Journal of Clinical Densitometry, vol. 5, no. 1, 3–9, Spring 2002

1094-6950/02/5:3–9/$11.75

Original Article

A National Random Survey of Bone Mineral Density Reporting in the United States*

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Abstract

The rapidly evolving technology of bone mineral density (BMD) testing has revolutionized the clinical care of osteoporosis; however, at present, there are no guidelines for BMD reporting. A survey was mailed to a random sample of bone densitometry centers in the United States registered in the National Osteoporosis Foundation database in order to evaluate the practice of BMD reporting in the United States. Of the 1200 questionnaires mailed, 22.5% were completed and returned. Spine and hip BMD were routinely measured at 71% of the centers and were expressed as T-scores by 90% of centers. The World Health Organization working group definition of osteoporosis was included in the report by 64% of the survey responders and was used as the sole criterion to make treatment recommendations by 34%. Fracture risk was reported by 70% of the centers and only the minority (<15%) applied appropriate age and gender restrictions. There were geographic and specialty variations in the practices of bone density reporting. Despite the established value of clinical densitometry in the care of patients at risk for osteoporosis, our survey revealed that clinical information, including fracture risk, was missing from many reports. A re-examination of the practice of clinical densitometry reporting is warranted.

Key Words: Survey; consensus; osteoporosis; bone mineral density.

Introduction

Osteoporosis is a common public health problem affecting one-third of women in the United States and is of increasing social and economic importance as the size of the aging population continues to grow. Despite the fact that osteoporosis is preventable and treatable, few women are treated until a fracture occurs. The World Health Organization (WHO) working group has established an operational definition for osteoporosis based on BMD measurement *(1).* Bone mineral density (BMD) is an important predictor of fracture risk *(2–5).* The relationship between BMD and fracture risk is stronger than that between serum cholesterol and cardiovascular events and between blood pressure measurements and stroke *(6).* BMD has, therefore, become increasingly utilized in the evaluation of patients at risk for osteoporosis with an estimated 10,000 DXA densitometers in the United States as

* Presented in part at the Twenty-first Annual Meeting of the American Society for Bone and Mineral Research.

Received 01/22/01; Revised 04/17/01; Accepted 05/14/01.

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of year 2000. When a patient undergoes a BMD measurement, the data generated include the BMD expressed in absolute units and as the number of standard deviations (SD) above or below the BMD of an age-matched control group (Z-score) or as the number of standard deviations above or below the BMD of a young control group (T-score). Whereas young healthy adults rarely fracture, up to one-third of elderly women may sustain a vertebral fracture or a hip fracture by age 80 *(7).* Therefore, in the evaluation of individual fracture risk, a comparison of BMD to a young healthy group may be more appropriate. Indeed, the WHO working group definition of osteoporosis is based on BMD expressed as T-score and not as Z-score and the National Osteoporosis Foundation (NOF) Task Force as well as the International Osteoporosis Foundation (IOF) recommendations for interventional therapy in osteoporosis are based on T-scores *(8,9).*

Several organizations have issued guidelines for BMD measurements *(8–13)* and attempts are being made to standardize BMD normative databases *(14).* However, there are no guidelines for BMD interpretation and reporting despite recommendations for testing, prevention, and treatment *(8,9),* including the recent NIH-sponsored Consensus Development Conference *(10).* The objective of this survey was to characterize BMD reporting across the United States in an attempt to evaluate the need for guidelines regarding the inclusion of essential, validated, and clinically relevant information in BMD reports.

Methods

The survey was conducted between June and October 1997.

Design

A list of all bone densitometry centers in the United States with their addresses was updated by Merck Bone Measurement Institute and was made available to us by the Institute and the National Osteoporosis Foundation in March 1997. At the time the study was conducted, the list included 2400 registered DXA densitometry centers. Two consecutive mailings each addressed to 600 randomly chosen different centers were sent.

