Osteoporosis and bone densitometry: Does the emperor have clothes?

Editorial

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In this issue (page 1253) Alexandra Papaioannou and colleagues describe a small group of women who either had osteoporotic fractures or were at high risk for osteoporosis and who were educated about the use of hormone replacement therapy and subsequently underwent bone densitometry. After educational guidance, a quarter of the group expressed an interest in starting hormone replacement therapy. After bone densitometry, this proportion increased to a little more than a third. Twelve months later, however, about half of those who had expressed interest in hormone replacement therapy had switched to nonhormonal medication (bisphosphonates), although the remainder were taking calcium to supplement their usual intake.

Rubin and Cummings[1] were the first to report that bone mineral density measurements influenced women's decisions about the use of hormone replacement therapy, but, unlike Papaioannou and colleagues, they provided no longer-term follow-up data. Both of these data sets reinforce the sense that bone measurement does weakly influence women's decisions about medication to treat bone loss. In the study by Papaioannou and colleagues, about one-third elected to take medication to increase bone mass, and two-thirds chose to increase their calcium intake, which will help sustain but not increase bone mass. That about half of the women chose bisphosphonates over hormone replacement therapy reflects the known reluctance of women to take supplemental hormones.

In both of these studies, measurement of bone mineral density influenced decision-making, but the use of densitometry for risk assessment in osteoporosis remains controversial in Canada. The provincial office of health technology assessment in Alberta[2] has concluded that bone densitometry is unsuitable for screening, and its counterpart in British Columbia[3] has recommended that it not be used in "well women."

Indeed, osteoporosis and bone measurements have each become a focus for different world views. On one hand, it can be argued that osteoporosis is simply part of aging and that treating it (and space requires that I simplify to some extent here) amounts to "medicalizing the menopause."[3] Others are afraid that bone measurement will cause undue concern in people found to have low bone mass. Such people may paradoxically avoid exercise for fear of fracture.[1] Another perspective is the impending time when, because of changing demographics, far too many hospital beds will be occupied by people undergoing surgery for osteoporotic fractures of the proximal femur — either spontaneous or resulting from trivial trauma — unless preventive measures are taken.[4]

There has also been a media debate about the use of bone densitometry, both in the printed press and on CBC television's *Marketplace*. Meanwhile, the number of densitometers in Canada, adjusted for population, is among the lowest in the developed world.[5,6]

It may serve to restate briefly what we know of postmenopausal osteoporosis. The role of bone densitometry and treatment in other forms of osteoporosis is much less of an issue.[7]

After achieving peak bone mass sometime between the ages of 20 and 30 years, both men and women lose bone at a rate of about 0.5% to 1% yearly, although there is considerable individual variation. Superimposed upon such loss is a phase

of more rapid loss immediately at and after menopause in women. Thus, both men and women may become osteoporotic, with age being a conspicuous risk factor and with women losing bone earlier and more extensively than men.

Osteoporosis is not symptomatic until it results in fragility fractures. Indeed, until bone measurement methods had evolved, such fractures constituted the diagnosis. More recently, osteopenia and osteoporosis have been defined for epidemiological purposes in menopausal women by a Working Group of the World Health Organization in terms of bone density (i.e., before fracture necessarily occurs) as follows:[8]

- Normal: a value for bone mineral density or content within 1 standard deviation (SD) of the young adult reference mean.
- Low bone mass (osteopenia): a value for bone mineral density or content more than 1 SD below the young adult mean but less than 2.5 SD below this value.
- Osteoporosis: a value for bone mineral density or content 2.5 SD or more below the young adult mean.
- Severe (established) osteoporosis: a value for bone mineral density or content 2.5 SD or more below the young adult mean in the presence of one or more fragility fractures.

Unfortunately, these definitions have often come to be used as intervention thresholds, a purpose for which they were never intended.

