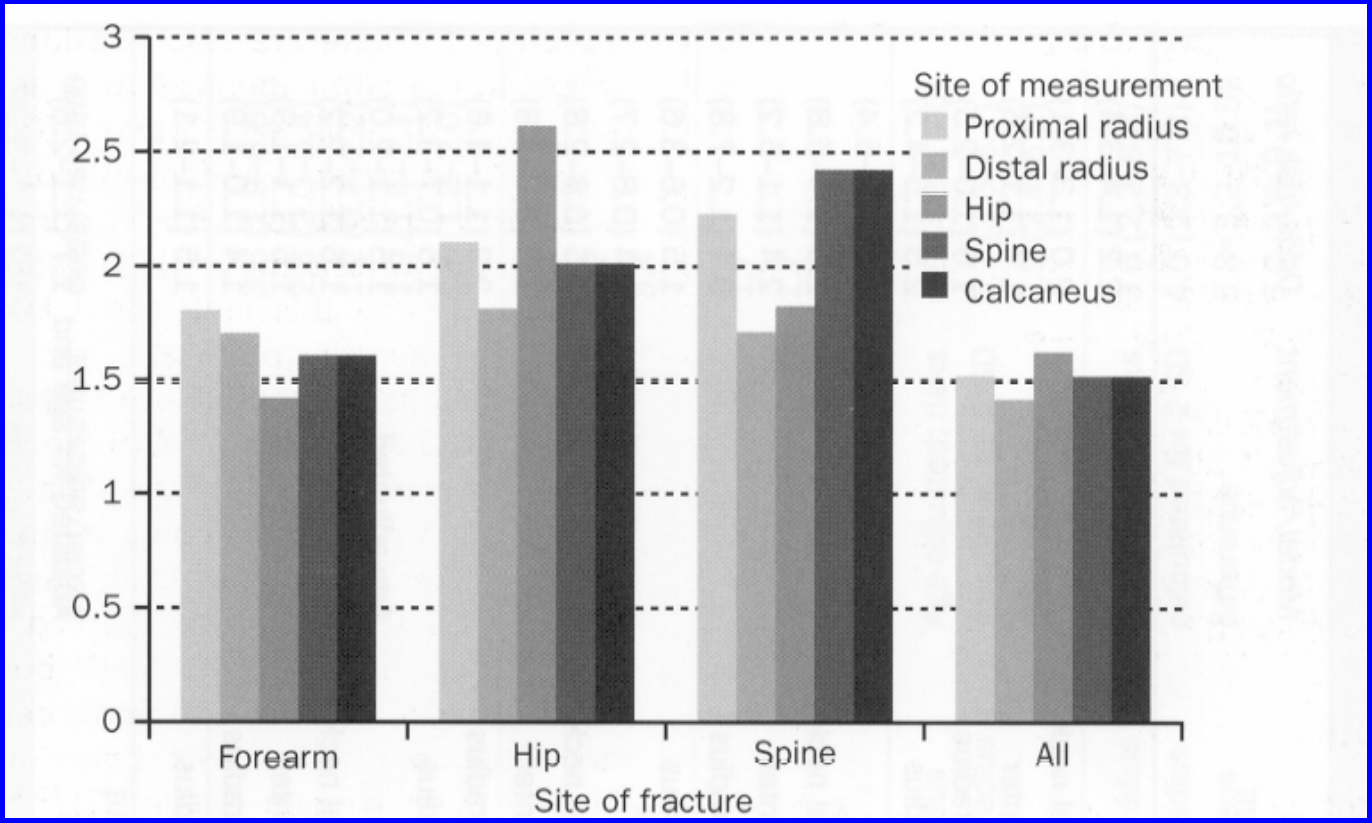
or around 5-8%

- Typical changes due to treatment 5-6% at 1y
- Monitoring at 1 year may not be diagnostic
- Monitoring at 2 years recommended



So why is DXA useful then?

When T score falls by 1 unit the risk of future fracture increases by factor of between 1.4 and 2.6 Marshall et al 1996



DEXA can be used to diagnose osteoporosis

- Osteoporosis is diagnosed in adults where T=-2.5 or less at the lumbar spine or hip (WHO criteria 1994)
- This may not necessarily represent a treatment threshold as a full clinical assessment is indicated prior to treatment

