**Introduction**

Osteoporosis is commonly defined as a condition characterized by low bone mass and microarchitectural deterioration of bone tissue, leading to enhanced bone fragility and a consequent increase in fracture risk. It is associated with the natural loss of bone that occurs with age, especially within 3-6 years after menopause, and predisposes women to bone fractures that occur most commonly at the hip, wrist and spine.

Low bone mineral density (BMD) is one of a number of risk factors for fracture. The intention of screening or case finding for low BMD is to identify those who are at increased risk of future fracture. Appropriate non-pharmacologic and pharmacologic interventions, typically continued over many years, can then be used to delay or reverse bone loss and thereby decrease the likelihood of fracture.

BMD measurement has also been used to monitor those with a confirmed diagnosis of osteoporosis, and those being treated with drugs or who have a health condition that may alter bone metabolism. The predictive value of BMD measurement for future fracture depends both on its analytical performance (accuracy and precision) and on the influence of other risk factors on the individual.

A recent BMJ article “How does it work?” provides a concise description of the procedures involved in a BMD scan. Various technologies have been developed to measure BMD. Dual energy X-ray absorptiometry (DXA) is currently considered the most accurate and precise method. Quantitative transmission ultrasound has also been used to measure BMD and some recent studies indicate that quantitative ultrasound predicts hip and non-spine fractures about as well as DXA. The evidentiary basis for the use of ultrasound is limited to findings in women over the age of 65. Many studies have investigated the diagnostic accuracy and costs of the various methods used, but data remain limited, particularly on the long-term precision of the different methods.

**Research Questions**

BMD measurement is used to diagnose osteoporosis, and to assess the risk of future fracture. It has been proposed for use in population screening to identify those women at increased risk for fractures, but this approach has not been supported by health technology assessments or systematic reviews. The use of BMD for case-finding in selected populations has been suggested as a more appropriate role for the technology. The main questions surrounding the use of BMD measurement for the testing of asymptomatic individuals are:
PRE-ASSESSMENT

Bone Mineral Density Screening

Can available technologies measure BMD with acceptable accuracy and precision? (The literature indicates that the accuracy of diagnosis varies between the various technologies used and between different manufacturers’ units.)

How accurately can BMD measured with these technologies predict risk of fracture in an individual?

How can BMD best be employed, in conjunction with other methods of assessing risk of future fracture, in the management of patients?

What are the harms associated with BMD testing and associated treatments? Potential harms include effects of radiation exposure and adverse effects of medications prescribed.

Is the detection of low bone mass, followed by therapeutic interventions, effective in preventing further bone loss, and more importantly, in preventing clinically significant fractures?

Assessment Process

Literature searches were run on the PubMed, The Cochrane Library and the UK Centre for Reviews and Dissemination (CRD) databases (the HTA Database, DARE and NHS EED). The web sites of a number of major HTA agencies were also scanned. The 1996 International Network of Agencies for Health Technology Assessment (INAHTA) joint project reports were used as a starting point.

The 2002 guidelines from the Scientific Advisory Council of the Osteoporosis Society of Canada and the 2002 US Preventive Services Task Force (USPSTF) recommendations provide recent reviews of the available evidence.

The following table lists selected assessments, systematic reviews and guidelines published on this topic from 1998 to date.

