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SHORT COMMUNICATION

An audit of bone densitometry practice with reference to ISCD, IOF and NOF guidelines

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Abstract *Introduction:* The impact of osteoporosis guidelines on clinical practice has not been fully evaluated. *Objectives:* To estimate the positive predictive value (PPV) of the National Osteoporosis Foundation (NOF), the International Osteoporosis Foundation (IOF) and the International Society for Clinical Densitometry (ISCD) guidelines for osteoporosis and compare it to the PPV of clinical judgement alone. *Methods:* All subjects tested for bone mineral density during the fall of 2001 in three teaching hospitals in Beirut were invited to participate. The reference databases used for the calculation of the T-score were the NHANES database for the hip and the manufacturer's database for the spine. The impact of using guidelines was measured by the increment in PPV. Osteoporosis was defined as a T-score ≤ -2.5 at either the spine or hip. *Results:* A total of 307 post-menopausal women were tested with dual-energy X-ray absorptiometry (DXA). In current practice (clinical judgement alone), the PPV for osteoporosis was 42.4%; using NOF guidelines, 236 women would have been tested, and the PPV would have been 46.2%. Similarly, using IOF or ISCD guidelines, 236 women would have been tested, and the PPV would have been 47.1%. *Conclusion:* Compared to current clinical practice, application of the ISCD, IOF and NOF guidelines may increase the predictive value of a central DXA for osteoporosis.

Keywords BMD · DXA · Guidelines · Osteoporosis

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Introduction

Osteoporosis is a growing public health concern [1] and identifying individuals at high-risk of fracture is and will remain a challenge to clinicians [2]. Bone mineral density (BMD) is one of the factors that impacts highly on this fracture risk [3–6]. As clinical risk factors for fragility fractures are poor predictors of BMD [7], clinicians standardly use other methods for assessing BMD, one of which is dual-energy X-ray absorptiometry (DXA). The DXA bone scan is widely used by the clinician as an indicator for making decisions on pharmacologic interventions for fracture risk reduction [8–10]. However, variations in clinical practice with respect to prescribing DXA have been reported [11–13]. The current guidelines for osteoporosis management [14–18] endorse a case-finding approach to identify high-risk individuals. The different guidelines are not uniform, however, and the differences that do exist among them [19, 20] reflect the different assumptions upon which they are based. To date, the impact of these guidelines on clinical practice has not been properly evaluated.

Our objectives were to compare the positive predictive value of clinical judgement alone with that of using only the National Osteoporosis Foundation (NOF), the International Osteoporosis Foundation (IOF) and the International Society for Clinical Densitometry (ISCD) guidelines in identifying patients diagnosed as being osteoporotic based on DXA bone density scans.

Materials and methods

Study population

All potential participants in the study had had a BMD assessment during the fall of 2001 in one of three teaching hospitals of Beirut, Lebanon (see flow chart; Fig. 1). Subjects were Lebanese residents, Caucasian, with a cultural background mixing western and oriental lifestyles. All three centers had central facilities for making DXA

bone density scans (BMD measurements) using Hologic machines (one center used a Hologic 4500 A and two centers, a Hologic 4500 W densitometer; Hologic, Bedford, Mass.).

Site selection for BMD was conducted according to the request of the referring physician. Information on risk factors included in the IOF, NOF and ISCD guidelines was collected by direct interview when the patients presented for the DXA scan. Reference databases for the calculation of the T-score included the NHANES III database for the hip and the manufacturer's database for the spine and the forearm.

Study design

This was a cross-sectional survey on patients referred for BMD measurement by DXA for an osteoporosis diagnosis. Information on clinical risk factors was collected using a structured questionnaire administered when the patients came to the during the DXA facility.

Clinical risk factors for which information was collected included the following: personal or first-degree relative history of fragility fracture, smoking habits, level of physical activity as the average number of hours spent a week in sports or outdoor activities, difficulties in activities of daily living on a five-level ordinal scale – from no difficulties to unable to perform – and past or current medications known to alter bone turnover. Educational background was assessed as a dichotomous variable – i.e. whether the individual had a university degree or not. Women were asked about menopausal status. Past or current therapy with calcium, vitamin D, bisphosphonates, calcitonin, estrogens and selective estrogen receptor modulators was also recorded.

Referral for BMD testing was classified as either diagnostic when DXA was requested for the first time or follow-up when there had been an earlier DXA measurement. T-scores for lumbar spine (L1–L4), hip (total hip) and forearm (distal third) were recorded. Osteoporosis was diagnosed when the T-score was ≤ -2.5 at either the spine or hip or 1/3 forearm.

Statistical analysis

The positive predictive value is calculated as the percentage of subjects with osteoporosis as assessed on the central DXA bone scan among those referred to the DXA facility based on clinical judgment alone or those who would have been referred to the facility on the basis of the guidelines. The observed positive predictive value in our practice, assumed to based on clinical judgment, is compared to the expected value had the NOF, IOF and ISCD guidelines been applied, using the information obtained on clinical risk factors included in the guidelines as reported in the questionnaire.

