*Journal of Clinical Densitometry: Assessment & Management of Musculoskeletal Health,* vol. ■, no. ■, 1–5, 2016

1094-6950/■:1–5/$36.00
http://dx.doi.org/10.1016/j.jocd.2016.06.003

**Original Article**

# Enhanced Precision of the New Hologic Horizon Model Compared With the Old Discovery Model Is Less Evident When Fewer Vertebrae Are Included in the Analysis

*Elizabeth A. McNamara,[†] Holly P. Kilim,[†] Alan O. Malabanan, LaTarsha G. Whittaker, and Harold N. Rosen**

*Department of Medicine, Division of Endocrinology and Metabolism, Beth Israel Deaconess Medical Center, Boston, MA, USA*

## Abstract

The International Society for Clinical Densitometry guidelines recommend using locally derived precision data for spine bone mineral densities (BMDs), but do not specify whether data derived from L1–L4 spines correctly reflect the precision for spines reporting fewer than 4 vertebrae. Our experience suggested that the decrease in precision with successively fewer vertebrae is progressive as more vertebrae are excluded and that the precision for the newer Horizon Hologic model might be better than that for the previous model, and we sought to quantify. Precision studies were performed on Hologic densitometers by acquiring spine BMD in fast array mode twice on 30 patients, according to International Society for Clinical Densitometry guidelines. This was done 10 different times on various Discovery densitometers, and once on a Horizon densitometer. When 1 vertebral body was excluded from analysis, there was no significant deterioration in precision. When 2 vertebrae were excluded, there was a nonsignificant trend to poorer precision, and when 3 vertebrae were excluded, there was significantly worse precision. When 3 or 4 vertebrae were reported, the precision of the spine BMD measurement was significantly better on the Hologic Horizon than on the Discovery, but the difference in precision between densitometers narrowed and was no longer significant when 1 or 2 vertebrae were reported. The results suggest that (1) the measurement of in vivo spine BMD on the new Hologic Horizon densitometer is significantly more precise than on the older Discovery model; (2) the difference in precision between the Horizon and Discovery models decreases as fewer vertebrae are included; (3) the measurement of spine BMD is less precise as more vertebrae are excluded, but still quite reasonable even when only 1 vertebral body is included; and (4) when 3 vertebrae are reported, L1–L4 precision data can reasonably be used to report significance of changes in BMD. When 1 or 2 vertebrae are reported, precision data for 1 or 2 vertebrae, respectively, should be used, because the exclusion of 2–3 vertebrae significantly worsens precision.

**Key Words:** BMD (bone mineral density); densitometer; LSC (least significant change); precision; spine.

## Introduction

Repeat bone densitometry is usually obtained to determine whether there has been a significant change in bone mineral density (BMD) over an interval of time. International Society for Clinical Densitometry (ISCD) guidelines suggest that the significance of changes in BMD over

[†]These authors share equal first coauthorship.

Received 03/4/16; Revised 05/12/16; Accepted 06/17/16.

*Address correspondence to: Harold N. Rosen, MD, Division of Endocrinology, GZ-609, Beth Israel Deaconess Medical Center, 330 Brookline Avenue, Boston, MA 02215. E-mail: hrosen@bidmc.harvard.edu

time be determined by comparing observed changes in BMD to locally determined least significant changes (LSCs). Measurements of spine BMD become less precise as fewer vertebrae are reported, but the guidelines do not specify whether the LSC used for the spine needs to be adjusted upward as fewer vertebrae are reported *(1)*.

Previous studies have shown that the deterioration of precision of spine BMD occurs incrementally as more vertebrae are excluded from analysis *(2,3)*. We wondered then if local spine LSC should vary according to the number of vertebrae reported, and if so, if there comes a point where precision is so poor that changes in spine BMD cannot be reported. We further wondered how the deterioration of precision with fewer vertebrae would be affected by changing to a newer densitometer, the Hologic Horizon, which seemed to have improved precision compared with older models. Toward that end, we examined the effect of the number of vertebrae and model of densitometer on the precision of the reported spine BMD in precision studies done over the years to establish the precision of newly acquired densitometers or newly trained technologists.