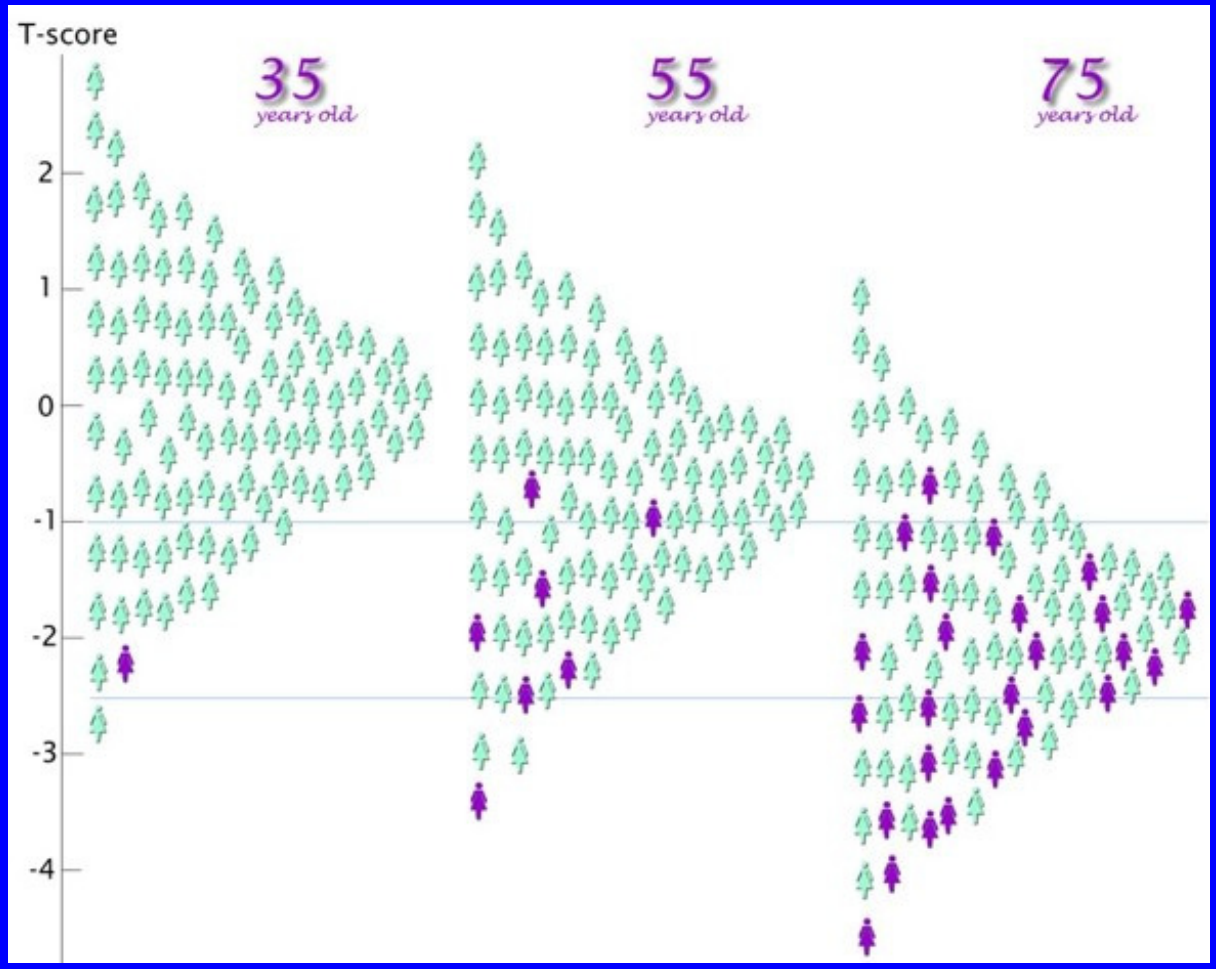
DEXA can be used to diagnose osteoporosis

- Normal bone: T-score better than -1
- Osteopenia: T-score between -1 and -2.5
- Osteoporosis: T-score less than -2.5
- Established (severe) osteoporosis

includes the presence of a non-traumatic fracture.

100 unselected US women at three ages lined up according to bone density T score

The ones in purple would have a fragility fracture within the next ten years



Kanis et al Osteoporos Int. 2002 Jul;13(7):527-36

How do we use DXA?

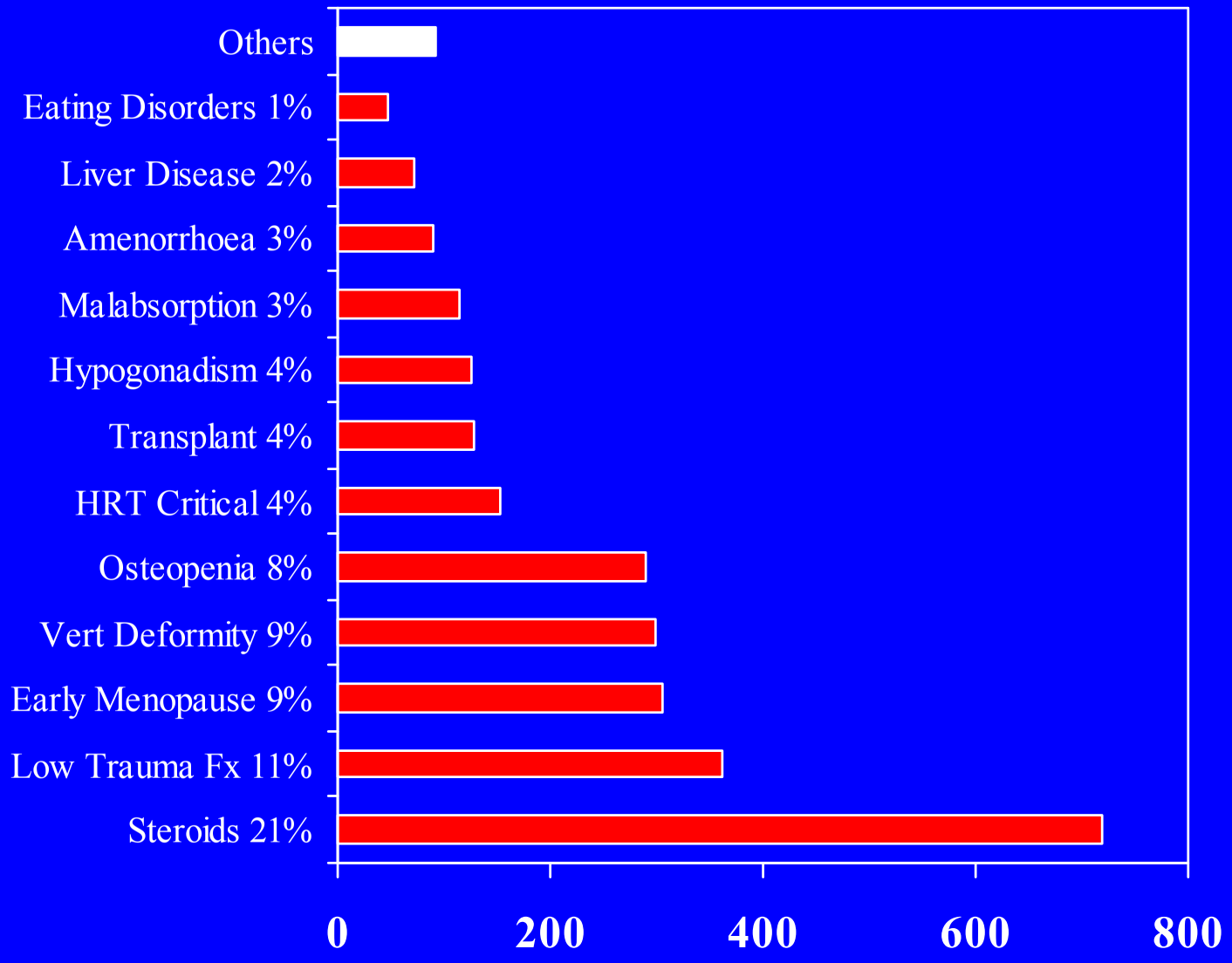
- Bone Density (DXA) is a sensitive indicator of future fracture but is not very specific
- It cannot therefore be used for population screening
- It can however be used along with clinical risk factors as part of a case finding strategy

