DXA: Improving Reporting of True Change in Bone Mineral Density

Measure Purpose	This measure aims to improve the clinical management of patients undergoing serial DXA through standardized reporting of bone mineral density (BMD) change. This measure enables clinicians to discern true biological change from unavoidable measurement variation. This will improve care for patients undergoing BMD monitoring.
Measure Type	Intermediate Outcome
Measure Level	Individual or Group Practice
Measure Rationale	Osteoporosis and low BMD is a major public health issue for millions of Americans aged 50 and older. Approximately 1.8 million Medicare beneficiaries sustained approximately 2.1 million osteoporotic fractures in 2016.[1] One in every two women will develop a fragility fracture after age 50. Although osteoporosis is often considered a silent disease, its impact is not. Approximately 24% of those with a hip fracture will die within a year of the fracture. Furthermore, about 20% of those sustaining a hip fracture require a nursing home stay and 60% do not return to pre-fracture functional level.[2] In addition to the morbidity and mortality burden, the economic costs of osteoporotic fractures are substantial, being projected to reach $25.3 billion annually by 2025, an increase of 50%.[3] Osteoporotic fragility fractures lead to more hospitalizations and hospital costs than myocardial infarction, stroke, or breast cancer.[4] Clearly, optimal management of this substantial health problem is essential.
	Osteoporosis diagnosis and management are currently suboptimal. Accurate DXA reporting is an essential component of high-quality osteoporosis detection and follow-up care. Radiologists now interpret the majority of these exams in the U.S.,[5] yet research demonstrates DXA interpretation errors are common.[6-9] In one study, interpretation errors were present in 80% of patients; 42% of errors were likely to impact patient management decisions. The most common major errors were reporting incorrect information on BMD change (70%) and incorrect diagnosis (22%).[10]
	To improve DXA quality, it is imperative to mitigate such errors. This includes applying established best practices to correctly report BMD changes. A critical reporting element includes describing the widespread performance of precision assessment and including this into routine DXA reporting. The standard precision metric in BMD measurement is the repeatability coefficient, better known as the least significant change (LSC). Many final DXA reports do not currently include this metric[11, 12] and therefore do not adequately

	communicate the significance of BMD measurement changes or the technical quality of the acquisition.[8, 13-15] The appropriate use of precision assessment in clinical practice is essential to determine if a measured BMD numerical difference in serial DXA exams is due to true physiological change or is due to unavoidable, random measurement error. This can be accomplished by understanding and measuring both inter- and intra-system measurement variations of DXA scanners.[13, 15, 16]
Measure Description	Percentage of exam final reports for all serial[i] DXA exams which have a comparable prior exam[ii] that include (1) an appropriate LSC[iii] statement referencing a facility's LSC values and (2) a second statement regarding whether the measurement differences between the current exam and prior exam constitutes a significant change or not.
Denominator	All serial DXA exams which have an available comparable prior exam[ii].
Numerator	Number of final reports for serial exams that include (1) an appropriate LSC[iii] statement referencing a facility's LSC values and (2) a second statement regarding whether the measurement differences between the current exam and prior exam constitutes a change (difference is greater than LSC value) or does not (difference is less than LSC value). *Note:* Sample documentation for meeting the measure numerator may be found in the Guidance section below.
Denominator Exceptions	Medical or technical reason(s) documenting the prior exam and current exam are too dissimilar for a meaningful comparison. Examples include but are not limited to factors that may compromise measurement accuracy such as artifacts, interim hip, vertebral or wrist fracture, arthroplasty, severe degenerative changes or other technical or patient related issues.
Guidance	To aid in determining the statistical significance of clinical measurement differences, the precision error in the form of the LSC should be calculated for each clinical DXA system and skeletal site. The LSC represents the smallest difference between two clinical BMD measurements on a single scanner that can be considered statistically significant with 95% confidence. When monitoring patients, the comparison should be made to prior DXA examinations of the same skeletal site and region of interest. The precision error and LSC[iii] of the specific scanner(s) and skeletal site should be ascertained and documented to determine if measured changes are statistically significant.[14, 15]

A statement comparing the current study to prior available studies should include assessment of whether any change in measured BMD is statistically significant.[14, 17]

Technologist precision and quantitative BMD comparisons in clinical practice should use the LSC expressed as an absolute value in grams per square centimeter.[15] This is preferable to using %CV as it is less affected by the baseline BMD value; as an example, the same absolute change in BMD with a very low baseline BMD would represent a greater percentage change compared with a higher baseline BMD. DXA precision calculators are available online to calculate precision as either grams per square centimeter or %CV.[18] The International Society for Clinical Densitometry provides minimum precision values, therefore, it is possible to determine whether a technologist meets these standards.[16] If a technologist has exceeded acceptable values, retraining is necessary.[16] If the LSC is inappropriately large, then changes in BMD over time with aging, disease or treatment cannot be detected within a clinically useful time interval.[16]

Facility LSC should be updated when a new DXA system is installed, a new technologist begins scanning patients, or a technologist's skill level has changed.[16]

If a DXA facility has not performed precision assessment, then quantitative comparison of serial BMD measurements is not possible.[8, 12, 15]

Follow-up DXA Report: Minimum Requirements Statement about the LSC at your facility and the statistical significance of the comparison.[17]

The manufacturer's LSC should not be used, because it does not account for differences in patients who will be tested and the performance and skill of the technologist.[15]

It is not possible to quantitatively compare BMD or to calculate a LSC between densitometers or facilities without cross-calibration.[16] When possible, patients should return to the same DXA device that was used to perform their most recent prior study, provided that the facility in vivo precision and LSC values are known and do not exceed established maximum values.[19]

If a prior study is available, but not an appropriate comparison[ii], a statement should be included in the report as to why the exams are not comparable. If no prior studies with an appropriate comparison are available, a statement can be included to the effect: Limited availability of data related to the prior exam prohibit direct comparison and assessment of change.