Summary of Findings

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<th>Type of report</th>
<th>Title</th>
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<th>Main findings</th>
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<td>Practice guideline</td>
<td>2002 clinical practice guidelines for the diagnosis and management of osteoporosis in Canada</td>
<td>Brown JP, Josse RG, for the Scientific Advisory Council of the Osteoporosis Society of Canada. CMAJ 2002;167(10 Suppl):S1-34. Available: <a href="http://www.cmaj.ca/cgi/reprint/167/10_suppl/s1.pdf">http://www.cmaj.ca/cgi/reprint/167/10_suppl/s1.pdf</a></td>
<td>“Strategies for identifying those at increased risk (i.e., those with at least one major or two minor risk factors) and screening with central dual-energy X-ray absorptiometry at age 65 years are recommended…”</td>
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| Practice guideline | Screening for postmenopausal osteoporosis | Nelson HD, Helfand M, Woolf SH, Allan JD. Ann Intern Med 2002;137(6):529-41. Text and background documents from the systematic review for the USPSTF available from AHRQ web site: http://www.ahrq.gov/clinic/3rduspstf/osteoporosis/ | “Although many studies have been published about osteoporosis in post-menopausal women, no trials have evaluated the effectiveness of screening; therefore, no direct evidence that screening improves outcomes is available.”
- “Instruments developed to assess clinical risk factors for low bone density or fractures have moderate-to-high sensitivity and low specificity…”
- Nevertheless, the USPSTF recommends that women aged 65 and older be routinely screened for osteoporosis, and that routine screening begin at age 60 for women identified as high risk due to their weight or estrogen status. The Panel based their recommendations on an outcomes table and called for a trial of screening strategies which will supersede this “indirect evidence.”
- The Panel did not make recommendations on the screening interval. |
| HTA | Densitometry as a diagnostic tool for the identification and treatment of osteoporosis in women | Bloomington (MN): Institute for Clinical Systems Improvement; 2000. Technology assessment report TA#31, revised. Available: http://www.icsi.org/ta/T31ar.pdf | “There is insufficient evidence to support mass screening for BMD; the need for BMD testing must be determined on an individual patient basis. Testing is of value when making individual decisions about therapies in lieu of estrogen therapy as well as when an individual’s decision about estrogen replacement therapy would be influenced by her knowledge of her BMD…” |
| HTA | Osteoporosis in postmenopausal women: diagnosis and monitoring | Rockville (MD): Agency for Healthcare Research and Quality; 2001. Evidence report / technology assessment no 28. Available: http://www.ahrq.gov/clinic/evptfiles.htm#osteo Summary available: http://www.ahrq.gov/clinic/epcsums/osteosum.htm | - "Much of the evidence for the diagnosis and monitoring strategies for osteoporosis comes from epidemiologic studies. To be more useful for clinicians and patients, future research should focus on the application of these data to the clinical setting and include a wider diversity of patient populations. Tools for assessing risk factors should be tested in prospective studies to determine if their use can correctly stratify women by risk factors, influence treatment decisions, and ultimately reduce fracture outcomes."
- "...Randomized, controlled trials of treatments for osteoporosis should be done to test the hypothesis that overall fracture risk, rather than bone measurement results alone, determines the likelihood that a patient will benefit from therapy..."

| HTA | Beyond the clinical effectiveness of bone mineral density testing in BC: a comprehensive approach to health technology assessment | Vancouver: BC Office of Health Technology Assessment; 2000. Available: http://www.chspr.ubc.ca/bc ohta/pdf/bcohta5c.PDF [Note: BCOHTA has issued other presentations based on their 1997 assessment on bone density measurement. These are available at: http://www.chspr.ubc.ca/cgi - bin/pub?program=bcohta&b y=subject ] | - In the context of their framework to assess the role of health technologies, the BCOHTA outlined several questions, including: "Does this test change patient categorization?" With respect to BMD they conclude that "BMD testing does not accurately identify women who will go on to fracture as they age. BMD testing is unable to accurately distinguish women at low risk of fracture from those at high risk." They conclude that the presence of multiple risk factors is a stronger predictor of hip fracture than BMD. |
### HTA