The indications for DEXA

based upon NOS 'Local Provision for Osteoporosis' and AGO report

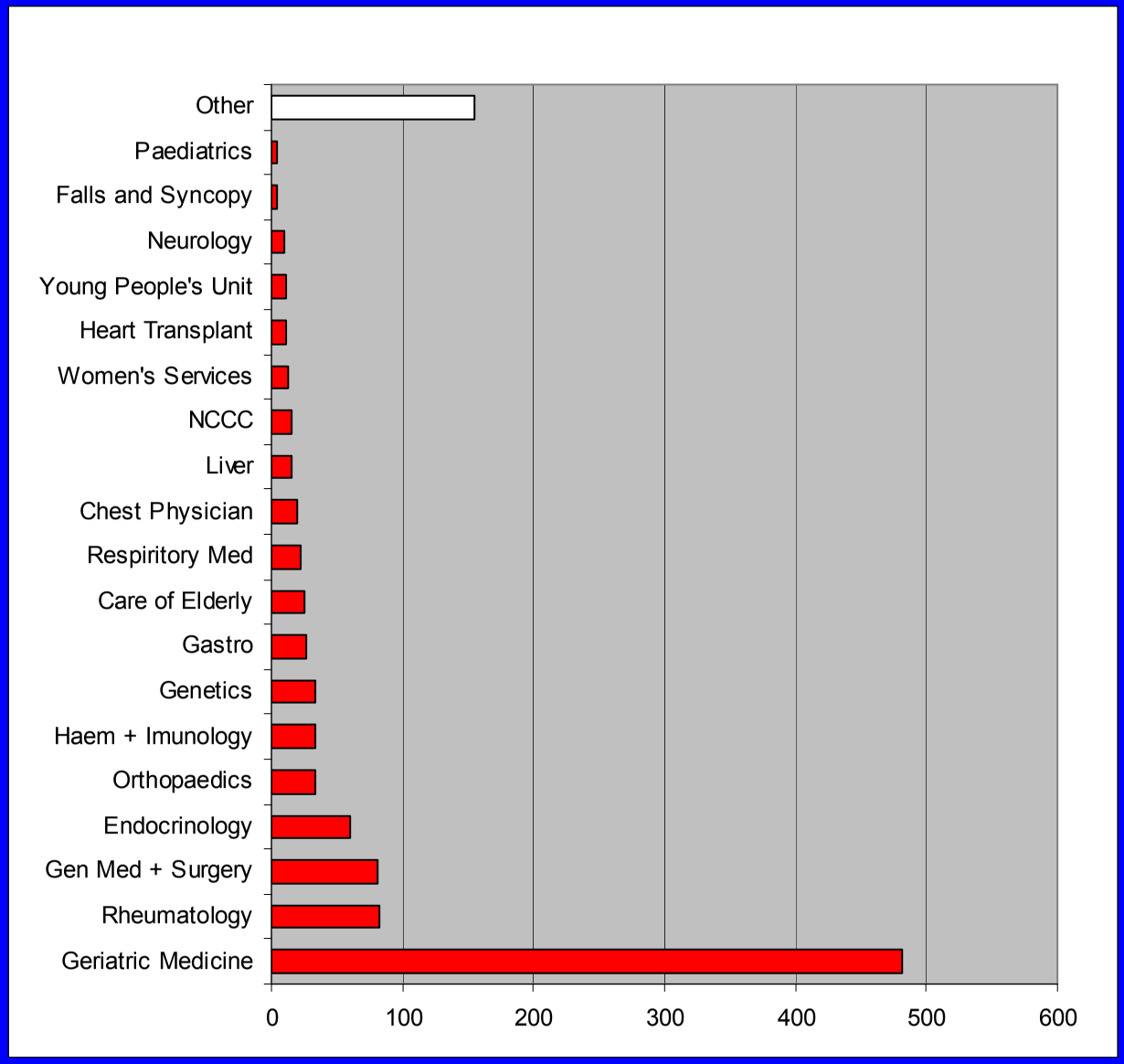
- Early Menopause
- Prolonged Amenorrhoea
- HRT Critical
- Vertebral Deformity
- Low Trauma Fractures
- Osteopenia on X-ray
- Long term/high dose steroids
- Eating disorders
- Chronic Liver disease
- Alcohol abuse
- Kidney dialysis
- Hyperparathyroidism
- PBC
- Hypogonadism
- Malabsorption Syndrome
- Transplant Assessment
- Growth Hormone
- JCA
- Thyroid Dysfunction
- Follow up/previous abnormal DEXA
- Other indication / trial patient