Geographic Distribution

The densitometry centers were divided into five geographic regions (Northeast, Northwest, Midwest, Southeast, Southwest) based on maps drawn in the cartographic division at the National Geographic Society, Washington DC.

Analyses

Descriptive statistics and chi-square analyses were performed using SPSS for Windows version 7.5 (SPSS Inc.). Results were significant at $p < 0.05$.

Results

Response Rate, Geographic and Specialty Distribution

Of the 1200 questionnaires mailed, 270 (22.5%) were completed and returned. The geographical distribution of the centers that completed the survey was as follows: 32% from the Northeast, 16% from the Midwest, 15% from the Southwest, 13% from the Southeast, 8% from the Northwest, and 16% unspecified. Radiologists, rheumatologists, and endocrinologists accounted for 29%, 27%, and 11% of the responders, respectively. The balance was composed of gynecologists (6%), orthopedists (5%), members of multispecialty groups (6%), internists (4%), family practitioners (8%), and unspecified (4%). For the purpose of the current analyses, radiologists, rheumatologists, and endocrinologists were kept as three discrete groups and the remainders were grouped together as "others."

Instrument Used, Sites Measured

The responding sites utilized Hologic (41%), Lunar (41%), and Norland (9%) equipment. Some centers (5%) used computerized tomography and the balance (4%) of the centers used more than one instrument. One anatomical site only was routinely measured in 13% of centers, two sites (the spine and hip) were measured in 71% of centers, and three sites (the spine, hip and forearm) were routinely measured in 11% of centers.

BMD Reporting

T- and Z- scores

Table 1 summarizes BMD reporting by T-score, *Z*-score, and % comparison to young and to age-

Table 1
BMD Reporting by the 270 Bone Densitometry Centers Responding to the Survey

	Yes		No		Unspecified	
Variable	*N*	%	*N*	%	*N*	%
T-Score	242	89.6	19	7.1	9	3.3
% Young control	211	78.1	51	18.9	8	3
Z-Score	151	55.9	105	38.9	14	5.2
% Age-matched control	153	56.7	104	38.5	13	4.8

matched values. T-scores were used by the overwhelming majority of responders. Whereas there were no specialty variations in reporting BMD as a T-score (> 87% did so within each specialty), there were specialty differences in reporting BMD as *Z*-scores: 65% of radiologists and endocrinologists, 57% of other physicians, and 40% of rheumatologists did so; $p = 0.02$. A similar trend was observed for reporting BMD as percent age-matched controls ($p = 0.034$). Finally, whereas 40% of survey responders reported all BMD parameters (T- and *Z*-scores, percent age-matched, and percent young normal), rheumatologists and endocrinologists were much less likely to do so (17% and 13%, respectively) compared to other specialties ($p = 0.022$).

WHO Definition for Osteoporosis

The WHO working group definition of osteoporosis was mentioned in 64% of the reports. There were specialty variations in the use of the WHO definition of osteoporosis: 89% endocrinologists, 67% rheumatologists, and 60% other specialties, including radiology ($p = 0.02$).

Fracture Risk

This was reported by 188 (70%) of the centers. Of those who reported fracture risk, 122 (65%) used a T-score, 11 (6%) used a *Z*-score, 26 (14%) used both, and 29 (15%) used neither or did not specify. Of those who reported fracture risk, 150 (80%) did not use any age restriction, 14 (7.5%) restricted it to age >50 yr, 9 (5%) to age >65 yr, and 14 (7.5%) did not specify what restriction they used. Whereas there were no specialty variations in reporting fracture risk, centers from the Northeast were less likely to report fracture risk (57%) compared to other geographic locations (> 70%) ($p = 0.022$).