In addition to age, there are several known risk factors for osteoporosis, some potentially modifiable (lack of exercise, diet and smoking, for example) and some not (race or family history). There are additional risk factors for fragility fractures (e.g., existing fractures, poor general health, poor balance and the use of sedatives). However, none of the risk factors other than age is powerful in predicting osteoporosis and fracture. The use of densitometry largely derives from the fact that it is the single best predictor of the risk of osteoporotic fracturing in an individual.[9]

Risk assessment has become important because there are now many ways to advise people at risk of fracture. These range from lifestyle modification (chiefly changes in the diet and weight-bearing exercise),[10,11] to hormone replacement (especially in women)[12] and vitamin D treatment, to therapy with calcitonin (particularly for the pain of spinal fracturing)[13] and other drugs that both increase bone mass and reduce fracture incidence (e.g., bisphosphonates[14]). On the horizon are newer generations of bisphosphonates and selective estrogen-receptor modulators.[15]

The technology of bone evaluation has also evolved (Table 1).[16,17] Dual energy x-ray absorptiometry has become the most prevalent method for risk assessment in the Western world, although its chief attribute is greater precision, which is less important in the initial evaluation of a patient than in follow-up. Recently, a number of methods for examination of the peripheral skeleton, using both x-rays and ultrasound, have emerged in parallel; these are distinctly cheaper in terms of both purchase price and use. Ultrasound measurements of the calcaneus have already been found to predict fracture risk in selected cases.[19]

It is increasingly recognized that all bone measurements are valid,[20] although site-specific data are best for determining fracture risk at that particular site. Because bone density measurements are of limited predictive power and hence widespread use might not be cost-effective, the Scientific Advisory Board of the Osteoporosis Society of Canada has not recommended their use for screening.[18] The Osteoporosis Society of Canada has adopted the view, shared by the international community, that physicians should only use one or another bone measurement for people at particular risk on the basis of more than one historical or lifestyle risk factor (a case-finding process). The BC Office of Health Technology Assessment[3] has rejected its use even in well women who meet this criterion on the grounds of inadequate cost-effectiveness. However, this report dismissed the cost of fractures other than those involving the hip because the methodology used in arriving at the cost of non-hip fractures has been questioned.[21] Moreover, all indirect costs were ignored.

Goeree and collaborators[22] have estimated that the total health care cost attributable to osteoporosis in Canada in 1993 was $465 million with, depending on attribution, as much as an additional $563 million spent on long-term care and $279 million in chronic care hospitals. These numbers are congruent with the US data, if population numbers are taken into account. Ray and associates[21] estimated the 1995 US expenditures attributable to osteoporosis as US$13.8 billion. These investigators concluded that 36.9% of the attributed health care expenditures resulted from fractures at sites other than the hip. Even if this number is as much as 10% in error the resulting number is too large to dismiss in a cost-effectiveness study, and it should be apparent to anyone dealing with such patients at first hand that the indirect costs of osteoporosis are also substantial. There are still insufficient data for truly evidence-based public policy in this context, although a model for cost-effectiveness analyses has been proposed.[23]

There are already large differences in practice between the provinces in the availability of both bone measurement and bone-active drugs. Meanwhile, a coalition of women physicians and advocacy groups in Quebec has recently persuaded the provincial government, not that the management of osteoporosis is "medicalizing the meno-

pause," but that inactivity in this context would have been discrimination against women. Ideology and political activism do strongly influence resource allocation and are legitimate in such a context, yet we must not confuse either with science.

If, for financial reasons, we in Canada decide not to use any method of bone measurement, we will be out of step with much of the developed world.[5,6,17,24] It is possible, I believe, to suggest a framework for the use of densitometry while investigating that use. Those not wanting to undergo such examinations would clearly be free to make that choice.

Certain lifestyle options are to be recommended and reinforced as people age, although these alone may not prevent fracturing. Such options have an effect on the whole person and not just his or her bones. Regular and frequent weight-bearing exercise and refraining from smoking or drinking excessively are examples. It might be argued that ensuring adequate intake of calcium (1000–1500 g/d after menopause) and vitamin D for bone health is not so much "medicalizing" life as it is a prudent measure to avoid "surgicalizing" it, to the extent that hip fractures are preventable. It is also wise to remain as nimble as age allows and to avoid the obvious preventable causes of falling (icy sidewalks and scatter rugs on slippery floors are examples).