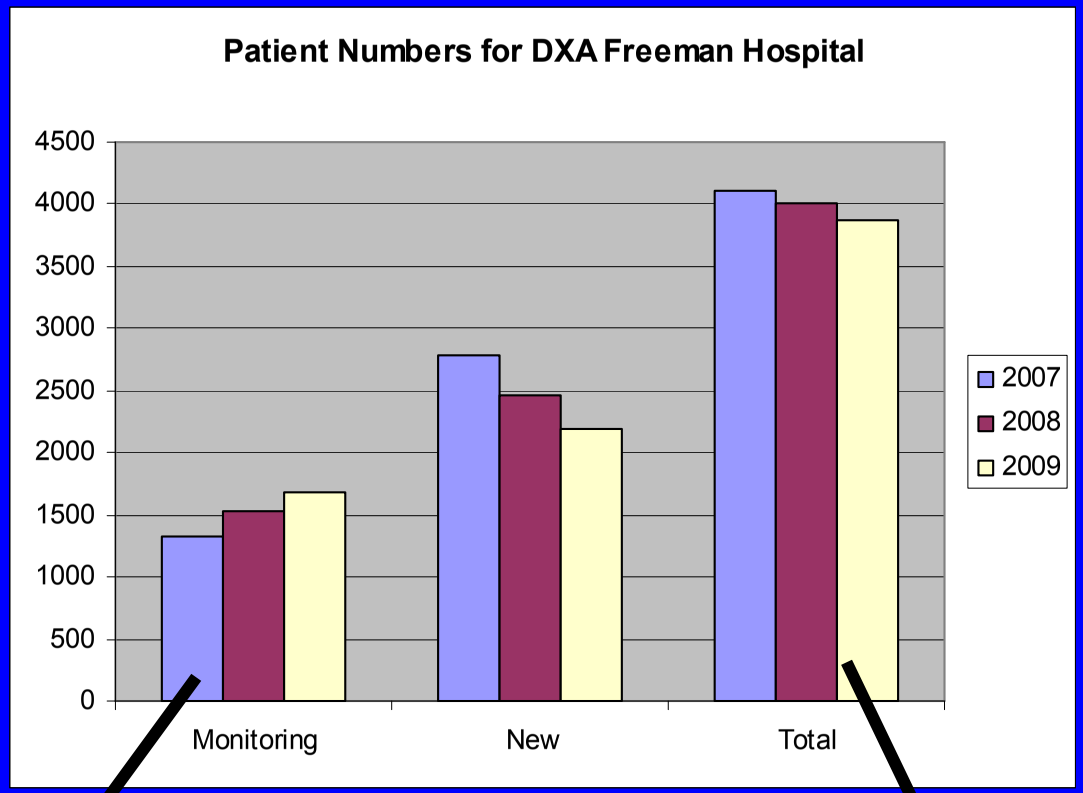
New patient clinical requests 2000-2001



Based on common indications e.g. www.nos.org.uk

Clinical requests by NUTH speciality snapshot July 2008



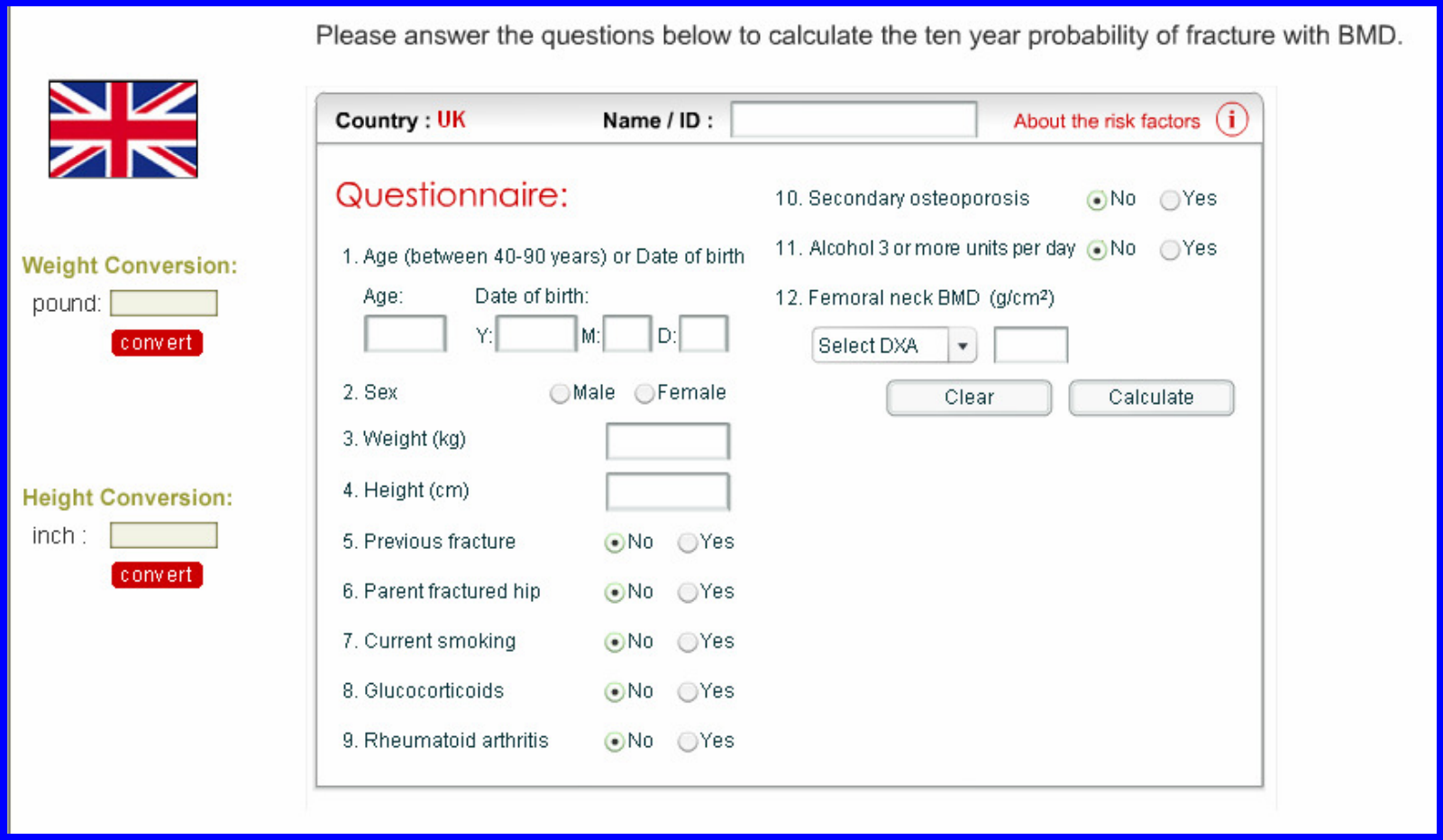


Min 2 years or about 5% change in BMD

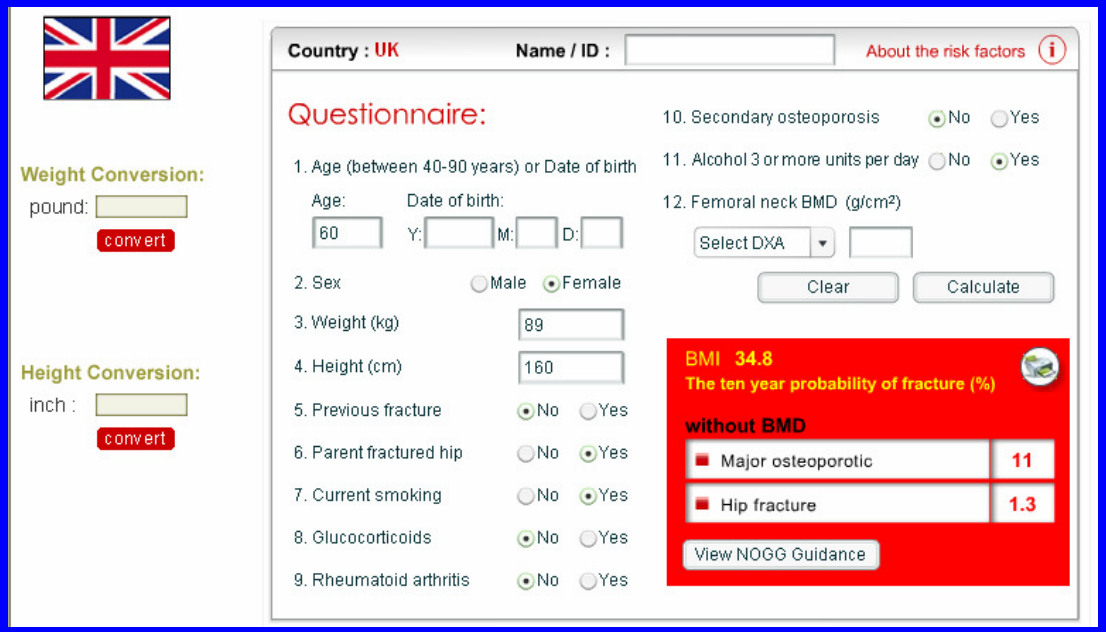
Broadly consistent with NOS guidelines

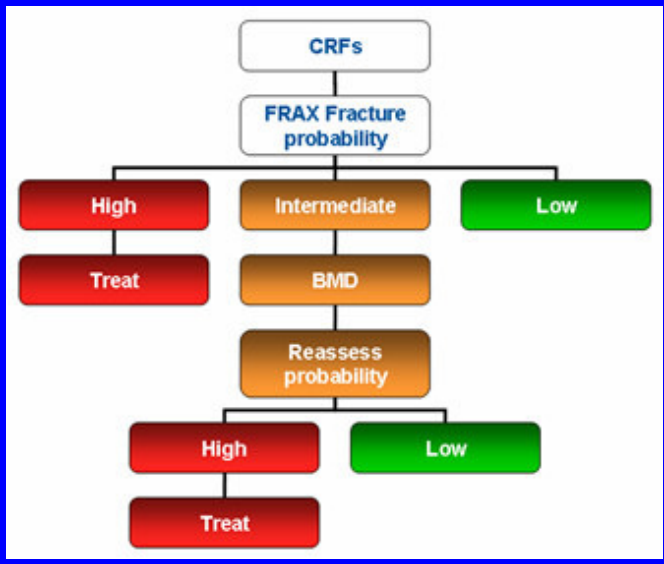
Point of care clinical risk assessment

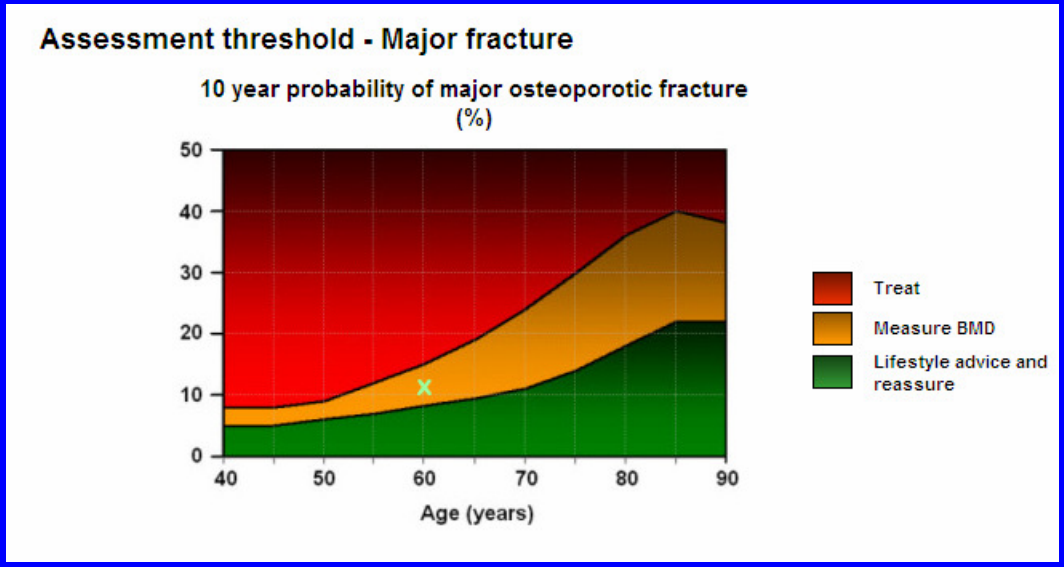
http://www.shef.ac.uk/FRAX/



