Decision Rules for Selecting Women for Bone Mineral Density Testing: Application in Postmenopausal Women Referred to a Bone Densitometry Unit

DOLORS MARTÍNEZ-AGUILÀ, CARMEN GÓMEZ-VAQUERO, ANTONI ROZADILLA, MONTSERRAT ROMERA, JAVIER NARVÁEZ, and JOAN M. NOLLA

ABSTRACT. ***Objective.*** Although several decision rules have been developed to identify postmenopausal women who may be selected for dual-energy x-ray absorptiometry measurements, information on their utility in a clinical setting is scarce. We evaluated the utility of 4 previously validated decision rules in a large group of Spanish postmenopausal women referred to a bone densitometry unit.

Methods. We reviewed the data on 665 postmenopausal women (mean age 54.2 ± 5.4 yrs). We selected the 4 decision rules that could be applied with the information that was available: the Osteoporosis Risk Assessment Instrument (ORAI), Osteoporosis Self-Assessment Tool (OST), Osteoporosis Index of Risk (OSIRIS), and Body Weight Criterion (BWC). The sensitivity, specificity, and predictive values of each decision rule were determined.

Results. The ORAI would recommend 45% of women for bone mineral density (BMD) testing, OST 46%, OSIRIS 37%, and BWC 70%. Sensitivity values obtained in the overall series were 64.1% for the ORAI, 69.2% for OST, 58.1% for OSIRIS, and 83.8% for BWC. The sensitivity increased progressively with age. The negative predictive value in the overall series was 88.5% for ORAI, 89.9% for OST, 88.4% for OSIRIS, and 90.6% for BWC.

Conclusion. In a complementary way with previous studies in older women, where decision rules were valuable to identify the majority of women likely to have osteoporosis, our data indicate that in younger postmenopausal women, decision rules are useful as a screening method to rule out the presence of osteoporosis and the need for BMD scanning. (J Rheumatol 2007;34:1307–12)

Key Indexing Terms:
OSTEOPOROSIS DENSITOMETRY POSTMENOPAUSAL WOMEN SCREENING METHODS

Osteoporotic fractures are associated with relevant morbidity rates, increased medical costs, and high mortality[1-3]. Epidemiological studies have consistently shown that bone mineral density (BMD) is a primary predictor of osteoporotic fractures. It has been established that each standard deviation reduction in BMD is associated with a 1.5 to 2.5-fold increase in fracture risk[2]. Therefore, identification of individuals with low BMD is essential to allow prophylactic treatment for the prevention of further fractures[4].

Bone densitometry plays a central role in diagnosing osteoporosis, predicting fracture and monitoring treatment. Dual-energy x-ray absorptiometry (DEXA) is regarded as the gold standard for BMD evaluation[5]. Unfortunately, the use of DEXA is limited because it is available only in specialized clinics.

Today, mass screening using DEXA is not recommended owing to its cost[6]. Thus, it is necessary to consider some strategy for selection of the target population[6]. There are no clear criteria to decide which women should undergo DEXA testing. Although several guidelines to identify subjects at high risk for osteoporosis are available[5,7-9], their implementation in practice is cumbersome.

In recent years, decision rules, simple tools obtained by questionnaire and based on a score, have been developed to identify postmenopausal women who may be selected for DEXA measurements[10-16]. They have been validated in several cohorts and it seems that they accurately identify the majority of women likely to have osteoporosis.

Information on the utility of these decision rules in a clinical setting is scarce[17-20]. We have applied 4 previously validated decision rules in a large group of Spanish postmenopausal women that had been referred to a bone densitometry unit.

From the Rheumatology Department, IDIBELL–Hospital Universitari de Bellvitge, L'Hospitalet de Llobregat, Barcelona, Spain.

Supported by a grant from the FIS of the Instituto Carlos III. Red de centros RCMN (C03/08), Madrid, Spain.

