

DXA Bone Density

TABLE OF CONTENTS

1. Introduction..... 2

2. Study logistics..... 3

2.1 Division of quality assurance responsibilities..... 3

2.1.1 Clinical center responsibilities..... 3

2.1.2 MOST DXA Quality Assurance Center responsibilities..... 4

2.2 Training and certification of MOST DXA operators..... 5

2.3 Review of DXA scans..... 5

2.3.1 Flagged scans..... 6

2.3.2 Random sample and outlier checks..... 6

3. DXA scan acquisition and analysis procedures..... 6

3.1 Participant biography..... 7

3.1.1 Patient biography – Baseline..... 7

3.1.2 Windows Based Software..... 8

3.1.3 Patient biography – Follow up..... 10

3.2 Hip scans..... 11

3.2.1 Hip acquisition..... 11

3.2.2 Hip analysis..... 13

3.3 Whole body scans..... 15

3.3.1 Whole body acquisition..... 16

3.3.2 Whole body analysis..... 17

3.4 Scan flagging criteria..... 17

3.5 Follow-up only: excessive bone loss procedures..... 18

4. Scanner quality control..... 19

4.1 Phantom scans..... 19

4.2 Whole body air scan for the QDR 4500..... 21

4.2.1 DOS-based software..... 21

4.3 Cross-calibration of scanners..... 23

4.4 Machine, software, and service problems..... 24

4.5 Hardware/software change control..... 24

5. Data management..... 25

5.1 Hard copies of scans..... 25

5.2 Electronic scan archive..... 25

5.3 Transfer of data to the MOST DXA Quality Assurance Center..... 26

5.4 Return materials sent by the MOST DXA Quality Assurance Center..... 30

Appendix A Hologic Whole Body Phantom Protocol..... 31

Appendix B Study Forms..... 35

MOST DXA Form..... 36

MOST DXA HOLOGIC BIOGRAPHY INFORMATION..... 39

MOST DXA Participant Scan Log..... 40

DXA Batch Record Form..... 41

DXA Repair/Service Log..... 42

Whole Body Air QC Scan Worksheet..... 43

Excessive bone loss alert letter..... 45

1. Introduction

The purpose of this manual is to describe the DXA body composition and bone mineral density (BMD) quality assurance programs for the clinical centers participating in the MOST study. It provides information specific to the Hologic QDR 4500A and QDR 4500W scanner operating under DOS or Windows based software and is intended as a supplement to the appropriate Hologic Users' Guide.

To use this manual effectively, it is essential to have read and understood the entire Hologic QDR 4500 User's Manual. The study densitometry operators are required to have participated in a Hologic QDR 4500 training session and should be familiar with all instrument features and procedures discussed in the Hologic User's Manual.

During the study, any questions regarding procedures that arise should be directed to:

MOST DXA Quality Assurance Center
University of California, San Francisco
185 Berry Street, Lobby 5, Suite 5700
San Francisco CA 94107-1762
Telephone: (415) 514-8096
Fax: (415) 514-8150

IMPORTANT: Unauthorized changes in scanner software or personnel can have a large impact on the integrity of study data. If, for any reason, changes in any of these areas are anticipated, please contact the MOST DXA Quality Assurance Center in San Francisco in advance for further instructions.

2. Study logistics

Table 1 summarizes the body composition and bone density scan acquisition schedule. A whole body and hip scan will be obtained at the initial and 84-month follow-up visit. Bone mineral density scans will be performed at the hip and whole body. Follow-up visit scans will be compared to the MOST baseline visit scans for positioning, analysis, and excessive bone loss at the hip.

Table 1. Scan Acquisition

| DXA Scans | Baseline | 84-Month |
|--------------------|----------|----------|
| Whole Body and Hip | X | X |

2.1 Division of quality assurance responsibilities

2.1.1 Clinical center responsibilities

The clinical centers must ensure the overall quality and completeness of the DXA data and that all protocols and procedures are strictly followed. Specific responsibilities include the following:

1. Require that operators are properly trained and certified. If there are state requirements for DXA operators, these must be met;
2. Identify a chief densitometry operator to train and supervise other operators;
3. Perform and review daily QC scans (all visits) and schedule cross-calibration scans of traveling phantoms (baseline);
4. Assure that proper archiving and back-up procedures for participant scans are performed and that archives are stored securely on appropriate archiving media until the end of the study;
5. Request and review random samples of scans from each clinical center.
6. Once per month (baseline) and every other month (follow-up) on or about the 1st of the month (February, April, June, August, October) send the following materials to the QA Center:
 - a. Printouts of plots of the daily QC data
 - b. Updated copies of participant scan and machine repair logs
 - c. Original printouts of flagged scans
 - d. Original printouts of other requested scans
 - e. Traveling optical disk with all newly acquired scan files obtained since the last data transfer

7. Reanalyze centrally reviewed scans, as requested by the QA Center
8. Assure proper functioning of hardware/software and request service from Hologic:
 - a. Notify Hologic and the QA Center of any machine or software problems or if the QDR machine is being relocated
 - b. Record machine/software problems and service on the Hologic DXA Repair/Service/Upgrade Log
 - c. Perform 5 (baseline) 10 (follow-up) QC phantom scans before (if possible) and after service
 - d. Perform 5 (baseline) 10 (follow-up) QC phantom scans before and after machine relocation
9. Contact the QA Center with any questions or problems that cannot be dealt with in the batch mailings;
10. Send a complete dbArchive at the end of each visit (i.e., end of baseline visit and end of follow-up visit after all participants have been scanned).

2.1.2 MOST DXA Quality Assurance Center responsibilities

The following are the responsibilities of the QA Center:

1. Write and maintain the quality assurance operations manual;
2. Promptly review the QC phantom scan data received from each clinical center in order to identify surges or drifts in machine performance;
3. Incorporate new participant data into the study wide database;
4. Review certification and flagged scans and return results to each clinical center;
5. (*Baseline:*) Request and review random samples of scans from each clinical center;
6. (*Baseline:*) Arrange for cross-calibration of all DXA instruments using traveling phantoms;
7. (*Baseline:*) Prepare quality control summary reports for MOST Steering Committee review;
8. Identify possible sources of error, and suggest possible solutions. **(However, the QA Center will not be responsible for the solution of a hardware or software problem; that will rest with the clinical center and Hologic.)**

Any questions or correspondence regarding this manual or the technical aspects of the DXA measurements should be directed to:

MOST DXA Quality Assurance Center
SF Coordinating Center
185 Berry Street, Lobby 5, Suite 5700
San Francisco, CA 94107-1762
Telephone: (415) 514-8096
Fax: (415) 514-8150

2.2 Training and certification of MOST DXA operators

To obtain consistent results, the densitometry operators must be aware of possible sources of error that may affect data collection and analysis. Only those operators who have been certified through Hologic training and the QA Center review are allowed to perform the scanning and analysis for this study.

Anyone performing scans for the MOST study must meet the following requirements:

1. Read and understand both the Hologic QDR4500 manual and this manual;
2. Successfully complete a Hologic QDR4500 training course;
3. Satisfactory review of each operator's initial scans by the QA Center.

It is the clinical center's responsibility to ensure that all of the above certification criteria are met as new operators are brought into the study. Since the Hologic central training sessions are held infrequently, there may be several months delay between when a new operator is hired and when certification is complete. Personnel not meeting these requirements may not scan participants without close supervision by a certified operator, unless specifically authorized by the QA Center.

Follow-up: In order for an individual operator to be certified to perform scans of a given skeletal site, the first 10 follow-up scans done on study participants at each skeletal site for each operator must be sent to the QA Center for review. Printouts of the corresponding baseline scans must accompany the follow-up scans. Printouts of the scans should be sent to the QA Center at the address listed above as soon as the first 10 follow-up scans have been completed.

2.3 Review of DXA scans

Scan analysis quality will be ensured by a central review of flagged whole body scans and flagged hip scans.

Scan analysis quality will be ensured by a central review of some analyzed participant scans. Whenever scans are to be reviewed centrally:

1. An original printout and electronic copy of the scan should be sent to the QA Center. Write the reason for the flagged scan on the scan printout and on the Participant Scan Log.
2. It is the responsibility of the operator to reanalyze the scan according to QA Center comments and return a printout of the reanalyzed scan with an electronic copy to the QA Center for verification.

Procedures for compiling and forwarding scans to the QA Center are outlined in Section 5. Data management.

2.3.1 Flagged scans

Any scans that appear unusual or difficult to analyze should be flagged for review by the QA Center. Guidelines for flagging scans are listed in Section 3.4 Scan flagging criteria.