Now available as an i-phone app !


Weight Conversion:
pound:
convert
Height Conversion:
inch :
convert
Country : UK
Name / ID :
About the risk factors
Questionnaire:
1. Age (between 40-90 years) or Date of birth
Age:
Date of birth:
60
Y:
M:
D:
2. Sex
Male
Female
3. Weight (kg)
89
4. Height (cm)
160
5. Previous fracture
No
Yes
6. Parent fractured hip
No
Yes
7. Current smoking
No
Yes
8. Glucocorticoids
No
Yes
9. Rheumatoid arthritis
No
Yes
10. Secondary osteoporosis
No
Yes
11. Alcohol 3 or more units per day
No
Yes
12. Femoral neck BMD (g/cm²)
Select DXA
Clear
Calculate
BMI 34.8
The ten year probability of fracture (%)
without BMD
Major osteoporotic
11
Hip fracture
1.3
View NOGG Guidance


CRFs
FRAX Fracture probability
High
Intermediate
Low
Treat
BMD
Reassess probability
High
Low
Treat

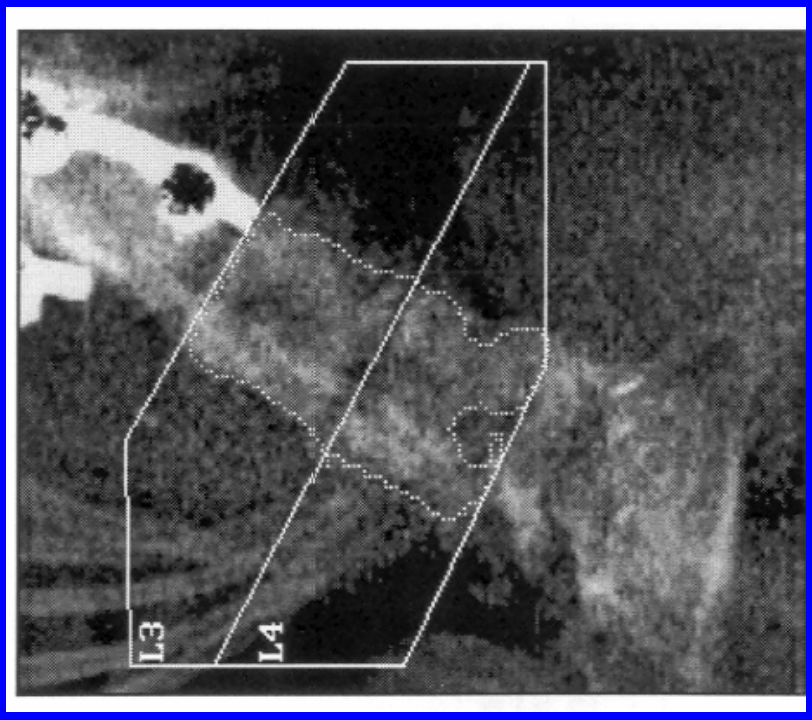

Assessment threshold - Major fracture
10 year probability of major osteoporotic fracture (%)
50
40
30
20
10
0
40
50
60
70
80
90
Age (years)
X
Treat
Measure BMD
Lifestyle advice and reassure