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- “…appropriate use of the technology may well involve selective use of BDM in association with the assessment of other clinical risk factors.” |
| Guidelines for the indication of bone densitometry in the assessment of fracture risk | Espallargues M, Estrada MD, Solà M, Sampietro-Colom L, del Río L; Granados A. Barcelona: Catalan Agency for Health Technology Assessment; 1999. Summary available: http://www.aatm.es/ang/informes/summ/br99004.html | - Although low bone mass is associated with fracture risk, BMD has a poor ability to identify, in individuals without a high fracture risk, those who will have a fracture from those who will not.  
- The evidence is insufficient to recommend BMD for population or opportunistic screening of asymptomatic individuals… |
| Quantitative ultrasound for bone density measurement                 | Homik J, Hailey D. Edmonton: Alberta Heritage Foundation for Medical Research; 1998. Available: http://www.ahfmr.ab.ca/hta/hta-publications/reports/qus.shtml | - “Quantitative calcaneal ultrasound appears to be a promising diagnostic technology but its role in diagnosis of osteoporosis remains unclear. Further evidence regarding its long-term precision, predictive ability and potential cost-effectiveness is required before its place in routine health care services can be established.” |
| HTA (consumer guide) | Osteoporosis and bone density testing: Questions and answers | St. Paul (MN): Health Technology Advisory Committee; 1998. Available: http://www.health.state.mn.us/htac/boneq&a.htm This is a consumer summary based on their 1997 HTA, Bone densitometry as a screening tool for osteoporosis in postmenopausal women. Available: http://www.health.state.mn.us/htac/bone.htm. | "If you are trying to decide whether to have a bone density test you should consult with your physician. In addition, you may want to ask yourself the following questions: - do I have one or more risk factors for osteoporosis?... – am I currently taking hormone replacement therapy?... – if I had a bone density test, would it make a difference in my decision to accept or reject treatment?... – will my health care plan pay for a bone density test?..."

| HTA | Osteoporosis: an overview of current prevention, diagnostic, and treatment methods | Plymouth Meeting (PA): ECRI; 1998. Available by subscription or purchase only: http://www.ecri.org | "Despite a variety of strategies to prevent, diagnose, and treat osteoporosis, there is no overriding consensus by physicians and researchers on the best preventive, diagnostic and treatment strategies. These disagreements are legitimate differences of opinion over the interpretation of scientific evidence, although some differences are not linked as much to science as they are to traditional competition between specialists and general practitioners, to how professionals are trained, to technology access in various communities, and to the behaviors and preferences of consumers..."

Bone Mineral Density Screening

The Canadian Coordinating Office for Health Technology Assessment (CCOHTA) is a non-profit organization funded by the federal, provincial and territorial governments. (www.ccohta.ca)

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**HTA** | Clinical utility of ultrasounds (US) for the diagnosis and monitorisation of osteoporosis and fracture prediction | Espallargues M, Rovira A. Barcelona: Catalan Agency for Health Technology Assessment. Forthcoming. | - This report is in progress (clinical effectiveness study)

**Issues**

- BMD measurements can predict risk of future fracture, but not with a high degree of accuracy.
- Because of limitations in the analytical performance of BMD measurement methods, there is substantial uncertainty in correctly classifying an individual as osteoporotic.
- There is still no study that demonstrates that bone mineral density screening programs, or the selective use of BMD testing, are effective in preventing fractures.
- There are limited diagnostic options for the physician and the development of assessment protocols, drawing on both BMD data and information on other risk factors, would be desirable.
- Health services policies should identify the most clinically relevant outcomes associated with the use of BMD measurement. Maintenance of bone health, prevention of hip fractures and prevention of vertebral fractures are all important issues.
- Follow-up BMD measurements at short time intervals will not provide a reliable measure of changes in BMD. The minimum acceptable interval between measurements will depend on the precision of the instruments used and the extent of bone loss in the individual, and may be intervals of two years or longer.
- Good quality control of BMD services is essential in all settings and applications.
- Any consideration of BMD testing should take account of the treatments that are to be used in those individuals identified as being at high risk of fracture. Issues to consider include available evidence of efficacy in terms of absolute (not relative) reduction in risk of fracture; likelihood of long-term compliance with treatment; and adverse effects of treatment.
**Conclusion**

Available evidence does not support the use of BMD measurement for population screening of asymptomatic individuals.

The use of BMD measurement for case finding with more selective testing, in conjunction with appraisal of other risk factors, is a more realistic application. However, evidence of effectiveness of this approach, in terms of prevention of fractures, remains limited.

With the exception of the recent Canadian and USPSTF recommendations for specific patient groups, assessments to date have recommended against the use of BMD measurement in population screening. The work currently underway at NICE, in the UK, and other HTA agencies, in Spain and Sweden, will provide further direction.

As much work in this area is being done by others, a more in-depth review by CCOHTA of the literature examining BMD screening and selective BMD testing would be redundant.

**References**