Flagged scans should be sent to the QA Center every month at baseline and every other month at follow-up on or about the 1st of the month (February, April, June, August, October). Note the reason(s) for flagging on the MOST Participant Scan Log and on the original printout for clarification of the problem. (*Follow-up:*) If the problem involves comparison to the baseline scan, include a copy of the baseline scan.

The printouts will be reviewed for standard positioning and analysis procedures and returned to the clinical centers with instructions for reanalysis, if appropriate. Often these problem scans have been analyzed correctly and will not require further action.

2.3.2 Random sample and outlier checks

Periodically during the study, a random sample of scans and scans with exceptionally high or low BMD (outliers) will be reviewed by the QA Center. In the initial phases of the study, a relatively large number of scans will be checked to verify site performance. These checks may result in requests for reanalysis by the QA Center.

3. DXA scan acquisition and analysis procedures

Standard scanning and analysis procedures for the hip and whole body bone density measurements are described in detail in the Hologic QDR 4500 User's Manual. Some of the information from the Hologic manual is repeated in this manual for emphasis. Please note, however, that some of the scanning evaluation protocols for this study differ from those detailed by Hologic.

- ***Baseline: Generally use the default Fast Array for all participant scan acquisition. An exception may be made for large participants if the Array mode provides a better quality***

scan. It is not possible to give an exact cut point. It is suggested to use Array mode when the participant weighs 170 pounds or more, the anatomy being scanned is very thick, or the scan image has a “moth eaten” look. The decision to use Array rather than Fast Array may be made at the discretion of the operator. Array may be used without first trying Fast Array.

NOTE: Default mode is the only mode available for whole body scans.

- **Be sure to completely fill out the appropriate MOST forms before and after scanning the participant (see Appendix B). This includes the Participant Scan Log and any forms provided by the Study Coordinator.**
- *Follow-up: Use the same scan mode (e.g., fast array or array) as was used on the baseline scan.*

3.1 Participant biography

3.1.1 Patient biography – Baseline

Be sure to use the capital letter "I", not the number one "1" when entering character data into the Patient Biography fields.

Be sure to use zero (0) and one (1) and not the letter "O" or lower case letter "i" or capital letter "I", when entering numerical data into the Patient Biography fields.

The Study Coordinator will send a DXA Biography Form with the participant listing the acrostic, MOST ID, sex, and ethnicity to be used in the Hologic biography. **If you do not get this form, insist on having it before scanning the participant. It is important that this information match the study records. Do NOT ask the participant. Get the information from the DXA Biography Form provided by the Study Coordinator.**

An example of the PATIENT BIOGRAPHY screen for a participant is shown in Fig 1.

Sex and Ethnic fields should be entered as described in the appropriate Hologic user's guide.

Patient Name Field: Please enter the participant's MOST acrostic. The acrostic will be provided by the study coordinator. **Use capital letters in this field.**

The acrostic entered in the Name Field **MUST match the official study acrostic** that will be provided by the Study Coordinator. Do not make up the acrostic yourself. Get it from the **DXA Biography Form** provided by the Study Coordinator.

Patient ID Field: The MOST ID used for tracking participants consists of the capital letter M, followed by the capital letter B for Birmingham clinic or capital letter I for Iowa clinic, followed by 5 numbers.

It is the single most important piece of information associated with each participant and must be entered correctly. Do not use spaces, dashes, or commas. Iowa staff must be careful to use the letter I, not the number 1, for the second character. Use the number keys for the numbers zero and one.

Consider the sample participant discussed above. Suppose the clinical center is Iowa and the five digit number is 00010, then Figure 1 demonstrates the correct method for entering the Most ID within the Pat ID field:

MI00010

Comment Field: Enter **VISIT 1** in this field. Use all capital letters.

Operator field: Enter the staff ID code provided by your study coordinator. You will always use this code when scanning MOST participants. Use uppercase for characters.

Ref MD Field: Enter **MOST** in this field. Use all capital letters.

Leave all other fields blank.

Figure 1. MOST Patient Biography Screen for DOS Based Software

_____ Patient Biography Information _____

Name: Acrostic

Soc Sec: **Pat ID:** MI00010

Comment: VISIT 1

Operator: I01 **Zip:**

DOB: **Sex:** F **Weight:** **Height:**

Ethnic: W **Ref MD:** MOST

3.1.2 Windows Based Software

Details about the Biography entry screen of the QDR for Windows software can be found in the QDR for Windows User's Guide, Chapter 6 Managing Patient Records. Please use the following instructions to enter your MOST Biographies in the Windows software.