There will remain a number of people who wish to further promote their bone health or to avoid a stooped posture and fractures of the hip and other bones, conditions that might have afflicted their parents or other relatives. These individuals may choose to do this by taking medication. A measurement of bone density may help them and their physicians in decision-making about treatment choices, and the cost of such a measurement will be trivial compared with taking, or thereby avoiding, medication over many years. Education must play a role for both patient and doctor, not least in the responsible use of medical resources by all concerned, as Pappaioannou and colleagues illustrate. A better understanding of the use and implications of bone mineral density testing is part of this. Such an understanding may favourably influence not only education but management.[25]

Recourse to bone measurement may be necessary because conventional radiographs can easily mislead one about the degree of bone mineralization, depending on the technical factors used in the exposure. However, it is worth noting that the radiographic demonstration of atraumatic fracture is as powerful a predictor of further fracturing as a 1 SD change in bone density, a fact that may make bone densitometry in such people redundant.[26]

Bone densitometry, like any other diagnostic test, has

Table 1: Techniques for bone measurement to determine fracture risk

Method (and energy used)	Site(s) measured	Comments	Approximate capital cost, Can$ ×000
Quantitative computed tomography* (x-rays)	Spine	CT scanner plus standards plus software. Probably the best single method.[18] Used chiefly for research in Canada because of limited access to CT scanners	1500
Peripheral quantitative computed tomography (x-rays)	Forearm (radius)	Small-aperture CT scanner permitting examination of the forearm (single- or dual-energy)	250
Single-photon absorptiometry (γ-rays [I-125])	Radius	Historically important. Little used now (no soft-tissue correction)	NA
Dual-photon absorptiometry (γ-rays [Gδ-153])	Spine, proximal femur, whole body	Largely replaced by dual-energy x-ray absorptiometry removing the uncertainty due to radionuclide supply and radioactive decay	100 (becoming unavailable)
Dual-energy x-ray absorptiometry (x-rays)	Spine, proximal femur, radius, whole body	Most widely used method now. Provides soft-tissue correction. Any site can be measured for which reference values are established	100–200
Radiographic absorptiometry (x-rays)	Intermediate phalanges	Computed digitization and analysis of 2 radiographs made at different kVps. Requires no specialized equipment locally (films sent for interpretation)	No marginal cost: uses existing x-ray facilities
Quantitative ultrasound absorptiometry (sound waves)	Calcaneus (patella, tibia), phalanges	Great promise as less expensive approach. Precision may be limiting factor, and results in young women are of uncertain implication.[19] Machine is portable	5–50
High-resolution magnetic resonance imaging (radiofrequency electromagnetic radiation in gradient magnetic field)	Potentially any site	Research applications to examine trabecular morphology	2000

*Although little used in Canada, this form of CT is used more often as a clinical test where CT access is greater (e.g., in the United States).

no role whatever if it is not to influence either physician or patient in their management or behaviour.

The subject of our national understanding of healthy and whole bones and the strategies to keep them that way — as well as the resources to be used — is not the mandate of any one faction but should result from an informed dialogue involving many parties, such as governments, public advocacy groups, health care workers including physicians, health policy developers, the pharmaceutical industry, indeed all stakeholders in this issue. In the long run, no interest will be served without a broad consensus and a policy that reflects all interests, entails much freedom of choice and is affordable. Those of us with a particular interest in this subject are in a position merely to ensure that our patients and fellow citizens take advantage of developments in evaluation and treatment, particularly as the tools for the former are becoming cheaper and the latter more effective.

The current polarization between the technology assessment community and those dealing with the disease is not productive. The former believes the latter to be in the pay of pharmaceutical manufacturers because many are collaborators in industrial clinical research — a non-sequitur. The latter recognize that the former, at least in BC, is directly funded by government (if flying a university faculty banner) and hence is believed to be serving a political agenda of resource constraint.

Technologies no more spring fully formed from the womb than do we. As a wise person observed, it was not the bacterial hypothesis that led to penicillin but the microscope that led to the bacterial hypothesis. A role for technology in risk estimation needs to be preserved while better methods are developed. For those who argue about the semantics of calling osteoporosis a disease, whether defined by densitometry or not, this debate is a distraction. The public must decide if, as the population ages, a high rate of hip and other fractures is a painful and expensive inevitability or an outcome to be avoided so far as possible. If so, several strategies are available — clinical evaluation, lifestyle changes, dietary modification, bone measurement and, sometimes, medication. The highly polarized debates in the history of medicine (concerning hypertension and anticoagulation, among others) have usually expended many trees to arrive at the middle ground. Osteoporosis, its investigation and management, and the use of bone densitometry are unlikely to be any different.

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