D. Martínez-Aguilà, MD, Research Fellow; C. Gómez-Vaquero, MD, PhD, Senior Registrar; A. Rozadilla, MD, PhD, Senior Registrar; M. Romera, MD, PhD, Senior Registrar; J. Narváez, MD, PhD, Senior Registrar; J.M. Nolla, MD, PhD, Chief of Section, Associate Professor.

Address reprint requests to Dr. J.M. Nolla, Rheumatology Department (Pl 10-2), Hospital Universitari de Bellvitge, Feixa LLarga s/n, 08907 L'Hospitalet de LLobregat, Barcelona, Spain.
E-mail: jm.nolla@csub.scs.es

Accepted for publication February 4, 2007.

MATERIALS AND METHODS

Study sample. The rheumatology department of the Hospital Universitari de Bellvitge has a bone densitometry unit that started their operation in 1991. At the onset of 1999, we mailed a questionnaire to all postmenopausal patients referred by gynecologists from June 1995 to May 1998. We attempted to identify the characteristics of the patients diagnosed with primary osteoporosis and further to optimize the access to the unit of the women with a short postmenopausal period. The questionnaire enclosed a letter explaining the purpose of the study, encouraging women to participate and asking them to answer the questions in relation to the date of BMD scanning.

The questionnaire was sent to 1059 women; in 28 cases it was returned because of a wrong postal address. Of the 1031 remaining patients, 718 (69.6%) answered the questionnaire; no differences between responders and nonresponders were found except for the frequency of osteoporosis (17.3% vs 11.9%, respectively; $p < 0.05$).

For the purpose of our study a sample of 665 women was selected, because in order to homogenize the series, we excluded patients < 40 years old (n = 12) or > 69 years old (n = 12) and patients with missing data (n = 29) (Figure 1).

Calculating decision rules scores. After a literature review, we selected the 4 decision rules that could be applied with the information that was available: the Osteoporosis Risk Assessment Instrument (ORAI)[11], Osteoporosis Self-Assessment Tool (OST)[12], Osteoporosis Index of Risk (OSIRIS)[13], and Body Weight Criterion (BWC)[14]. Their characteristics are as follows.

ORAI[11]. Points are given for age: 15 if ≥ 75 years, 9 if 65–74, and 5 if 55–64 years; weight: 9 points if < 60 kg and 3 if 60–69.9 kg; and estrogen use: 2 points if not currently taken.

OST[12]. The score is calculated by the equation: 0.2× (weight in kg – age in yrs), truncated to yield and integer.

OSIRIS[13]. Points are given for weight: 2× kg and remove the last digit; estrogen use: 2 points if currently taken; age: – 2× years and remove the last digit; history of fracture: – 2 points if a history of prior low impact fracture is present.

BWC[14]. The score consists of body weight in kg.

Age, weight, and height were recorded in the densitometry software; all other variables were extracted from the mailed questionnaire.

Decision rules thresholds for recommending BMD testing. Risk index for osteoporosis. Previously validated cutpoints (ORAI ≥ 9, OST < 2, OSIRIS ≤ 1, and BWC < 70 kg) were used to determine whether a given woman would be recommended to undergo BMD testing for a particular decision rule.

Each decision rule was then converted into a risk index to differentiate between low, moderate, and high risk for osteoporosis, as follows. ORAI: low risk, a score < 9, moderate risk, a score between 9 and 17, high risk, a score > 17. OST: low risk, a score > 1, moderate risk, a score between –3 and 1, high risk, a score < –3. OSIRIS: low risk, > 1, moderate risk, a score between 1 and –3, high risk, a score < –3. BWC: low risk, ≥ 70 kg, moderate risk, 57 to 70 kg, high risk, < 57 kg.