An example of the PATIENT BIOGRAPHY and PATIENT CONFIRMATION screens for a participant with acoustic JSMI scanned by staff with MOST staff number 'I01', etc. at Iowa are shown in Figures 2 and 3.

Last Name Field: Enter the participant's MOST acoustic. The acoustic will be provided by the study coordinator. **Use capital letters in this field.**

The acoustic entered in the Last Name Field **MUST match the official study acoustic** that will be provided by the Program Coordinator. Do not make up the acoustic yourself. Get it from the form provided by the Study Coordinator.

First Name and Middle Initial fields: Leave blank

Patient ID Field: The MOST ID used for tracking participants consists of the capital letter M, followed by the capital letter B for Birmingham clinic or capital letter I for Iowa clinic, followed by 5 numbers.

It is the single most important piece of information associated with each participant and must be entered correctly. Do not use spaces, dashes, or commas. Iowa staff must be careful to use the letter I, not the number 1, for the second character. Use the number keys for the numbers zero and one. Use uppercase for characters.

Consider the sample participant discussed above. Suppose the clinical center is Iowa and the five digit number is 00010, then Figure 2 demonstrates the correct method for entering the Most ID within the Patient ID field:

MI00010

Sex, Ethnicity: Enter information.

Referring Physician Field: Enter MOST

Patient Comment: Enter VISIT 1 Use all capital letters

Leave all other fields blank.

PLEASE NOTE: THE STAFF ID CODE and CURRENT HEIGHT AND WEIGHT ARE ENTERED AS FOLLOWS:

After entering or selecting a Biography, the Patient Confirmation screen will appear (Figure 3). Leave the Current Height and Weight blank. For Operator, enter the last three numbers of the MOST staff ID code of the DXA operator performing the scans. See your Study Coordinator for a staff ID code.

Figure 2. MOST Patient Biography Screen for Windows Based Software

Patient Biography

Last Name: Acrostic

First Name:

Middle Initial: Sex: F

Ethnicity: White

DOB Month:

Patient ID:MI00010 Day:

Identifier2: Year:

Referring Physician:MOST

Menopause Age: Weight: lb Height: in

Patient Comment: VISIT 1

Figure 3. MOST Patient Confirmation Screen for Windows Based Software

Patient Confirmation

Patient's Current Height: in

Patient's Current Weight: lb

Operator: I01

3.1.3 Patient biography – Follow up

The Patient Biography was created in the Hologic database for the MOST baseline scan. Do not create a new biography for the follow-up visit. The participant's current weight and height must be entered in the database. Do not presume that the weight and height has not changed since baseline.

Be sure to use the numbers zero (0) and one (1), not the letters "O" and "I" when entering numerical data into the Patient Biography fields and vice versa.

Figure 4. MOST Follow-up Visit Patient Biography Screen

_____ Patient Biography Information _____

Name: SMITH, JOHN
Soc Sec: _____ **Pat ID:** MB01010
Comment: Follow-up Visit
Scan Code: B01 **Zip:** _____
DOB: 10/20/30 **Sex:** M **Weight:** 160 **Height:** 5' 9"
Ethnic: W **Ref MD:** MOST

3.2 Hip scans

3.2.1 Hip acquisition

Baseline:

The appropriate HOLOGIC user's guide should be consulted for the proper hip scanning and analysis procedures. Clarifications and exceptions for the MOST Study are noted below.

1. **Generally use the default Fast Array for all participant scan acquisition. An exception may be made for large participants if the Array mode provides a better quality scan. It is not possible to give an exact cut point. It is suggested to use Array mode when the participant weighs 170 pounds or more, the anatomy being scanned is very thick, or the scan image has a "moth eaten" look. The decision to use Array rather than Fast Array may be made at the discretion of the operator. Array may be used without first trying Fast Array.**
2. The **RIGHT hip is the preferred** hip unless it has hardware. If the right hip is not appropriate to scan, scan the left hip.
3. **If both hips have hardware** or for some other reason a hip scan can not be obtained, the participant can be in the study. Fill out the appropriate MOST form to inform the study coordinator that no hip scan was performed. **All missing scans must be accounted for.**
4. No metal or plastic object should remain in the scanning area. Check for jewelry, coins or other objects in the hip pockets, zippers, buttons, rivets, belts or any other clothing fasteners, as well as hip and back braces.
5. Keep the participant's hands out of the scanning area by placing them well away from the hips.