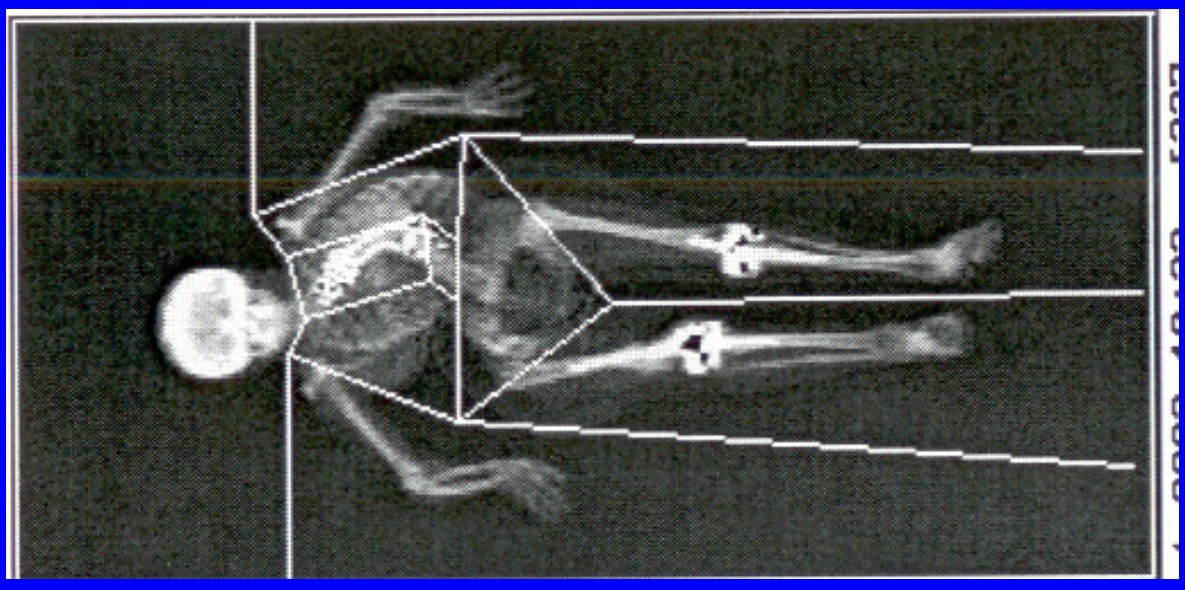
Case study

A young women with severe scoliosis

Relevant History

- Young woman aged 31
- Severe Scoliosis
- Multiple joint replacements
- Limited Mobility


L3
L4



Findings

- Measured at 26 years and 32 years
- Z(L3/L4) = -2.0 and -2.5
- Z(WB) @32: +8.73 [influenced by metal]
- BMD(pelvis) @32: close to expected
- BMD(arms) @32: 20-30% below expected

Conclusions?

- L3/4 may not be representative
- Whole body BMD not diagnostic
- Some evidence of localised bone loss
- Utility of forearm measurements?
- Interpret all BMD with caution

Other patient pathways?

Emergency Admissions Unit (W43)

Dr Ashley Price Dr Soumya Kumble

- 50-60 patients per day admitted
- Variety of conditions
- Indications for DXA / treatment?
- 62 admissions over 3 days Jan 2009
- FRAX tool
- N=21 reassure, N=14 DXA; N=11 Treat
- Need largely unmet at present
- Very early days

Radiology Reports

Dr Geoff Hide; Sister Sharon Abdy

- Spine x-rays may identify vertebral fracture
- Not always followed up by GP
- Indications for DXA / treatment?
- Local audit suggests several per month
- Supported by data from Glasgow
- Pathway to DXA / Treatment unclear
- Early days

GP case finding

Dr Wendy Carr

- Co-ordinated case finding strategy
- Led by single GP practice
- Selected patients offered DXA at FRH
- Technical report produced
- Service level agreement (SLA) in place
- Approx 20 patients per month
- On-going

What's new

- Vertebral Fracture Assessment
  - Total spine x-ray at same time as BMD
  - Lower dose than conventional spine x-rays
- Electronic requesting (soon)
- Electronic reports (eventually)

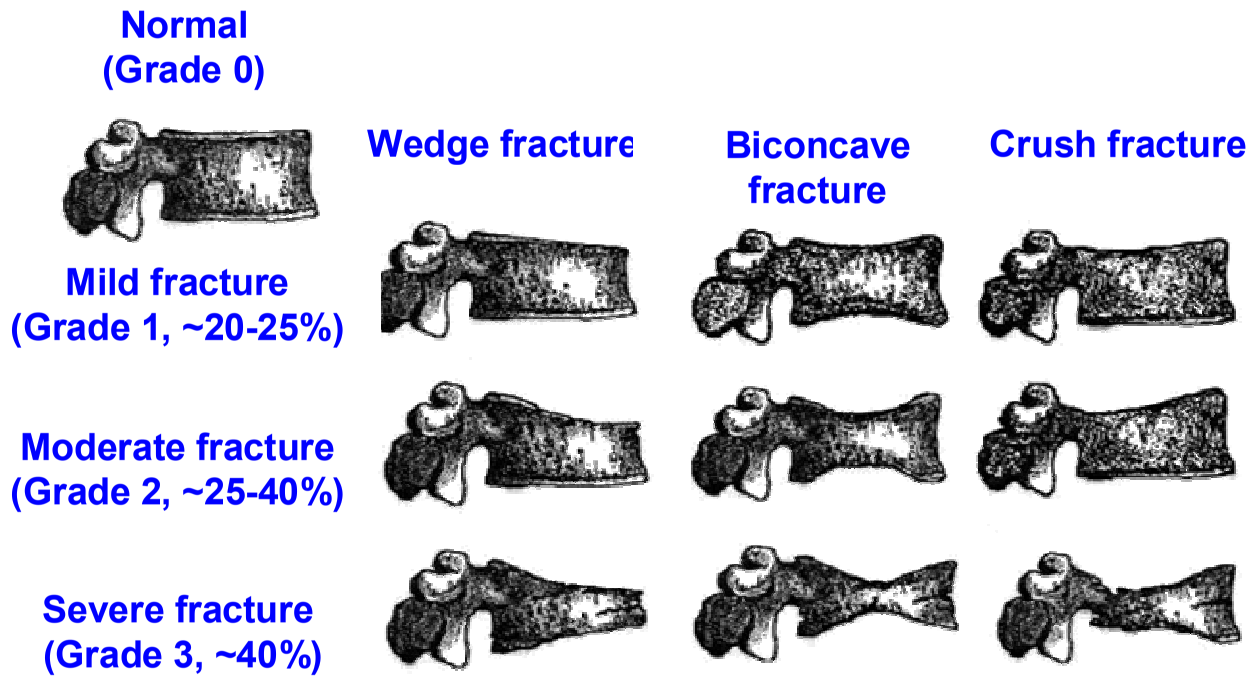
A patient who has already fractured could fracture again…