Outcome measure. BMD (g/cm^2) was measured at lumbar spine (L2-L4) and femoral neck by DEXA (Hologic Inc., Waltham, MA, USA). Calibration with a lumbar spine phantom is performed daily and with a femoral phantom weekly. The T-score (comparison with healthy subjects of the same sex with peak bone mass) and the Z-score (comparison with age and sex matched healthy controls) were established by comparison with data from the study of BMD at the lumbar spine and femoral neck in a Spanish population performed by the Multicentre Research Project on Osteoporosis (MRPO)[21]. Our aim was to generate standard curves for BMD at both sites. The total sample size was 2442 subjects of both sexes stratified according to survival rates, demographic distribution by local regions, and sex ratio in the Spanish population. The measurement of BMD was performed with a Hologic QDR device. The MRPO members considered that the results were representative of BMD values in the Spanish population.

We used the World Health Organization (WHO) thresholds[22] to classify our patients into 3 diagnostic categories as follows: (1) normal, a BMD T-score > –1 standard deviation (SD); (2) osteopenia, a T-score between –1 and –2.5 SD; (3) osteoporosis, a T-score < –2.5 SD. In each case the lowest BMD T-score at the lumbar spine (L2-L4) and femoral neck was considered.

Statistical analysis. Demographic and other characteristics of the study population were tabulated as means and SD, or proportions as applicable. Differences among groups of patients were calculated by analysis of variance or chi-squared test as applicable. The sensitivity, specificity, and the area under the receiver-operating characteristic (ROC) curve of each decision rule for selecting women with osteoporosis by BMD testing were determined; sensitivity was defined as the proportion of osteoporotic women with a positive test (proportion of individuals with osteoporosis who were correctly identified by the test) whereas specificity was defined as the proportion of women without osteoporosis whose test was negative (proportion of individuals without osteoporosis who were correctly identified by the test). Additionally, predictive positive value (proportion of individuals with a positive test result who had osteoporosis) and negative predictive value (proportion of individuals with a negative test result who did not have osteoporosis) for each risk index (low, moderate, and high) were calculated. We determined 95% confidence intervals (CI).

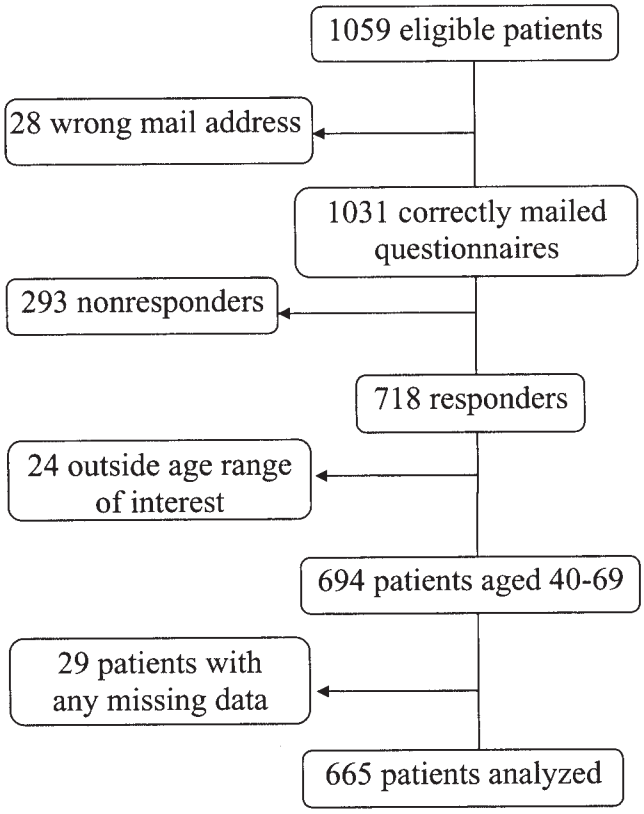

Figure 1. Selection of the final sample of patients.

RESULTS

Table 1 summarizes the characteristics of the 665 women included in the study.

Mean lumbar BMD was 0.906 ± 0.146 g/cm^2, mean lumbar T-score –1.19 ± 1.38 (95% CI –1.30 to –1.09), and mean lumbar Z-score –0.14 ± 1.14 (95% CI –0.23 to –0.05). At the femoral neck, mean BMD was 0.742 ± 0.108 g/cm^2, mean T-score –0.90 ± 0.99 (95% CI –0.98 to –0.83), and mean Z-score –0.02 ± 1.10 (95% CI –0.11 to 0.06).