6. Ensure rotation of the hip by holding the knee and the ankle when positioning the leg. Optimum positioning of the leg is most important to achieve a consistent projection of the femur. Scan the other side if you cannot rotate the foot inward due to pain. **A small or missing lesser trochanter on the scan image indicates proper hip rotation.**
7. After proper rotation attach the leg to be scanned to the angled foot positioner supplied by the manufacturer.
8. The participant should be made as comfortable as possible to reduce the chance of unwanted movements. Use a pillow for the head. Maintain the participant at a comfortable body temperature for the duration of the scan.
9. Instruct the participant to remain still until the end of the measurement. Make sure that the leg is not moved during the scan. Rescan if necessary. Flag any scans in which the participant has moved and has not been rescanned.
10. Print out a hard copy of each scan and file in the participant's folder.

Follow up:

1. Refer to the baseline hip scan printout. Use the DXA Bone Density Follow-up Visit TELEForm (see Appendix B) to determine and document which side to scan. Store the DXA Bone Density Follow-up Visit TELEForm in the participant's clinic binder; do not send to the QA center. If the opposite hip from baseline must be scanned, perform the acquisition and analysis according to the baseline MOST DXA operations manual instructions.
2. Refer to the baseline hip scan printout. Position the hip in exactly the same position as baseline (even if the baseline positioning was not optimal). In particular the hip rotation must be the same. The best way to check hip rotation is to be sure that the lesser trochanter has the same size, shape, and location on the follow-up scan as at baseline.
3. **If it is impossible to reproduce the positioning from baseline** (e.g., pain, worsening arthritis), produce the best possible scan. **Flag** the follow-up scan, write the problem on the scan printout and send copies of both the baseline and follow-up scan to the QA center.
4. Refer to the baseline hip scan printout. **Use the same scan mode (e.g., fast array or array) as was used on the baseline scan.**
5. No metal or plastic object should remain in the scanning area. Check for jewelry, coins or other objects in the hip pockets, zippers, buttons, rivets, belts or any other clothing fasteners, as well as hip and back braces.
6. Keep the participant's hands out of the scanning area by placing them well away from the hips.
7. Ensure rotation of the hip by holding the knee and the ankle when positioning the leg. Optimum positioning of the leg is most important to achieve a consistent projection of the femur.
8. After proper rotation attach the leg to be scanned to the angled foot block supplied by the manufacturer.
9. The participant should be made as comfortable as possible to reduce the chance of unwanted movements. Use a pillow for the head and a small pillow under the knee of the leg not being scanned. Maintain the participant at a comfortable body temperature for the duration of the

scan.

10. Instruct the participant to remain still until the end of the measurement. Make sure that the leg is not moved during the scan. Flag any scans in which the participant has moved and has not been rescanned.
11. Print out a hard copy of each scan and file in the participant's folder.

3.2.2 Hip analysis

Baseline:

Global Region of Interest The procedures outlined in the appropriate Hologic user's guide are to be followed. The points listed below are for emphasis.

1. The lateral side of the global ROI should be at least 5 mm (5 lines) beyond the outer edge of the greater trochanter to provide sufficient soft tissue for analysis, although it should not extend outside the participant's body.
2. The bottom edge of the global ROI should be at least 1 cm (10 lines) below the lesser trochanter to provide sufficient soft tissue for analysis.
3. In order to facilitate the use of hip axis length software, the top and medial edges of the ROI should be expanded past the acetabulum to include the medial edge of the pelvic bone.
4. In the event that the global ROI must be expanded to allow complete filling of the bone edges (see below) in low BMD participants, all edges must be at least two steps away from the border of the scan field

Bone Edges If the bone edges are not properly determined by the analysis program, increase the size of the global ROI by first moving the top border up 10 lines further from the femoral head, then by moving the medial border 10 lines further out, if possible, to include more soft tissue in the analysis. Repeat as needed. Do not move the bottom or lateral border. Do not fill in bone edges manually unless absolutely necessary. The software will automatically fill any "holes" within the bone. Occasionally, the bursa or tendons surrounding the greater trochanter can be calcified. This will produce "knobs" that can merge with the trochanter and throw off the automatic placement of the four regions. Expanding the global ROI will not always separate these from the trochanter and they will have to be manually excluded. Flag for review by the QA Center any cases in which you manually alter the bone edge.

