

# Practical Considerations When Replacing a DXA System

Kevin E. Wilson, PhD  
Hologic, Inc., Bedford, MA, USA

## Introduction

The introduction by Hologic of dual energy x-ray absorptiometry (DXA) revolutionized the field of osteoporosis assessment in 1987.<sup>1</sup> The first-generation DXA systems employed rectilinear scanning with a thin pencil beam. Pencil-beam systems have been largely replaced by fan-beam technology, resulting in faster acquisition, greater accuracy and increased resolution.

As legacy DXA systems become obsolete and new diagnostic protocols are introduced, data compatibility and migration issues arise, impacting continuity of care. Replacing a system made by a different manufacturer heighten these concerns.

This paper addresses practical considerations for upgrading DXA systems that will help clinicians properly migrate data and calibrate equipment, so that patient care is uninterrupted.

## Calibration and Data Migration

When upgrading or replacing a DXA system, the ability to obtain continuity of the bone mineral density (BMD) results on different systems is the primary concern.<sup>2-5</sup> Because BMD changes slowly over time, the importance of system long-term stability arises as even small differences can affect the reliability of results.<sup>6</sup>

The International Society for Clinical Densitometry (ISCD) recommends when changing hardware, but not the entire system, or when replacing a system with the same technology (manufacturer and model), cross-calibration should be performed with a phantom before and after hardware changes.<sup>7</sup> When upgrading to a different technology (pencil to fan-beam, changing kVp, filtration, manufacturer, etc.), studies have shown that differences beyond what can be detected by phantoms can occur.<sup>4,8</sup> In these cases, the ISCD recommends an *in vivo* cross-calibration.<sup>7</sup>

Hologic has developed proprietary systems to ensure proper calibration and data migration regardless of whether the upgrade is from one Hologic system to another, or from a non-Hologic to a Hologic system.

## Replacing a Hologic Legacy Fan-beam System with a New Hologic Fan-beam System

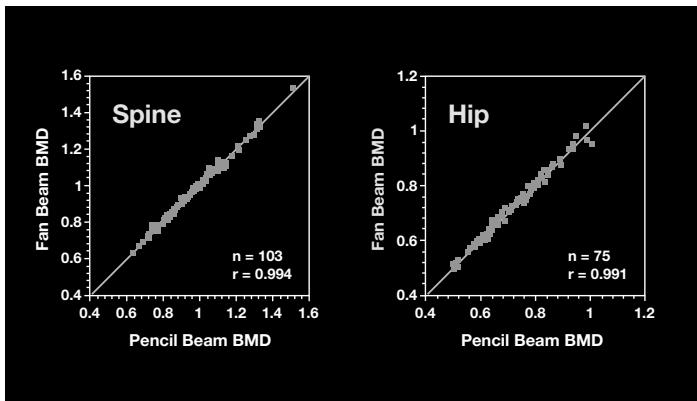
As noted previously, it is important that calibration changes are not introduced into patient data. Hologic's patented Internal Reference System provides continuous pixel-by-pixel calibration, so that every sample of data is in agreement with the factory calibration value, thus ensuring data integrity over time.<sup>6</sup> When upgrading to a new system, the Hologic service team performs a cross-calibration procedure to standardize the new system's calibration to the legacy system's calibration. This procedure is done by first scanning an anthropomorphic spine phantom 20 times on each system. Then the mean of the scans from each system is taken, and the new equipment can be recalibrated to within one percent of the legacy system.

Hologic takes additional steps to guarantee backward data compatibility to further ensure accurate monitoring of BMD results. The new system features the same beam geometry, kVp, mA and filtration. In addition, all legacy QDR-4500 or Delphi scan modes are available for AP Spine, hip and whole body. This enables physicians to perform follow-up scans using the same acquisition and analysis technique as the baseline scan, thus increasing confidence in monitoring long-term changes.