The overall frequency of osteoporosis at either lumbar

Table 1. Characteristics of the 665 postmenopausal women who formed the study sample.

Characteristic	
Age, yrs	54.2 ± 5.4
Time since menopause, yrs	8.4 ± 6.4
Height, cm	154.8 ± 5.9
Weight, kg	65.7 ± 9.8
Body Mass Index, kg/m^2	27.4 ± 3.9
Estrogen use (%)	
Ever	287 (43)
Past	127 (19)
Current	160 (24)
History of low impact fracture (%)	158 (24)
ORAI score, mean ± SD	7.6 ± 4.5
OST score, mean ± SD	2.0 ± 2.0
OSIRIS score, mean ± SD	2.3 ± 2.5

ORAI, Osteoporosis Risk Assessment Instrument; OST, Osteoporosis Self-Assessment Tool; OSIRIS, Osteoporosis Index of Risk.

spine or femoral neck was 17.6% (16.7% at lumbar spine, 3.8% at femoral neck). The proportion of women with osteoporosis increased with age from 8.7% among women aged 40–49 years (n = 127) to 16.5% among women aged 50–59 years (n = 419) and 31.1% among women aged 60–69 years (n = 119). In women aged 40–64 years (n = 632) it was 16.8% and in women aged ≥ 65 years (n = 33) it was 33.3%.

Table 2 shows the population stratified on the basis of the 3 WHO diagnostic categories. The ORAI recommended 45% of women for BMD testing, OST 46%, OSIRIS 37%, and BWC 70%.

Table 3 shows the sensitivity, specificity, predictive values, and area under ROC of each decision rule for selecting women with osteoporosis for BMD testing in the overall series (n = 665) and Table 4 shows the same data in the patients without low impact fracture history (n = 507). Table 5 summarizes the same data when the population was distributed by age periods.

Finally, Table 6 shows the proportion of women with low, moderate, or high risk for osteoporosis by each decision rule and corresponding positive predictive values.

DISCUSSION

There are 3 steps involved in developing and testing tools to aid clinical decision-making: development, validation in several cohorts, and impact assessment. Information on their utility in different populations is especially important in order to establish the generalizability of these approaches and to assure their validity in practice[11].

We analyzed the value of 4 decision rules for selecting individuals for bone mineral testing in 665 Spanish postmenopausal patients referred by gynecologists to our densitometry unit; women were in middle age and presented a short duration of the postmenopausal period.

The relevance of these decision rules could decrease in the future. It seems that there is a progressive tendency to recommend the identification of individuals based on fracture risk rather than BMD status[23]. The BMD would be one among other factors to predict fracture risk. However, currently, the importance of the WHO categories in the decision-making remains high.

Our study is retrospective and was performed in a clinical setting. It should be interpreted in the light of several considerations. First, we did not test all decision rules that have been published; due to the available information, we were unable to analyze the utility of those that employ more complex formulas. However, the decision rules included are simpler to calculate and can be easily used in practice.

Second, our series was historical; it is possible that the pattern of estrogen use in our area has been changed, as a consequence of the results of the Women's Health Initiative

Table 2. Characteristics of 665 postmenopausal women stratified on the basis of 3 WHO diagnostic categories. The lowest BMD T-score at the lumbar spine and femoral neck was considered.