The NOF [17] recommends BMD testing among all post-menopausal women aged 65 and older and in post-menopausal women younger than 65 who have one or more clinical risk factors, including personal and family history of fragility fracture, smoking and a weight less than 57 kg. BMD testing is also justified when BMD results influence the decision for osteoporosis therapy and among women with prolonged hormone replacement therapy (HRT).

The IOF recommends BMD testing among post-menopausal women with one or more clinical risk factors, including a personal and family history of fragility fracture, with significant height loss or kyphosis or with evidence of radiographic osteopenia or vertebral deformity [14, 15].

The ISCD [18] recommends BMD testing among all post-menopausal women aged 65 and older and in post-menopausal women with one or more clinical risk factors or with health conditions known to be associated with bone loss. BMD testing is also recommended when BMD results influence the decision for treatment and in women with prolonged HRT.

Each set of guidelines is evaluated for the site used for BMD measurement and the number of sites included, i.e. three, two or one site.

Results

Seven hundred and twenty-two subjects were referred for BMD measurement by DXA during the study period. Of these, 407 (56.4%) subjects had a diagnostic DXA, and the remaining were follow-up. Among these 407 subjects, 94.1% were females (n=383). Males (n=24) were excluded from the analysis. Pre-menopausal women (n=76) were also excluded from the analysis, thereby limiting the study population to post-menopausal women, 80.2% of whom were DXA referrals (n=307) with a mean (SD) age of 61.6 (9.3) years (Fig. 1).

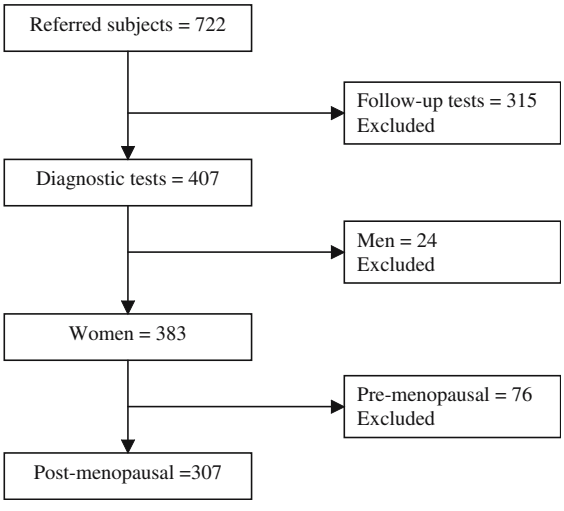

Fig. 1 Flow chart of the selection criteria used for selecting the study cohort of 307 post-menopausal women

Table 1 Prevalence of clinical risk factors included in the guidelines among post-menopausal women (n=307) referred for a DXA bone scan in our clinical practice

Age 65 years and above	40.1%
Weight less than 57 kg	12.4%
Smoking	43.3%
Personal history of fragility fracture	24.8%
Family history of fragility fracture	18.9%
With one or more clinical risk factors	41.0%

BMD measurement at three sites was requested in 206 subjects (67.1%), two sites in 92 subjects (30.0%), one site in six subjects, and in three patients the information was missing.

Among post-menopausal women (n=307) the prevalence of clinical risk factors was as follows: 40.1% of the subjects were aged 65 years and older; 4.6% had a body mass index below 23 kg/m^2; 12.4% weighed less than 57 kg; 43.3% had a smoking habit; 24.8% had a personal history of fragility fracture; 18.9% had a family history of fragility fracture. The prevalence of post-menopausal women with one clinical risk factor was 41.0%, that with two risk factors, 17.6% and that with more than two risk factors, 3.3% (Table 1). The proportion of women with at least two risk factors was higher among those aged 65 years and older.

The overall frequency of post-menopausal osteoporosis using a single site was 37.5, 17.9 and 25.4% at the spine, hip and forearm respectively. Using two sites, the spine or the hip, the frequency of osteoporosis increased to 42.4% and reached 48.5% with any site. Among women aged 65 and older, the frequency of osteoporosis was 48.0, 30.9 and 48.0% at the spine, hip and forearm sites, respectively, 57.7% at either the spine or the hip and 70.7% at any site.

Applying NOF guidelines the number of post-menopausal women who would have been referred for BMD measurement in our study population was estimated to be the sum of all women aged 65 and older and post-menopausal women younger than 65 years with a history of fragility fracture and smoking or a weight less than 57 kg. Accordingly, based on the NOF guidelines 236 (76.9%) post-menopausal women would have been tested instead of 307, and the predictive value for osteoporosis would have moderately increased up to 40.3, 21.6 and 30.5% at the spine, hip and forearm sites, respectively, 46.2% using two sites, the spine or the hip and 53.8% using any site.