## Replacing a Pencil-beam System with a Fan-beam System or Changing Manufacturers

Machine calibration is only one of the concerns when upgrading from an older Hologic pencil-beam system or a system from a different manufacturer to a Hologic DXA fan-beam system. It is also necessary to convert existing patient data to ensure compatibility with the new system. The APEX™ software, which ships with every new Hologic Discovery™ DXA system, not only provides the latest in functionality and precision, but it also maintains backward compatibility with previous generation Hologic DXA systems. If desired, the software enables the reanalysis of previous scans using the same algorithms for consistency of data.

There are known systematic differences in how BMD values are measured and reported among various manufacturers. Researchers at the University of California, San Francisco, developed standardization formulas that allow for conversion of BMD values from one manufacturer to another at the AP spine, total hip, femoral neck and trochanteric regions of interest.<sup>9-11</sup> These conversion formulas, which were originally developed on pencil-beam systems, were recently re-examined in a multi-site cross-calibration study, and excellent agreement was seen at the proximal femur.<sup>12</sup> A small systematic difference was seen at the AP spine, most likely due to the different positioning used when measuring the spine on the GE Prodigy system (legs were flat on the table, instead of elevated to remove lordosis as in the original standardization study.)



**Figure 1:**  
A comparison of BMD between two different DXA scanners, a pencil-beam scanner and a Hologic fan-beam scanner.

When replacing non-Hologic technology, Hologic employs a proprietary process to capture, convert and calibrate existing BMD values for both the spine and hip. First, BMD values and patient demographics are captured from the legacy system database. Once the data is extracted, the industry-accepted conversion formulas are applied to convert the original BMD results to Hologic-equivalent values. The converted values are then transferred to a new Hologic database. After the database has been migrated to the new system, the usable results will appear in BMD format for use in charting patient rate-of-change.

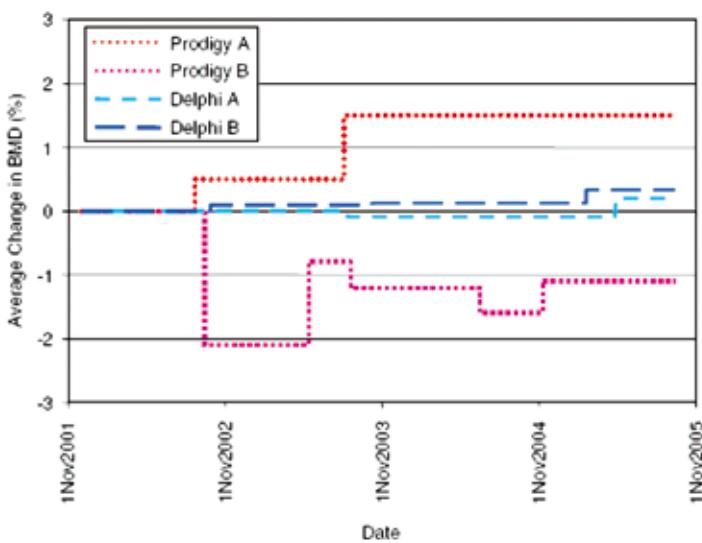
Measurement Site	Conversion Equation
Lumbar Spine	Hologic BMD= 0.918 x Lunar BMD – 0.038
Total Hip	Hologic BMD= 0.971 x Lunar BMD – 0.037
Femoral Neck	Hologic BMD= 0.8638 x Lunar BMD – 0.039
Trochanter	Hologic BMD= 0.8588 x Lunar BMD – 0.023

**Table 1. Lunar DXA Systems<sup>9,11</sup>**

Measurement Site	Conversion Equation
Lumbar Spine	Hologic BMD= 0.924 x Norland BMD + 0.077
Total Hip	Hologic BMD= 1.004 x Norland BMD + 0.020
Femoral Neck	Hologic BMD= 0.906 x Norland BMD – 0.012
Trochanter	Hologic BMD= 0.8697 x Norland BMD + 0.067

**Table 2. Norland DXA Systems<sup>9,11</sup>**

Whenever there is a technology change (pencil to fan-beam, change in kVp or filtration), it is important to determine if the older machine has changed from its original manufacturing calibration. This is a potential problem if the machine has not been regularly serviced, if a strict QC program has not been followed, if the standard positioning for the AP spine has not been used (i.e. legs are not elevated), or if the machine does not have an internal reference system to maintain agreement with the original manufacturer's calibration.