	Normal n = 218	Osteopenia n = 330	Osteoporosis n = 117	p
Age, yrs	52.8 ± 5.0	54.3 ± 5.3	56.6 ± 5.6	< 0.001
Time since menopause, yrs	7.0 ± 5.6	8.5 ± 6.3	10.3 ± 7.1	< 0.001
Height, cm	156 ± 6	154 ± 5	154 ± 5	< 0.001
Weight, kg	68.6 ± 10.2	65.2 ± 9.0	61.7 ± 9.3	< 0.001
Body Mass Index, kg/m^2	28.0 ± 4.1	27.4 ± 3.7	26.1 ± 3.7	< 0.001
Estrogen use, n (%)				
Ever	88 (31)	148 (52)	51 (18)	NS
Past	45 (35)	64 (50)	18 (14)	NS
Current	43 (27)	84 (52)	33 (21)	NS
History of low impact fracture	50 (23)	72 (22)	36 (31)	NS
ORAI score, mean ± SD	6.06 ± 3.95	7.83 ± 4.39	9.96 ± 4.70	< 0.001
OST score, mean ± SD	2.80 ± 2.12	1.87 ± 1.86	0.92 ± 1.83	< 0.001
OSIRIS score, mean ± SD	3.11 ± 2.49	2.24 ± 2.33	0.95 ± 2.35	< 0.001

NS: nonsignificant.

Table 3. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and area under the receiver-operator curve (AUROC) of each decision rule for selecting women with osteoporosis* in the overall series (n: 665).

	Percentage of Women Selected	Sensitivity, % (95% CI)	Specificity, % (95% CI)	PPV, % (95% CI)	NPV, % (95% CI)	AUROC (95% CI)
ORAI	45.1	64.1 (54.7–72.7)	58.9 (54.7–63.1)	25.0 (20.2–30.3)	88.5 (84.8–91.6)	0.615 (0.560–0.671)
OST	46.2	69.2 (60.0–77.4)	58.8 (54.5–62.9)	26.4 (21.5–31.7)	89.9 (86.3–92.9)	0.640 (0.586–0.694)
OSIRIS	36.7	58.1 (48.6–67.2)	67.9 (63.8–71.8)	27.9 (22.3–33.9)	88.4 (84.9–91.3)	0.630 (0.573–0.687)
BWC	69.6	83.8 (75.8–89.9)	33.4 (29.4–37.5)	21.2 (17.5–25.2)	90.6 (85.7–94.2)	0.586 (0.532–0.639)

* BMD T-score < –2.5 SD by lowest value at lumbar spine or femoral neck. BWC: Body Weight Criterion.

Table 4. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and area under the receiver-operator curve (AUROC) of each decision rule for selecting women with osteoporosis* in the patients with no low impact fracture history (n = 507)

	Percentage of Women Selected	Sensitivity, % (95% CI)	Specificity, % (95% CI)	PPV, % (95% CI)	NPV, % (95% CI)	AUROC (95% CI)
ORAI	46.5	69.1 (57.9–78.9)	57.6 (52.8–62.4)	23.7 (18.4–29.7)	90.7 (86.6–93.9)	0.634 (0.570–0.699)
OST	46.9	74.1 (63.1–83.2)	58.2 (53.4–62.9)	25.2 (19.8–31.2)	92.2 (88.3–95.1)	0.661 (0.599–0.724)
OSIRIS	30.4	53.1 (41.7–64.3)	73.9 (69.5–78.0)	27.9 (21.0–35.7)	89.2 (85.5–92.3)	0.635 (0.566–0.704)
BWC	72.2	86.4 (77.0–93.0)	30.5 (26.2–35.1)	19.1 (15.2–23.5)	92.2 (86.5–96.0)	0.585 (0.522–0.648)

* BMD T-score < –2.5 SD by lowest value at lumbar spine or femoral neck.

trial[24,25]. This circumstance could slightly limit the value of the data concerning the ORAI and OSIRIS. Moreover, data on estrogen use was based on recall several years after the DEXA was performed.

Third, although the study sample consisted of women referred by gynecologists, we cannot be sure that all patients had primary osteoporosis; however, we are confident that this circumstance has little effect on the value of our study. Finally, we estimate that the frequency of osteoporosis and the prevalence of prior fractures is higher than in the general population of the same age; it is feasible that a selection bias exists because the patients were recruited from a bone densitometry unit, and were willing to answer a mailed questionnaire.

