Frequently asked questions on measurement of bone mineral densitometry

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Introduction

Osteoporosis currently afflicts over half of women and almost 30% of men aged over 60 years; this figure will grow as the population ages. Fractures—especially of the hip—result in considerable social and economic costs to the individual and to society, as well as leading to an appreciable mortality.

Bone mineral density measured with dual-energy x-ray absorptiometry is the 'gatekeeper' to osteoporosis treatments in New Zealand and the best way to estimate future fracture risk. Hence it is important to be familiar with some of the technical aspects of densitometry and its application in the community. Clarification of some of these areas may facilitate more effective utilisation.

What are the indications for bone mineral density (BMD) assessment?

The indications for BMD testing, as recommended on the Osteoporosis New Zealand website (http://www.bones.org.nz), are listed in Table 1. As pointed out on the site, BMD should only be measured if it will impact management.

What is the accuracy?

The precision of DXA is approximately 1.0–1.5% for spine and total hip BMD.[1] DXA scanners have excellent long-term precision because their calibration is very stable and there are effective instrument quality control procedures (provided by the manufacturers) to detect any long-term drifts. The test–retest variation for spine and hip DXA is 2–3%, resulting in T-score accuracy errors of ± 0.5.[2]

What is the radiation dose?

The effective radiation dose is 1–10 μSv.[3] Context is provided in Table 2.

Are spine or hip measurements better?

The best way of predicting fracture risk at any given site is to measure BMD at that site—for example, DXA of the proximal femur predicts femoral fracture better than measurements at other sites.[4] Similarly, for vertebral or wrist fractures.

The spine is the best site for follow-up measurements because treatment changes are usually the

Table 1. Indications for bone densitometry

Women over 60 years and men over 70 years with risk factors such as: Glucocorticoid therapy Parental history of a hip fracture Low body weight (< 58 kg) or body mass index (< 20 kg/m²) History of smoking or heavy alcohol intake Premature menopause in women or hypogonadism in males Rheumatoid arthritis Malabsorption, chronic liver or renal disease
Any woman over 65 years or man over 75 years considering specific measures to prevent osteoporosis
Any individual prescribed long-term glucocorticoids or other medications associated with osteoporosis, e.g. anticonvulsants, aromatase inhibitors
Women with a history of premature menopause
Postmenopausal women or older men with a history of minimal trauma fracture

(from Osteoporosis New Zealand—www.bones.org.nz)

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Table 2. Effective radiation dose of DXA compared to urban background and other medical procedures[3]

DXA	1-10 µSv
Chest x-ray	30 µSv
Mammogram	130 µSv
Annual background (urban environment)	2000 µSv
CT pelvis	5000 µSv

largest at this site and the precision error is lower than at other sites.[5,6]

How do the fracture risk calculators compare?

The WHO Fracture Risk Assessment Tool (FRAX) algorithm (available at http://www.shef.ac.uk/frax) accounts for 14 risk factors (as listed in Table 3) in calculating 10-year probabilities of hip and major osteoporotic (humerus, forearm, hip or clinical vertebral) fractures.[7] It incorporates data from 12 independent fracture studies, over 60 000 men and women (from four continents) and 250 000 person-years of follow-up.[8] The Garvan Institute fracture risk calculator (http://garvan.org.au/promotions/bone-fracture-risk/calculator) requires fewer data and emphasises past fractures and falls.

Table 3. Clinical risk factors included in FRAX algorithm—www.shef.ac.uk/frax

Country of geographic origin
Ethnic origin
Age
Sex
Weight
Height
Previous history of fracture (after age 50)
Parental history of hip fracture
Current smoking status
Corticosteroid therapy (current or past)
Rheumatoid arthritis
Secondary osteoporosis
Alcohol intake (≥3 units daily)
Hip BMD

Table 4. Pharmac Special Authority for subsidy criteria for alendronate[10]

One significant osteoporotic fracture demonstrated radiologically and T-score ≤ -2.5
One significant osteoporotic fracture demonstrated radiologically, and either the patient is elderly, or densitometry scanning cannot be performed because of major logistical, technical or pathophysiological reasons
Two significant osteoporotic fractures demonstrated radiologically
T-score ≤ -3.0
Ten-year risk of hip fracture (according to FRAX or Garvan calculator) ≥ 3%
Patient has had a Special Authority approval for zoledronic acid (underlying cause—osteoporosis) or raloxifene
The patient is receiving systemic glucocorticosteriod therapy (≥ 5 mg per day prednisone equivalents) and has already received or is expected to receive therapy for at least three months; and • T-score ≤ -1.5; or • one significant osteoporotic fracture demonstrated radiologically; or • Special Authority approval for zoledronic acid (underlying cause—glucocorticosteroid therapy) or raloxifene

Table 5. Recommended intervals for serial DXA for detecting development of osteoporosis[14]

Normal BMD or 'mild osteopenia' (T-score not less than -1.5)	15 years
'Moderate osteopenia' (T-score between -1.5 and -2.0)	5 years
'Advanced osteopenia' (T- score between -2.0 and -2.5)	1 year

A recent study found that the Garvan Institute calculator overestimated hip fracture rates and FRAX (with BMD measurements) underestimated osteoporotic and hip fracture rates.[9] However, BMD should continue to be used to calculate fracture risk which informs treatment decisions.

How can BMD results be used to plan treatment?

BMD and/or fracture risk scores are used as the arbiters for osteoporosis treatment as treatment is considered cost-effective at certain thresholds of fracture risk. For example, Special Authority for Subsidy is granted under the Pharmac schedule[10] for alendronate according to the criteria in Table 4. By comparison, the threshold for treatment is set at a hip fracture risk in the next 10 years of 4% in the United Kingdom and Sweden.[11]

Why are there discrepancies between hip and spine T-scores?

A number of factors can spuriously affect the T- (and Z-) score at the hip and spine, including

degenerative bone/joint disease and aortic calcification which leads to spuriously high BMD measurements.[12] However, some conditions do tend to preferentially affect BMD at the spine more than the hip (e.g. steroid use) or the hip over the spine (e.g. hyperparathyroidism).

How often should DXA be repeated?

The International Society of Clinical Densitometry (ISCD) currently recommends no more frequent than biennial re-testing,[13] formulated from the known precision of DXA equipment and that the normal rate of postmenopausal bone loss is 1–2% per year.

Prospective clinical study of postmenopausal women concluded that development of osteoporosis is adequately detected by DXA frequency stratified by previous DXA findings for that individual[14] (summarised in Table 5). In most instances, this is much less frequent than the minimum two-year interval recommended by ISCD. However, it is also suggested that patients with advanced osteopenia should have repeat testing in one year, which directly contradicts the ISCD's recommendation.

Are DXA results from different facilities interchangable?

No. Different facilities use different equipment made by different manufacturers which, in turn, utilise different reference databases. It is best, therefore, to use the same software for repeat scans wherever possible.

SUMMARY

- DXA is a fast, reliable, low-radiation method for assessing BMD, which is the arbiter for osteoporosis treatment eligibility and the best determinant of future fracture risk.
- Web-based fracture risk calculators can utilise BMD data to provide further information for medical practitioners and patients.
- The interval for serial BMD assessment for detecting development of osteoporosis should be planned according to the previous DXA findings.

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COMPETING INTERESTS
None declared.