Osteoporosis in Pulmonary Clinic Patients*

Does Point-of-Care Screening Predict Central Dual-Energy X-ray Absorptiometry?

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Study objectives: **Patients in a pulmonary clinic have disorders that predispose them to osteoporosis and may use glucocorticoid therapy, which has been associated with low bone mineral density (BMD) and increased fracture risk. Ideally, all patients at risk for osteoporosis would be screened using the best test available, which is central BMD by dual-energy x-ray absorptiometry (DXA). We proposed to stratify the risk for osteoporosis by the use of a simple questionnaire and point-of-care heel ultrasound BMD measurements.**
Design: **Cross-sectional screening study.**
Setting: **Pulmonary clinic in a single Veterans Affairs Medical Center.**
Patients: **Approximately 200 male and female patients who had not had previous BMD testing were eligible for the study, and 107 gave consent.**
Interventions: **One hundred seven men (white, 71 men; black, 35 men; and Asian, 1 man) underwent heel BMD testing and filled out a questionnaire. Ninety-eight men underwent a central DXA.**
Results: **Of 98 subjects, 24.5% had a spine, total hip, or femoral neck (FN) T-score of ≤ −2.5, which is the generally accepted definition of osteoporosis diagnosed using DXA, and 44.9% had a T-score of ≤ −2.0. The best-fit models for predicting FN or total hip BMD included body weight, heel BMD, corticosteroid use for ≥ 7 days, and race, which accounted for 52 to 57% of the variance. When a heel ultrasound T-score of −1.0 was tested to predict a central DXA T-score of −2.0, the sensitivity was 61% and the specificity 64%. Adding the questionnaire score and body mass index (BMI) to the heel T-score improved sensitivity but not specificity. Moreover, BMI and age predicted central BMD with similar sensitivity and specificity. Importantly, of 24 patients with a central DXA T-score of ≤ −2.5, only 14 were identified by a heel T-score of ≤ −1.0.**
Conclusions: **Although the findings from a heel ultrasound plus the answers to a questionnaire were reasonably good indicators for predicting the presence of low BMD, little predictability was gained over the use of BMI and age. In a group of pulmonary clinic patients, the prevalence of osteoporosis was clinically significant, and central DXA testing was the preferable technique for identifying patients who were at risk for fracture.** ***(CHEST 2003; 123:2012–2018)***

Key words: bone density; densitometry; lung diseases; osteoporosis; questionnaires; radiograph; ultrasonography

Abbreviations: BMD = bone mineral density; BMI = body mass index; BUA = broadband ultrasound attenuation; CI = confidence interval; DXA = dual-energy x-ray absorptiometry; FN = femoral neck; QUI = quantitative ultrasound index; ROC = receiver operating characteristics; RR = relative risk; SOS = speed of sound

Patients with pulmonary diseases are commonly treated with oral or inhaled glucocorticoids. Such therapy clearly increases the risk for the development of osteoporosis.[1–4] Moreover, patients with various pulmonary diseases may have bone loss due to decreased physical activity,[5] smoking,[6] chronic

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disease,[7] and perhaps the muscle wasting of emphysema. In an ideal world, all patients with lung diseases would be screened for osteoporosis[8] using central bone mineral density (BMD) measurements made by dual-energy x-ray absorptiometry (DXA). However, because of the expense and unavailability of DXA testing, many patients with osteoporosis are not identified and treated. Various peripheral bone density measurements have been used in several populations[9–12] to try to identify patients who may be at risk for osteoporosis. In addition, risk assessment questionnaires have been used in women[13] and men[14] to help stratify risk. We devised a questionnaire based on published instruments but that were adapted to the special characteristics of patients with pulmonary diseases. We hypothesized that a peripheral bone density measurement (*ie*, heel ultrasound bone density) plus a questionnaire could determine which patients in a pulmonary clinic had osteoporosis, as measured by central DXA.