Despite these criticisms, our study may establish an approach to the utility of the decision rules for selecting women for BMD testing in practice. A remarkable point of our study is the low frequency (5%) of patients aged 65 or more years. Several authorities indicate that BMD testing should be performed on all women age 65 and older regardless of risk factors[9,26,27]. Thus, to establish the value of the decision rules in younger postmenopausal women can be useful, as it is obvious that some clinicians indicate a BMD evaluation in subjects with no risk factors other than being Caucasian, postmenopausal, and female.

Our results provide evidence that the ORAI, OST, OSIRIS, and BWC are effective to optimize the use of bone densitometry in young postmenopausal women; the negative predictive value obtained with each test seems acceptable in clinical practice. Nevertheless, the sensitivity values in the overall series were unsatisfactory and clearly lower than those observed by Cadarette, *et al*[17]. The principal difference with that study is the mean age of patients (62.4 yrs); women in our series were significantly younger. This could explain, at least in part, the discordances. Interestingly, we observed that sensitivity increased progressively with age; it was nearly 90% in women age 60–69 years, in all the instruments we tested. Our data emphasize that age is an important variable in determining sensitivity and specificity.

The value of clinical screening tools in young postmenopausal women had been previously tested in 2 studies. Gourlay, *et al*[18], in Belgium, found that the OST, ORAI, and

Table 5. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) for selecting women with osteoporosis* in several age ranges.

	Sensitivity, % (95% CI)	Specificity, % (95% CI)	PPV, % (95% CI)	NPV, % (95% CI)
ORAI				
40–49 yrs	45.4	69.8	12.5	93.1
(n = 127; OP 8.7%)	(16.7–76.6)	(60.6–78.0)	(4.2–26.8)	(85.6–97.4)
50–59 yrs	55.1	63.1	22.7	87.7
(n = 419; OP 16.5%)	(42.6–67.1)	(57.8–68.2)	(16.6–29.9)	(83.0–91.5)
60–69 yrs	86.5	25.6	34.4	80.8
(n = 119; OP 31.1%)	(71.2–95.5)	(16.6–36.4)	(24.9–45.0)	(60.6–93.4)
OST				
40–49 yrs	36.4	81.0	15.4	93.1
(n = 127; OP 8.7%)	(10.9–69.2)	(72.7–87.7)	(4.4–34.9)	(86.2–97.2)
50–59 yrs	63.8	59.7	23.8	89.3
(n = 419; OP 16.5%)	(51.3–75.0)	(54.4–64.9)	(17.8–30.6)	(84.6–93.0)
60–69 yrs	89.2	23.2	34.4	82.6
(n = 119; OP 31.1%)	(74.6–95.5)	(14.6–33.8)	(25.0–44.8)	(61.2–95)
OSIRIS				
40–49 yrs	27.3	90.5	21.4	92.9
(n = 127; OP 8.7%)	(6.0–61.0)	(83.7–95.2)	(4.7–50.8)	(86.5–96.9)
50–59 yrs	49.3	70.0	24.5	87.5
(n = 419; OP 16.5%)	(37.0–61.6)	(64.9–74.8)	(17.6–32.5)	(15.2–24.7)
60–69 yrs	83.8	26.8	34.1	78.6
(n = 119; OP 31.1%)	(68.0–93.8)	(17.6–37.8)	(24.4–44.7)	(59.0–91.7)
BWC				
40–49 yrs	90.9	31.9	11.2	97.4
(n = 127; OP 8.7%)	(58.7–99.8)	(23.5–41.2)	(5.5–19.7)	(86.2–99.9)
50–59 yrs	81.2	34.6	19.6	90.3
(n = 419; OP 16.5%)	(69.9–89.6)	(29.6–39.8)	(15.2–24.7)	(84.0–94.7)
60–69 yrs	86.5	30.5	36.0	83.3
(n = 119; OP 31.1%)	(71.2–95.5)	(20.8–41.6)	(26.0–46.8)	(65.3–94.4)

* BMD T-score < –2.5 SD by lowest value at lumbar spine or femoral neck. OP: osteoporosis.