Recommendations for Workup of Bone Loss

A workup for secondary causes of bone loss was recommended by 153 (57%) of the survey responders. There were differences in the cutoff used to recommend such workup. The most common was a T-score < –2.5 by 38 (25%) of the centers and a *Z*-score < –2 by 27 (18%) of the centers. There was no recommendation for tests to rule out secondary causes of bone loss in 116 (43%) of responders. Of those who made a recommendation for testing ($N = 154$), serum calcium, parathyroid hormone, or TSH levels were the most commonly recommended tests (40%), followed by serum and/or urine electrophoresis (24%), serum 25-hydroxyvitamin D level (21%), 24-h urinary calcium (15%), and 24-h urinary cortisol excretion (2%). There were specialty variations in the proportion of centers recommending the workup for secondary causes of bone loss: 75% rheumatologists, 66% endocrinologists, and 33% radiologists ($p = 0.0001$).

Recommendations for Prevention/Treatment

Nonprescription Therapy

Nonprescription therapy for osteoporosis prevention and treatment was recommended by 56% and 52% of the centers, respectively (Table 2). The most commonly used regimen was that of a combination of calcium/vitamin D and exercise in 57–58% of these reports. There were specialty variations in the recommendation of nonprescription therapy for osteoporosis prevention and treatment: Rheumatologists provided such recommendation in > 80% of cases, followed by

Table 2
Recommendations for Nonprescription Therapy for Osteoporosis Prevention and Treatment by the 270 Bone Densitometry Centers Responding to the Survey

	N (%)	*N* (%)
A—Prevention		
Recommendation made	Yes	No
	150 (56)	120 (44)
Therapy recommended		
Calcium	11 (7)	
Calcium/vitamin D	23 (15)	
Calcium/vitamin D/exercise	85 (57)	
Others	20 (13)	
Unspecified	11 (7)	
B—Treatment		
Recommendation made	Yes	No
	139 (52)	131 (48)
Therapy recommended		
Calcium	6 (4)	
Calcium/vitamin D	25 (18)	
Calcium/vitamin D/exercise	81 (58)	
Others	15 (11)	
Unspecified	11 (8)	

Table 3
Recommendations for Prescription Therapy for Osteoporosis Prevention and Treatment by the 270 Centers Responding to the Survey

	N (%)	*N* (%)
A—Prevention		
Recommendation made	Yes	No
	137 (51)	133 (49)
Basis for recommendation		
Solely WHO definition of osteoporosis	41 (30)	
WHO definition and clinical history	19 (14)	
WHO, BMD score, and clinical history	52 (38)	
Other miscellaneous criteria	13 (9)	
Unspecified	12 (9)	
B—Treatment		
Recommendation made	Yes	No
	157 (58)	113 (42)
Basis for recommendation		
Solely WHO definition of osteoporosis	54 (34)	
WHO definition and clinical history	17 (11)	
WHO, BMD score, and clinical history	46 (29)	
Other miscellaneous criteria	29 (19)	
Unspecified	11 (7)	

other physicians (65%), endocrinologists (45%), and radiologists (< 17%) ($p < 0.0001$).

Prescription Therapy

Prescription therapy for osteoporosis prevention was recommended by 51% and for osteoporosis treatment by 58% of the centers (Table 3). The same BMD cutoff, a T-score < –2.5, was used both for prevention and therapy of osteoporosis. This cutoff was used as the sole basis for such recommendation in 30–34% of centers, whereas it was used as one of the criteria for prescription therapy for osteoporosis prevention in 112 (81%) and for treatment in 117 (75%) reports making such recommendations. There were significant specialty variations in the proportion of physicians making recommendations for prescription therapy for osteoporosis prevention and treatment: 84% rheumatologists, 76% other physicians, 51% endocrinologists and 17% radiologists ($p = 0.0001$).