Applying IOF guidelines, the estimated number of post-menopausal women who would have been tested is also 236, and the predictive value for osteoporosis would also have moderately increased up to 41.1, 26.1, and 30.5% at the spine, hip and forearm, respectively, 47.1% using either the spine or hip and 54.2% at any site.

With ISCD guidelines, the values were exactly the same as those observed when we used IOF guidelines.

Consequently, if the ISCD, IOF or NOF guidelines would have been applied, the number of post-menopausal women referred for DXA would have decreased by about 25% (n=236) compared to clinical judgement alone (n=307), and the predictive value for osteoporosis would have moderately increased by 5% (from 42.3 to 46.2%). (Tables 2 and 3).

Table 2 Positive predictive value (PPV)[a] of clinical judgment alone for detecting subjects with osteoporosis defined as a T-score ≤−2.5 on a central DXA bone scan

	Clinical judgment		
	DXA	No DXA	Total
T-score ≤−2.5	130	0	130
T-score >−2.5	177	0	177
Total	307	0	307

[a]PPV=130/307=42.3%

Table 3 PPV[a] of the guidelines for detecting subjects with osteoporosis defined as a T-score ≤−2.5 on a central DXA bone scan

	Clinical judgment		
	Concordant with the guidelines DXA	Discordant with the guidelines No DXA	Total
T-score ≤−2.5	109	21	130
T-score >−2.5	127	50	177
Total	236	71	307

[a]PPV=109/236=46.2%

Discussion

The results of our study suggest that application of the IOF, NOF or ISCD guidelines may increase our ability to detect subjects with osteoporosis based on BMD measurements. Using those guidelines may help the clinician to select individuals at higher risk for osteoporosis as defined by a T-score ≤−2.5 compared to clinical judgement alone in combination with a central DXA bone scan. We believe that this result could have very important implications for developing countries where resources for healthcare are limited, and simpler, effective means for providing good healthcare are needed. We are not aware of any previous study addressing the impact of the current guidelines for osteoporosis management on case identification with central DXA in clinical practice.

Based on our results, no one set of guidelines is superior to any other in terms of high-risk subject identification. A difference in the population risk factor profile may possibly alter the effect of a particular set of recommendations with respect to DXA practice. In our sample, 40.1% of the post-menopausal women were aged 65 years and older; 12.4% weighed less than 57 kg; 43.3% smoked and 24.8% had a personal history of fragility fracture. It will be important to replicate these trials in different populations.

We were able to identify most of the relevant risk factors included in the guidelines from our data set, although our questionnaire did not include all of the clinical risk factors or conditions associated with bone loss and it did not capture information on "loss of height", "radiographic evidence of demineralization", and "when decision making prolonged HRT is based on BMD results". This missing information on these variables may underestimate the increase in DXA predictive value with the use of the guidelines if subjects with missing information were at higher risk of osteoporosis. Otherwise, the increase in predictive value would be even larger had individuals with missing information been at lower risk. We have no reason to believe there is a particular systematic bias in that respect.

Our results reflect DXA referrals among tertiary care centers. The positive predictive value of DXA for osteoporosis may be lower within community-based healthcare centers as the prevalence of osteoporosis is likely to be lower in this population. However, the negative predictive value of the guidelines would likely be higher in this setting, and this is also important in clinical practice.

It is debatable whether the gain achieved in terms of positive predictive value of DXA with the use of guidelines is not offset by missing those subjects who could have been identified as having osteoporosis had they been offered a DXA scan based on clinical judgment. In our study, 71 of the 307 subjects would have not been referred for DXA based on the guidelines, and 21 of these who had osteoporosis would have been missed.

However, based on clinical judgment alone, of the 307 subjects who were offered DXA, 130 were identified as having osteoporosis. Had the guidelines been used to select 307 subjects for DXA referral, the expected number of subjects with a T-score ≤ -2.5 would have been 142 instead of 130.

In summary, compared to clinical judgment alone, the use of the guidelines will increase the likelihood of finding osteoporosis among those referred to central DXA. For a given number of DXA measures, the probability of finding osteoporosis is higher if subjects were referred according to the guidelines than if they were selected with no reference to the guidelines, as assumed in our clinical practice.

Conclusion

In our current practice, which reflects tertiary care center referrals, the predictive value of BMD testing for osteoporosis among post-menopausal women was 37.5, 17.9 and 25.4% using the spine, hip and forearm sites, respectively. Using NOF, the predictive value of DXA for osteoporosis increased to 40.3, 21.6 and 30.5%, respectively, and with the IOF or ISCD guidelines, the predictive value of DXA for osteoporosis increased to 41.1, 26.1, and 30.5% respectively.

Our results suggest that using IOF, NOF or ISCD guidelines for DXA referral is associated with an increase in the predictive value of DXA for osteoporosis, providing an argument for the disseminations of such guidelines. These findings need to be replicated in different populations and settings.

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