Table 6. Proportion of women with low, moderate, or high risk for osteoporosis* by each decision rule and corresponding positive predictive value (PPV).

	Distribution of Study Sample, %	PPV, %
ORAI		
Low (< 9)	54.9	11.5
Moderate (9 to 17)	43.9	24.3
High (> 17)	1.2	50.0
OST		
Low (> 1)	53.8	10.1
Moderate (–3 to 1)	46.2	26.4
High (< –3)	0	—
OSIRIS		
Low (> 1)	63.3	11.6
Moderate (–3 to 1)	36.0	26.8
High (< –3)	5.7	47.4
BWC		
Low (≥ 70)	30.4	9.4
Moderate (57 to 69)	52.9	18.2
High (< 57)	16.7	30.6

* BMD T-score < –2.5. * SD by lowest value at lumbar spine or femoral neck.

SCORE (based on race, presence of rheumatoid arthritis, low trauma fracture, estrogen use, age, and weight) risk assessment tools had similar discriminatory ability to identify osteoporosis at the femoral neck in a referral population of postmenopausal women aged 45–64 years (mean 56 yrs) compared to women aged ≥ 65 years (mean 70.7 yrs). However, the results obtained by Rud, *et al*[19], in Denmark, question the utility of all 3 evaluated clinical decision rules (OST, ORAI, and SCORE) to select healthy perimenopausal and early postmenopausal women (mean age 50.5 yrs) for DEXA.

There are clear guidelines recommending that all women with previous low impact fracture be referred for DEXA testing[9]. In this way, we analyzed the value of the decision rules excluding patients with a known history of fracture. We found no major changes with respect to the overall series.

As in previous studies, each decision rule was converted into a risk index to differentiate low, moderate, and high risk for osteoporosis. Converting the decision rules into risk indices may be useful for clinicians, mainly for educating patients regarding their risk of osteoporosis[11]. Our data on positive predictive value (proportion of sample in the catego-

ry with osteoporosis) also validate previously proposed cut-points.

In a complementary way with previous studies, where decision rules were valuable to identify the majority of women likely to have osteoporosis, our data indicate that in younger postmenopausal women, decision rules would be useful as a screening method to rule out the presence of the disease and the need for BMD scanning. A population-based study would be valuable to assure the scientific reliability of our findings.