**Figure 2:**

**An example of undetected drift over time with different DXA scanners**

The clinical implication is that patients will be misdiagnosed with the drift of calibration. It has been shown that the ability to detect the least significant change is increased when technology is changed, even if the customer stays with the same manufacturer.

## Conclusion

Advances in technology have increased the need to replace older generation DXA systems and have raised issues regarding proper patient monitoring, including access to previously acquired results and data compatibility with new equipment.<sup>13</sup>

Hologic's systems help overcome these concerns with its proprietary processes for cross-calibration, as well as data migration and conversion using industry-accepted standards. The

numerous benefits of the Discovery™ systems – including acquisition speed, long-term precision and such enhanced applications as cardiovascular risk assessment and body composition analysis – combined with the ease and accuracy of data migration – make Hologic a sound clinical choice when upgrading to a new DXA system.

## References

- <sup>1</sup> FDA 510k K871553, October 10, 1987.
- <sup>2</sup> Oldroyd, B., Smith, A.H. & Truscott, J.G. Cross-calibration of GE/Lunar pencil and fan-beam dual energy densitometers—bone mineral density and body composition studies. *Eur J Clin Nutr* **57**, 977-87 (2003).
- <sup>3</sup> Frost, S.A., Nguyen, N.D., Center, J.R., Eisman, J.A. & Nguyen, T.V. Discordance of longitudinal changes in bone density between densitometers. *Bone* **41**, 690-7 (2007).
- <sup>4</sup> Blake, G.M., Harrison, E.J. & Adams, J.E. Dual x-ray absorptiometry: cross-calibration of a new fan-beam system. *Calcif Tissue Int* **75**, 7-14 (2004).
- <sup>5</sup> Pearson, D., Horton, B. & Green, D.J. Cross-calibration of DXA as part of an equipment replacement program. *J Clin Densitom* **9**, 287-94 (2006).
- <sup>6</sup> Hangartner, T.N. A study of the long-term precision of dual-energy x-ray absorptiometry bone densitometers and implications for the validity of the least-significant-change calculation. *Osteoporos Int* **18**, 513-23 (2007).
- <sup>7</sup> Shepherd, J.A. et al. Cross-calibration and minimum precision standards for dual-energy x-ray absorptiometry: the 2005 ISCD Official Positions. *J Clin Densitom* **9**, 31-6 (2006).
- <sup>8</sup> Blake, G.M. Replacing DXA scanners: cross-calibration with phantoms may be misleading. *Calcif Tissue Int* **59**, 1-5 (1996).
- <sup>9</sup> Hui, S.L. et al. Universal standardization of bone density measurements: a method with optimal properties for calibration among several instruments. *J Bone Miner Res* **12**, 1463-70 (1997).
- <sup>10</sup> Genant, H.K. et al. Universal standardization for dual x-ray absorptiometry: patient and phantom cross-calibration results. *J Bone Miner Res* **9**, 1503-14 (1994).
- <sup>11</sup> Lu, Y., Fuerst, T., Hui, S. & Genant, H.K. Standardization of bone mineral density at femoral neck, trochanter and Ward's triangle. *Osteoporos Int* **12**, 438-44 (2001).
- <sup>12</sup> Fan, B., Lu, Y., Genant, H., Fuerst, T. & Shepherd, J. Does standardized BMD still remove differences between Hologic and GE-Lunar state-of-the-art DXA systems? *Osteoporos Int* **21**, 1227-36.
- <sup>13</sup> Wilson, K.E. Emerging trends in dual energy x-ray absorptiometry. *Radiol Manage* **28**, 50-5 (2006).

## United States / Latin America

35 Crosby Drive  
Bedford, MA 01730-1401 USA  
Tel: +1.781.999.7300  
Sales: +1.781.999.7453  
Fax: +1.781.280.0668  
[www.hologic.com](http://www.hologic.com)