Femoral Midline Unevenness (notches) in the upper or lower edge of the femoral neck can throw off the femoral midline so that it does not run down the center of the neck. This will in turn cause the femoral neck box to twist. If the midline looks like it might be off or the box is twisted, it may be necessary to adjust the bone mask (e.g., filling in neck notches) in order to obtain appropriate positioning of the midline. The position of the midline itself should not be altered. If you have made changes to the scan such as filling in bone in order to alter the midline, or if the midline still seems off, please flag these cases for review by the QA Center.

Femoral Neck Box If the default neck box provided by the Hologic program looks reasonably placed, leave it unchanged.

1. Whenever possible, use the maximum width of the neck box (default). The neck box should be perpendicular to the neck axis. Always anchor the neck box at the inflection, or "turning point" of the greater trochanter. On some scans, it will be necessary to lengthen the neck box in order to get correct placement of the neckbox. If the maximum area of the neck that can be covered by the femoral neck box is less than 1 cm^2 , the participant should be rescanned with special care taken to improve the rotation and degree of abduction of the leg. Since such a narrow neck box would be only 2 to 3 lines wide, you will only rarely have a problem with this constraint.
2. If the area of the neck region is less than 2.5 cm^2 , attempt to increase the width of the neck box to the maximum possible while still avoiding inclusion of the trochanter, ischium, or femoral head and acetabulum. In order to obtain maximum size of the neck box, the ischium may be deleted.
3. If the default neck box partially extends into the trochanter, or femoral head and acetabulum, adjust its location or size while maintaining the maximum possible area.
4. The Hologic software is sometimes unable to provide an appropriate placement of the neck box and other regions. This can occur if the projected neck axis is too short or the neck is too close to the ischium. Soft tissue between the neck and ischium will be read as bone, and the automatic placement of the femoral midline will fail. If this happens, use the procedure described in the appropriate Hologic user's guide for deleting the bone of the ischium. Deleting this will not adversely affect the analysis, as this bone is not included in the reported regions of interest.

Trochanteric Line The trochanteric line should intercept the bone edge just below the lateral aspect of the greater trochanter. There is no need to correct minor deviations (up to about 3 pixels).

Follow up:

Load the baseline scan onto the hard disk. Display this baseline evaluation using the COMPARE feature along with the current scan to be analyzed. It is important to realize that proper comparison of a follow-up hip scan to its baseline depends upon maintaining the identical size and relative position of the region markers. Vertical or horizontal shifts of these regions by one or more pixels can greatly alter the final values of the analysis.

Global Region of Interest

1. The width and height of the global ROI must be the same as that used on the baseline.
2. The dotted lines from the baseline defining the bone region should overlay the follow up as

closely as possible. Occasionally there are small changes in adduction and rotation of the leg that were not eliminated by rescanning. The region surrounding the neck should have the best fit.

3. If the global ROI cannot be moved to the appropriate position because it is too large, the baseline scan will have to be reanalyzed with a properly reduced global ROI. Then the follow up should be analyzed comparing it to the reanalyzed version of the baseline. **Flag** cases in which the baseline had to be reanalyzed.

4. Use **<Control>** **<End>** to accept the global ROI and bone mask.

Bone Edges If the bone edges do not fill in properly on the follow-up analysis, first the baseline will have to be reanalyzed with a larger ROI, and then proceed with the comparison scan analysis.

Femoral Midline Unevenness (notches) in the upper or lower edge of the femoral neck can throw off the femoral midline so that it does not run down the center of the neck. This will in turn cause the femoral neck box to twist. If the midline looks like it might be off or the box is twisted on either the baseline or follow-up scan, it may be necessary to adjust the bone mask (e.g., filling in neck notches, deleting the ischium) in order to obtain appropriate positioning of the midline. The position of the midline itself should not be altered. If you have made changes to the scan such as filling in bone in order to alter the midline, or if the midline is still off, flag these cases for review by the QA Center.

Femoral Neck Box If the current location is optimally matched to the location of the neck box of the baseline analysis, use it unchanged.

1. If the current location is not optimally matched to the location of the neck box on the baseline, adjust the current region to achieve maximum correspondence. The size of the neck box must be the same on both baseline and follow up.
2. If the current location cannot be satisfactorily adjusted while maintaining the same sized neck box, reanalyze the baseline within the constraints outlined above.
3. It is most important to have the neck box location and size correspond as closely as possible. If you cannot get the neck boxes to match, **flag** the scan for review by the QA Center.