The following is an example of acceptable documentation included in the final report:

	At *Facility Name* the least significant change in BMD with 95% confidence is 0.020gm/cm2 at the mean total femur or 0.025 gm/cm2 at a single total femur.
	At *Facility Name* the least significant change in BMD with 95% confidence is 0.035 gm/cm2 at the L1-4 region OR
	0.040 gm/cm2 at the L2-4 region OR
	0.045 gm/cm2 at the L1-3 region OR
	0.055 gm/cm2 at the L1-2 region.
	At *Facility Name* the least significant change in BMD with 95% confidence is 0.040 gm/cm2 at the 1/3 radius.
Definitions	i. Serial exams are DXA studies in which there is a previous exam performed on the same skeletal site. ii. Comparable exams are studies performed using the same DXA system or a system that has been appropriately cross calibrated with the current DXA system. iii. Least significant change (LSC) is a precision value that determines whether a measured BMD difference is statistically significant between DXA exams; therefore, representing a true change rather than random measurement error. LSC values are distinct for each anatomic site routinely evaluated (i.e., lumbar spine L1-L4, hip and forearm). When multiple technologists are performing exams within a facility, it is acceptable to establish the facility LSC for a specific anatomic site from the pooled average LSC values of all facility technologists, assuming values are similar.[15] This should be updated continuously as technologists change.

References	Bibliography
1. Hansen D, Pelizzari PM, Pyenson BS 2021 Medicare cost of osteoporotic fractures: 2021 updated report. Milliman, milliman.com 2. LeBoff MS, Greenspan SL, Insogna KL, et al. 2022 The clinician's guide to prevention and treatment of osteoporosis. Osteoporosis International 33:2049-2102 3. O'Malley CD, Johnston SS, Lenhart G, et al. 2011 Trends in dual-energy X-ray absorptiometry in the United States, 2000-2009. J Clin Densitom 14:100-7 4. Singer A, Exuzides A, Spangler L, et al. 2015 Burden of illness for osteoporotic fractures compared with other serious diseases among postmenopausal women in the United States. Mayo Clin Proc 90:53-62 5. Pelzl C, Proudt T, Christensen E 2022 DXA Interpretation Claims, Medicare Physician/Supplier Procedure Summary Limited Data Set. In: Radiology ACo (ed) 6. Martineau P, Morgan SL, Leslie WD 2021 Bone Mineral Densitometry Reporting: Pearls and Pitfalls. Can Assoc Radiol J 72:490-504 7. Messina C, Bandirali M, Sconfienza LM, et al. 2015 Prevalence and type of errors in dual-energy x-ray absorptiometry. European Radiology 25:1504-11 8. Licata AA, Binkley N, Petak SM, et al. 2018 Consensus statement by the American Association of Clinical Endocrinologists and American College of Endocrinology on the quality of DXA scans and reports Endocrine Practice 24:220-229 9. Fenton JJ, Robbins JA, Amarnath AL, et al. 2016 Osteoporosis Overtreatment in a Regional Health Care System. JAMA Internal Medicine 176:391-3 10. Krueger D, Shives E, Siglinsky E, et al. 2019 DXA errors are common and reduced by use of a reporting template. Journal of Clinical Densitometry 22:115-124 11. Clynes MA, Westbury LD, Dennison EM, et al. 2020 Bone densitometry worldwide: a global survey by the ISCD and IOF. Osteoporos Int 31:1779-1786 12. Lewiecki EM, Binkley N, Morgan SL, et al. 2016 Best Practices for Dual-Energy X-ray Absorptiometry Measurement and Reporting: International Society for Clinical Densitometry Guidance. Journal of Clinical Densitometry 19:127-40 13. Radiology ACo 2020 ACR-AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Dual-Energy X-ray Absorptiometry (DXA) Equipment, Reston, VA: American College of Radiology 14. Radiology ACo 2018 ACR–SPR–SSR Practice Parameter for the Performance of Dual-Energy X-Ray Absorptiometry (DXA) ACR Practice Parameters and Technical Standards Reston, VA: American College of Radiology

15. Baim S, Wilson C, Lewiecki EM, et al. 2005 Precision assessment and radiation safety for dual-energy x-ray absorptiometry: Position paper of the International Society for Clinical Densitometry. Journal of Clinical Densitometry 8:371-378

16. Shepherd JA, Lu Y, Wilson K, et al. 2006 Cross-calibration and minimum precision standards for dual-energy X-ray absorptiometry: the 2005 ISCD Official Positions. Journal of Clinical Densitometry 9:31-6

17. The Working Group for the ISCD Position Development Conference 2004 Indications and reporting for dual-energy x-ray absorptiometry. Journal of Clinical Densitometry 7:37-44

18. Lewiecki EM ISCD Advanced Precision Calculating Tool https://iscd.org/learn/resources/calculators/advanced-calculator/?Token=ae395bc4-ec2d-46fa-af0f-8013c67b9b30

19. Jankowski LG, Warner S, Gaither K, et al. 2019 Cross-calibration, Least Significant Change and Quality Assurance in Multiple Dual-Energy X-ray Absorptiometry Scanner Environments: 2019 ISCD Official Position. J Clin Densitom 22:472-483