## Methods

Precision study for the Horizon-A (Hologic, Waltham, MA) was done by acquiring spine BMD in fast array mode twice on 30 patients. Precision study for the Discovery-A was done by acquiring spine BMD in fast array mode twice on 30 patients in 10 precision studies done on 2 Discovery densitometers, and pooling the results for a total of 284 patients. A total of 6 ISCD-certified Certified Bone Densitometry Technologists were involved in these precision studies, although each individual precision study was done by 1–2 technologists. If a precision study was done by 2 technologists, care was taken to make sure that each individual patient was scanned twice by the same technologist. Inclusion criteria for subjects were adults >18 yr of age who have 4 vertebrae that could be included for valid analysis. Exclusion criteria for participation were pregnancy, inability to agree to participate in the study, or inability to cooperate enough to acquire a valid study. Daily quality control was done on each densitometer using the spine phantom. In the year between May 2015 and May 2016, coefficients of variability (CVs) for the 2 Discovery densitometers were 0.427% and 0.489%, whereas the CV for the Horizon densitometer was 0.315% ($p < 0.05$ for the comparison of the Horizon CV to the Discovery CV).

The pairs of data were used to calculate the LSC according to ISCD guidelines. The significance of the difference between LSCs was assessed using an *F*-test, which takes the simple ratio of standard deviations (SDs) as the *F*-statistic, which is significant at $p < 0.05$ if the ratio is >1.84 if both SDs are based on 30 degrees of freedom (df), >1.68 if one of the SDs is based on >120 df, and >1.35 if both of the SDs are based on >120 df. No adjustments were made for multiple comparisons. The significance of differences in the mean of continuous variables was assessed by the Kruskal–Wallis test, and the significance of the differences in dichotomous variables was assessed by chi-square analysis.

Institutional review board (IRB)-approved informed consent was not obtained from participants because ISCD's position is that participation in precision studies is standard clinical practice and not research and therefore should not require IRB approval and written informed consent *(1)*. We have obtained permission from our IRB to follow these guidelines, although of course each patient agreed verbally and in writing to participate in the precision assessment.

## Results

Baseline demographic characteristics are shown in Table 1 for the Horizon, and the pooled precision studies on the Discovery. Two subgroups of the Discovery precision studies are also shown: one for the pooled precision studies done on a single Discovery densitometer (called "Discovery—single densitometer") and one for the study done on the Discovery by the same technologist who did the Horizon precision study (called "Discovery—same technologist"). There were no significant differences in baseline characteristics between the Horizon and the Discovery groups in age, height, weight, body mass index, spine *T*-score, and gender distribution. The only significant difference between the Horizon precision study and the others was in the percentage of patients who were white; this was 96% in the Horizon study, and 70% in the pooled Discovery studies.

When 1 vertebral body was excluded from analysis, there was no significant deterioration in precision. When 2 vertebrae were excluded, there was a nonsignificant trend to poorer precision, and when 3 vertebrae were excluded, the deterioration in precision was significant. The LSC for L1 alone is significantly worse than those for L1–L4 and L1–L3, but not significantly worse than that for L1 and L2. All of these findings were true on both the Discovery and Horizon densitometers. The actual LSCs for spines using only L1, though, were not bad, always <0.05 g/cm$^2$ (Table 2).

When 3 or 4 vertebrae were reported, the precision of the spine BMD measurement was significantly better on the Hologic Horizon than on the Discovery, but the difference in precision narrowed and was no longer significant when 1 or 2 vertebrae were reported (Table 2). Of course, it is always possible that the Horizon precision study showed better precision not because the densitometer was more precise, but because the particular technologists involved were more skilled. In an attempt to account for this possibility, the results of a precision study done by the same technologist on the Discovery densitometer were compared. This technologist's precision study on the Discovery was not nearly as good as her precision study on the Horizon, although the differences lacked statistical significance because so many fewer patients were used.