Ward's Triangle If the Ward's triangle box appears on the follow-up scan in a significantly different position than on the baseline, or if after reanalysis of the baseline its location is different than that of the original baseline placement, flag the scan for review by the QA Center.

Trochanteric Line The trochanteric line should intercept the bone edge at the same point on all scans. Matching is easily done during the compare analysis, especially since you will have the baseline to consult during the compare.

3.3 Whole body scans

The HOLOGIC Operator's Manual should be consulted for the proper whole body scanning and analysis procedures. Clarifications and exceptions for the MOST Study are noted below.

3.3.1 Whole body acquisition

Before scanning the participant have a printout of the baseline scan available, if this is a follow-up scan and refer to the baseline printout for positioning of the participant; this is to ensure consistent scanning of the same area. Careful positioning and visual comparison of the current scan with baseline are essential for producing precise measurements.

Use the DXA Bone Density TELEForm (baseline) (Appendix B) or DXA Bone Density Follow-up Visit TELEForm (follow-up) (see Appendix B) to determine and document artifacts. Store the DXA Bone Density TELEForm in the participant's clinic binder; do not send to the QA center.

The following points should be followed when possible. However, if this is a follow-up visit, repositioning the same as baseline always takes precedence:

1. Have the participant remove all clothing, including shoes, and dress them in a hospital gown. Check that no metal or plastic objects remain in the scanning area. This includes hair clips and pins, snaps, zippers and buttons. Have participant remove any jewelry, earrings, bracelets, watches, or rings.
2. Position the participant in the center of the scanning table with their head just below the head of the table. ***It is extremely important that the participant is correctly positioned on the exact center of the table.*** The arms should be separated from the sides of the body with the hands placed palm down, within a few centimeters of the table edge. If the hands do not fit in the scan field, tuck the hands under the thighs.
3. Place a loop of tape around the top of the feet so that the feet are slightly inverted - this will help to prevent motion during the scan and create a separation between the tibia and fibula. If the feet do not fit in the scan field, keep the legs straight and cut the feet from the scan field.
4. Verify that the participant is aligned with the scanner axis (solid line on the table). If during scanning it is apparent that part of the participant's body lies outside the scan field, restart the scan.
5. The participant should be positioned as comfortably as possible since this reduces the chances of unwanted movements. In general, try to avoid the use of any pillows or blankets. If the participant feels uncomfortable in that position, you may use pillows for the head only after the upper half of the scan is done. You may then carefully place a pillow under the head of the participant without causing motion artifacts. This procedure should be practiced with the participant before scanning. If the participant cannot lie flat at all without the aid of a pillow (due to kyphosis), use a radio-lucent pillow.
6. If the participant is very tall, try to include their feet in the scan by placing their head

near the very top of the table.

7. Instruct the participant not to move until the end of the measurement.
8. Print out a hard copy of each scan and file in the participant's folder.

3.3.2 Whole body analysis

Baseline

1. Locate the horizontal shoulder line just below participant's chin.
2. The vertical shoulder lines should bisect the shoulder joints and separate the arms from the trunk. Avoid including any arm soft tissue in the body ROIs. It is acceptable for the arms to be out of the scan region, if this is the only way to position them.
3. Align the spine ROI with the curvature of the spine, if possible. Divide the spine at the T12-L1 disc space.
4. The horizontal line above the pelvis should be just above the iliac crest. The angled lines defining the pelvic triangle should bisect the femoral neck.
5. The vertical line between the legs should run between the participant's feet and evenly divide the legs. The lateral leg lines should be moved to include as much of the thigh soft tissue as possible without crossing the hands. If necessary it is okay to cross the hands.
6. Sub-region cut line placement should be such that left/right symmetry is maintained, i.e., placement of lines on the left side of the body should match those on the right.
7. Print out a hard copy of each scan and file in the participant's folder.

Follow up

Display the baseline evaluation using the COMPARE feature and compare it to your current image on the screen.

Match the location of the region markers as closely as possible to the baseline measurement. Optimally matched, in this context, means that the markers should be at the same position between the body regions as on the baseline image.