Materials and Methods

Subjects

Over a 4-month period, we visited a weekly general pulmonary clinic in a single Veterans Affairs medical center. Only patients who had not had a previous measurement of BMD (by any technique) were eligible for the study. Patients were asked whether they would participate, and all signed a consent form approved by the Veterans Affairs medical center institutional review board. After signing the consent form, each patient filled out the questionnaire and underwent heel ultrasound BMD testing (Sahara densitometer; Hologic, Inc; Bedford, MA). Standard heel measurements include broadband ultrasound attenuation (BUA) and speed of sound (SOS) through the calcaneus. From BUA and SOS, a quantitative ultrasound index (QUI), sometimes called the *stiffness QUI*, is calculated, as is an apparent BMD and a T-score (*ie*, the number of SDs from the mean of healthy, white, young women), as provided by the manufacturer. The QUI, BMD, and T-score are calculated automatically by the instrument. We also calculated a heel T-score based on data from healthy young men obtained by Nattrass et al.[15] Within 1 month, 98 patients underwent testing of central bone density (QDR 4500 densitometer; Hologic, Inc). We measured the BMD and T-score of the spine (L1 to L4), the total hip, and the femoral neck (FN). The DXA T-scores were also calculated by the instrument using the manufacturer's normal data for spine BMD, which were obtained from young subjects who had been matched for gender and ethnic group, and using National Health, Education, and Nutrition Survey data for hip measurements.

Derivation and Calculation of Questionnaire Score

We modified questionnaires that had been devised for other populations[13,14] to derive a questionnaire that would be particularly applicable to a predominantly male population of patients who had pulmonary diseases. Twenty-four questions could each be answered "yes" or "no." The questionnaire (Table 1) was scored by the individual question, and a total score was devised by giving 1 point for each answer that reflected a potential risk factor. We determined which questions represented independent variables (identified in Table 1), so that the final number of independent questions used to calculate the score was 14.

Table 1—*Proportional Distribution of Risk Factors Answered in the Affirmative*

Risk Factor	Answer "Yes," %
Family history of osteoporosis*	11.2
Family history of bone fracture*	33.6
Age ≥65, yr*	51.4
Asthma	24.4
COPD	40.8
Emphysema	36.4
Bronchitis	20.2
Other pulmonary diseases	39.3
History of osteoporosis	5.6
Bone fracture last year*	2.8
Fracture was nontraumatic	33.3
Past fractures*	19.6
Ever used prednisone	50.4
Use of corticosteroids >7 d*	42.1
Currently receiving prednisone	16.1
Ever used inhaled steroids	80.8
Use of inhaled steroids >7 d*	78.0
Currently receiving inhaled steroids	78.8
History of stomach surgery*	19.6
History of hip replacement*	1.9
Calcium supplement/multivitamins*	36.8
Cannot walk one block without getting short of breath*	54.2
Cannot climb a flight of stairs without getting short of breath	68.2
Change in height >1 inch*	35.8
Falls in the last year*	30.8

*Variables considered to be independent and thus used for determining the questionnaire score. Race was the 14th variable used in calculating the final questionnaire score (1 point if white; 0 points if black or other).

Data Management and Analysis

All the data were entered into a database for later analysis (SPSS, version 10.0 for Windows; SPSS Inc; Chicago, IL). Analyses included multiple regression and calculation of relative risk (RR). Characteristics of the screening tests were determined, and receiver operating characteristic (ROC) curves were constructed for individual tests as well as for combinations of tests. The BMD in the spine, total hip, and FN were used as dependent variables in the multiple regression models. Osteoporosis and severe osteopenia were defined as a T-score obtained by central DXA of ≤ -2.5 and ≤ -2.0, respectively. Significance was determined using a two-sided α level of 0.05.

Results

Over a 4-month period, 107 subjects from the pulmonary clinic agreed to participate, of approximately 200 patients who attended the clinic and were eligible for the study. About 100 additional clinic patients had already undergone BMD testing for