- fragility fracture (45+)
- no trauma (standing height or less)
- includes vertebral deformity
- independent risk for further fracture
- an indication for treatment without BMD

RCP Guidelines 2001

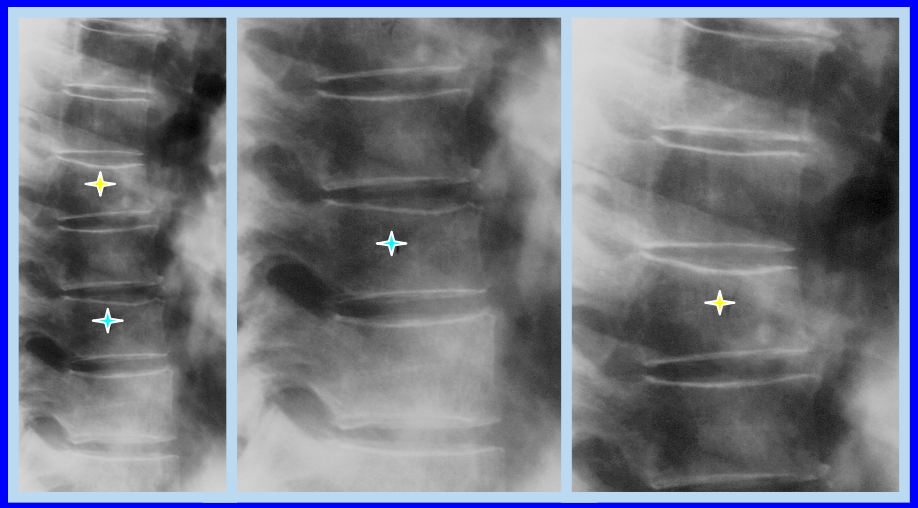
Pre-existing fracture and low BMD greatly increases risk of future fracture

May identify pre-existing fractures by semi-quantitative grading…



Genant et al (1993)

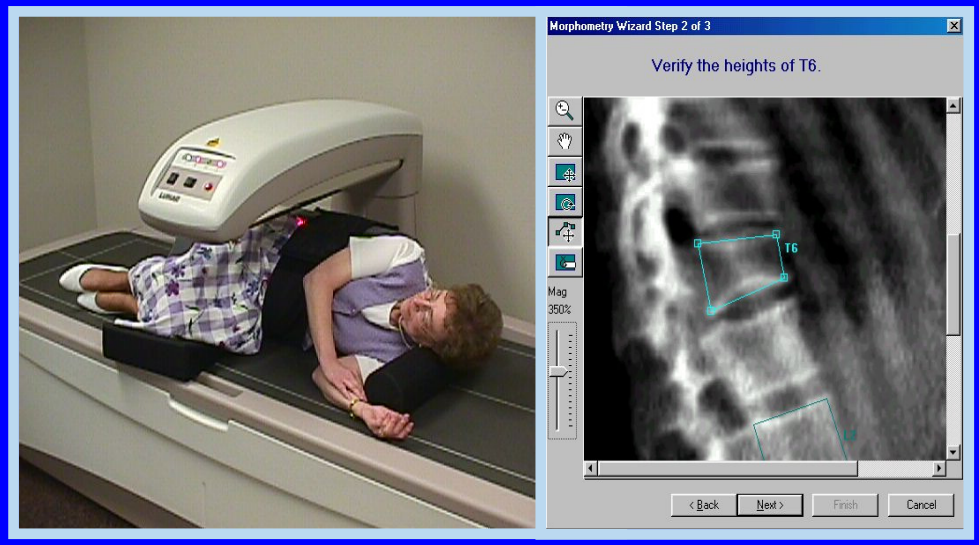
Lateral spine x-rays allow visual grading against the grading chart…



…or a quantitative assessment measuring vertebral heights directly

Vertebral Fracture Initiative (2006)

…or we may identify and grade vertebral fractures using DXA



Vertebral Fracture Initiative (2006)

So BMD and vertebral morphometry together – one stop shop!

Advantages of morphometry by DXA

- semi-automated alignment
- semi-automated positioning
- better penetration (100-140kVp)
- single view for whole spine
- dose about 1/50th (0.006mSv)
- includes BMD assessment
- single or dual energy options
- able to see most vertebra?

Thank-you