REFERENCES

1. Cummings SR, Melton LJ. Epidemiology and outcomes of osteoporotic fractures. Lancet 2002;359:1761–7.
2. Center JR, Nguyen TV, Schneider D, Saambrock PN, Eisman JA. Mortality after all major types of osteoporotic fracture in men and women: an observational study. Lancet 1999;353:878-82.
3. Fraenkel L, Gulanski B, Wittink DR. Preference for hip protectors among older adults at high risk for osteoporotic fractures. J Rheumatol 2006;33:2064-8.
4. Solomon DH, Levin E, Helfgott SM. Patterns of medication use before and after bone densitometry: factors associated with appropriate treatment. J Rheumatol 2000;27:1496–500.
5. US Preventive Services Task Force. Screening for osteoporosis in postmenopausal women: recommendations and rationale. Ann Intern Med 2002;137:526–8.
6. Raisz L. Screening for osteoporosis. New Engl J Med 2005;353:164-71.
7. Lewiecki EM, Watts NB, McClung MR, et al. Official positions of the International Society for Clinical Densitometry. J Clin Endocrinol Metab 2004;89:3651–5.
8. Kanis JA, Black D, Cooper C, et al. A new approach to the development of assessment guidelines for osteoporosis. Osteoporosis Int 2002;11:192–202.
9. Leib ES, Binkley N, Bilezekian JP, Kendler DL, Lewiecki EM, Petak SM. Position development conference of the International Society for Clinical Densitometry. J Rheumatol 2006;33:2319–21.
10. Lydick E, Cook K, Turpin J, Melton M, Stine R, Byrnes C. Development and validation of a simple questionnaire to facilitate identification of women likely to have low bone density. Am J Man Care 1998;4:37–48.
11. Cadarette SM, Jaglal SB, Kreiger N, McIsaac WJ, Darlington GA, Tu JV. Development and validation of the Osteoporosis Risk Assessment Instrument to facilitate selection of women for bone densitometry. CMAJ 2000;162:1289-94.
12. Koh LKH, Sedrine WB, Torralba TP, et al, on behalf of the Osteoporosis Self-Assessment Tool for Asians (STA) Research Group. A simple tool to identify Asian women at increased risk of osteoporosis. Osteoporosis Int 2001;12:699–705.
13. Ben Sedrine W, Chevallier T, Zegels B, et al. Development and assessment of the Osteoporosis Index of Risk (OSIRIS) to facilitate selection of women for bone densitometry. Gynecol Endocrinol 2002;16:245–50.
14. Michaelson K, Bergström R, Mallmin H, Holmberg L, Wolk A, Ljunghall S. Screening for osteopenia and osteoporosis: selection by body composition. Osteoporosis Int 1996;6:120–6.
15. Weinstein L, Ullery B. Identification of at-risk women for osteoporosis screening. Am J Obstet Gynecol 2000;183:547–9.
16. Salaffi F, Silveri F, Stacanti A, Grassi W. Development and validation of the Osteoporosis Prescreening Risk Assessment (OPERA) tool to facilitate identification of women likely to have low bone density. Clin Rheumatol 2005;24:203–11.
17. Cadarette SM, McIsaac WJ, Hawker GA, et al. The validity of decision rules for selecting women with primary osteoporosis for bone mineral density testing. Osteoporosis Int 2004;15:361–6.
18. Gourlay ML, Miller WC, Richy F, Garrett JM, Hanson LC, Reginster JY. Performance of osteoporosis risk assessment tools in postmenopausal women aged 45-64 years. Osteoporosis Int 2005;16:921-7.
19. Rud B, Jensen JE, Mosekilde L, Nielsen SP, Hilden J, Abrahamsen B. Performance of four clinical screening tools to select peri- and early postmenopausal women for dual X-ray absorptiometry. Osteoporosis Int 2005;16:764-72.
20. Chan SP, Teo CC, Ng SA, Goh N, Tan C, Deurenberg-Yap M. Validation of various osteoporosis risk indices in elderly Chinese females in Singapore. Osteoporos Int 2006;17:1182–8.
21. Diaz Curiel M, Carrasco de la Peña JL, Honorato Perez J, Pérez Cano R, Rapado A, Ruiz Martínez I on behalf of the Multicentre Research Project on Osteoporosis. Study of bone mineral density in lumbar spine and femoral neck in a Spanish population. Osteoporosis Int 1997;7:59–64.
22. World Health Organisation. Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. WHO technical report series 843. Geneva: WHO; 1994.
23. Kanis JA, Borgstrom F, De Laet C, et al. Assessment of fracture risk. Osteoporos Int 2005;16:581–9.
24. Rossouw JE, Anderson GL, Prentice RL, et al. Risks and benefits of estrogen plus progestin in healthy postmenopausal women: principal results form the Women's Health Initiative randomized controlled trial. JAMA 2002;288:321–33.
25. U.S. Preventive Services Task Force. Hormone therapy for the prevention of chronic conditions in postmenopausal women: recommendations from the U.S. Preventive Services Task Force. Ann Intern Med 2005;142:855–60.
26. National Osteoporosis Foundation. [Internet] Available from: http://www.nof.org/osteoporosis/bonemass.htm. Accessed March 29, 2007.
27. Meunier PJ, Delmas PD, Eastell R, et al. Diagnosis and management of osteoporosis in postmenopausal women: clinical guidelines. International Committee for Osteoporosis Clinical Guidelines. Clin Ther 1999;21:1025-44.