Recommendation for Follow-up and Comments on Significance of Changes over Time

A follow-up BMD was recommended by 74% of responders. The three most commonly recommended follow-up periods were 1 yr in 55%, 1–2 yr in 9%, and 2 yr in 13% of those responders. Sixty percent of responders commented on statistical significance of BMD changes over time. This was more likely to be done by rheumatologists (85%) and endocrinologists (79%) than radiologists (48%) ($p < 0.0001$). The responders used the software provided by their densitometer in 40% of the cases, their own center's quality assurance data in 14%, and a combination of both in 24% of the cases.

BMD Report Format

A short technical report that only includes the data generated by the densitometer software (i.e., BMD, T- and *Z*-scores) was used by 10% of responders. Some additional clinical information such as recommendation for workup, prevention, or therapy

for osteoporosis was used by 90% of survey responders. However, a detailed clinical report that reports fracture risk, recommends a workup for secondary causes of bone loss and recommendations of prevention and treatment therapy for osteoporosis was used by only 28% of centers. There were specialty variations for the use of this comprehensive report: 52% rheumatologists, 24% endocrinologists, and 4% radiologists (p = 0.0001). Eighty-six percent of responders used the same format when reporting BMD to various specialists, whereas only 14% used different formats.

Discussion

To our knowledge, this is the first national survey evaluating the practice of BMD reporting in the United States. In this survey, the majority of centers relied on the spine and the hip as the skeletal sites usually measured. The perceived importance of BMD comparison to peak bone mass is illustrated by the fact that 90% of responding centers expressed BMD as a T-score and made use of the T-score when reporting fracture risk in two-thirds of reports mentioning such risk. Despite the fact that bone density is of value in predicting fracture risk, one-third of survey respondents did not report fracture risk and only the minority applied age restriction when reporting such risk. The WHO working group definition for osteoporosis was mentioned in the report of 64% of centers and was used by over one-third of the centers in the decision-making processes regarding recommendations for workup for secondary causes for bone loss, and by over three-fourths of centers as a criterion for the institution of interventional therapy. There was geographic variation in reporting fracture risk and there were significant specialty variations in BMD reporting. Less than one-third of densitometry centers issued a detailed clinical report.

At the time the study was conducted, the spine and hip were the sites routinely measured by the majority of study respondents. It is well recognized that when measuring BMD simultaneously at several sites, discordance may be found in the classification of the patient as osteopenic, osteoporotic, or normal, depending on the site used for that classification *(15–17).* Accelerated bone loss takes place perimenopausally at the spine *(18)* and in patients receiving chronic steroid therapy *(19),* whereas patients with hyperparathyroidism experience selective cortical bone loss *(20).* In addition, in elderly subjects, spine BMD may be falsely elevated as a result of the presence of osteophytes and calcification of the aorta *(21).* Two independent studies demonstrated that the hip is a better predictor of hip fracture than the spine *(3,5),* and for that reason, the NOF task force based its cost-effectiveness analyses for the practice guidelines based solely on the measurement of a hip BMD *(8).* Several organizations have specified which skeletal site to measure with somewhat slightly different conclusions *(8–13).* Therefore, a national consensus on which site to measure routinely according to the clinical situation may be helpful.

Several studies have demonstrated that for each age-adjusted standard deviation decrease in BMD, fracture risk increases by 1.5 to 2.5-fold, depending on the site and fracture in question *(3,5).* Whereas a T-score was reported in over 90% of reports, fracture risk assessment was missing from one-third of reports. Despite the fact that studies relating bone density to fracture risk were mostly conducted in elderly women *(5),* in the majority of reports in our study mentioning fracture risk, age restrictions were not applied. The fracture risk was reported usually using the T-score and, much less often, the *Z*-score, even though the T-score is usually the variable used to make recommendations for intervention. Furthermore, whereas T- and *Z*-scores provide relative risks of fractures, it may be more clinically relevant to provide an individual's absolute or lifetime fracture risk rather than relative risk, as has been proposed by several investigators *(22–25).* This provides an estimate of an individual's probability of a fracture based on his/her BMD age and estimated rate of bone loss. This clinically relevant decision aid has not been routinely implemented in clinical practice, although the most recent NOF guidelines used this concept to generate their normograms and guidelines *(8).* It is to be recognized that the omission of fracture risk by one-third of the responders in our survey reflects the current lack of consensus on how to best report fracture risk to date.

Because of the continuous relationship between BMD and fracture risk, the concept of a "fracture threshold" has fallen out of favor. However, treatment thresholds are constantly used in clinical practice *(26).* Indeed, despite the progressive relationship

between cholesterol and the risk of coronary artery disease, the National Cholesterol Education Panel guidelines make recommendations for treatment intervention based on thresholds and the patient's risk profile *(27).* The use of threshold or cutoff is also essential to clinical decision-making in osteoporosis at the individual level and at the public health level *(8,28).* This need for simplification is illustrated by the fact that over one-third of the survey responders used the WHO definition of osteoporosis as the sole criterion to recommend a workup for secondary causes of bone loss and for making both prevention and treatment recommendations despite the lack of evidence, in large part, for such practice. Indeed, the WHO operational definition of osteoporosis was derived as a diagnostic not therapeutic, threshold for osteoporosis *(28).* Furthermore, although it is agreed to treat all women with osteoporosis as defined by bone density or the presence of atraumatic fractures, it is less clear at which level to intervene for prevention. Furthermore, factors other than BMD (previous history or family history of fractures, smoking, etc.) are also important in formulating treatment recommendations *(8).* Finally, whereas the WHO operational definition for osteoporosis using a T-score cutoff of –2.5 applies to BMD measured with DXA technology, this does not apply to all the peripheral densitometers, including ultrasonometry, that are now increasingly available. Recently, efforts from a working group from the NOF and ISCD have been directed at the generation of T-score equivalents that attempt to address some of these issues.

A recent study demonstrated that the majority of primary care physicians prefer detailed clinical reports as opposed to short technical reports *(29).* However, detailed clinical reports may not always be possible because of the multidisciplinary nature of physicians involved in the management of osteoporotic patients, some of whom may not be trained to give detailed clinical recommendations.

The average rate of bone loss in a recently postmenopausal women is 2–3%/yr at the spine and 1% at the hip and is less in older women. Given the enhanced precision of DXA densitometry with an estimated in vivo precision of 1.5% *(30,31),* at an average rate of bone loss of 1%/yr it would take about 3 yr to detect such a change as being significant. Our survey demonstrates that the most widely recommended follow-up interval was 1 yr, which is too short in view of the above considerations. This is particularly relevant in view of the recent concerns regarding BMD regression to the mean as demonstrated in the treated as well as the placebo groups in several large osteoporosis trials *(32).*

Even though the mailed survey was based on a random sample that represents 25% of all DXA densitometry centers registered in the national database in 1997, it is possible that there may have been selection bias based on response. Moreover, with the growing interest in osteoporosis since 1997, over 10,000 bone density devices are available across the United States. Finally, our survey is relevant to BMD reporting for central DXA densitometry only, because at the time the survey was conducted, peripheral measurements and ultrasonometry were not widely utilized. To our knowledge, however, our study is the only of its kind evaluating the practice of bone densitometry reporting.

In conclusion, despite rapidly evolving densitometry technology, its wide availability, and the substantial evidence for its usefulness in predicting fracture risk, our survey demonstrates that the practice of densitometry reporting is not always evidence based, that clinical information is often not contained in the reports, and that there is significant geographic and specialty variability. We realize that no unique bone density report can address all of the above issues and that it would, ultimately, have to be modified depending on the individual practice environment. However, this study provides the basis for re-examining the practice of clinical densitometry reporting and will, hopefully, provide the impetus to generate a consensus on how to improve such practice. This is yet another important issue facing densitometry in the new millennium that needs to be addressed in order to optimize the clinical utility of this tool and assist physicians in their care of patients with or at risk for osteoporosis *(33).*

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