If adjustment cannot be done satisfactorily, it will be necessary to reanalyze the baseline scan. If it is necessary to reanalyze the baseline measurement, all subsequent follow-up measurements should be reanalyzed using COMPARE.

3.4 Scan flagging criteria

General

- Scan has unusual appearance or is difficult to analyze
- Any of the following in scan field (either in the bone or soft tissue)
 - Unusual anatomical variations
 - Surgical hardware
 - Participant motion during scan
 - Superimposed buttons, pins, zippers, pacemakers, vitamin pills, etc.
- Bone edges have been altered in any way
- (*Follow-up only*) ROI used on follow up is different size than used at baseline
- (*Follow-up only*) Follow-up scans cannot be reasonably matched to baseline analysis

Hips

- Femoral midline is not aligned and cannot be corrected by following the analysis procedures as outlined in the MOST operations manual
- Neck box width reduced from default
- Ward's triangle persistently located outside of Ward's region - difficulties in redefining search region
- Analysis program repeatedly fails to place regions appropriately - major operator interaction required for analysis

Whole Body

- Internal or external artifacts that cannot be removed
- Participant motion without rescanning (these scans are extremely susceptible to motion artifacts)
- Unable to fit both arms in scan field
- (*Follow-up only*) Significant changes in positioning between baseline and follow-up scan.

3.5 Follow-up only: excessive bone loss procedures

Excessive Bone Loss (EBL) is defined in Table 2. Use the Hologic Rate-of-Change plots to determine the **actual** (not annualized) percent loss between the baseline and follow-up visit.

For **DOS based software** (this software is in use at the beginning of the follow-up visit): Do **NOT use the first** Rate-of-Change plot that appears; this is annualized. Instead hit Home key to get the actual Rate-of-Change.

Table 2. EBL Criteria

| | |
|-----------------------------|--|
| Follow-up Time Point | Actual Rate of Change for Total Spine or Total Hip BMD Compared to Baseline |
| Follow-up Visit | Greater than or equal to 15% |

If EBL is found, rescan by having the participant get off and on the table, repeat the positioning and scanning / analysis, and check again for EBL. **This will necessitate analyzing the follow-up scans while the participant is still on the scan table.**

Whether or not the scan confirms EBL, fill out the “Excessive Bone Loss Form” (see Appendix B) and notify the study site investigator about procedures for providing the participant and their physician with the appropriate MOST Sample Excessive Bone Loss letter (see Appendix B). These letters can be altered by the Principal Investigator as desired.

Do not discuss the presence or implication of EBL with a participant until the principal investigator has been informed, confirmed the bone loss, and has informed the onsite staff how to proceed.

4. Scanner quality control

Monitoring of machine performance throughout the study is the joint responsibility of the clinical centers and the QA Center. Table 3 lists the quality control procedures and schedule.

Table 3. Quality Control Scanning Schedule

| Phantom | Scanning frequency |
|--|--|
| Local Hologic Tissue Bar | 1 time/week |
| Local Hologic Spine Phantom | 3 to 5 times/week and always on a day that participants are scanned |
| Local Hip Phantom | 2 times/week |
| Local Whole Body Phantom | 3 times/week |
| Whole Body Air Scan | 1 time/week |
| <i>(Baseline)</i> Hologic “Gold Standard” Hip, Spine, and Block phantoms | <i>(Baseline)</i> “Traveling Phantoms” that are mailed to the clinical center and scanned one time, usually near the beginning of the study. |

4.1 Phantom scans

Perform the spine and hip QC phantom scans as outlined in the Hologic manual, Quality Control Chapter. **Be sure to scan the hip phantom in Array mode, not the default Fast Array mode** (Fast Array hip scans cannot be added to the QC database). The results of these scans should be reviewed locally for abrupt changes in machine performance and the results sent to the QA Center once a month.

Whole body quality control consists of Hologic whole body phantom scans, whole body air scans and tissue bar scans. Hologic whole body phantom comes with instructions from Hologic and there are supplemental instructions in Appendix A. The instructions for the whole body air scans are in Section 4.2 of this manual. The tissue bar comes with instructions from Hologic.

Points of procedure to note:

1. Create only one patient biography per phantom. There should be a biography for the Spine, Hip and Whole Body phantoms. Avoid duplication of phantom biographies by using the patient menu to select the appropriate biography prior to scanning the phantom.
2. Use the following instructions to create the phantom biographies. The phantom serial number is on the phantom label. It may have letters in front of the numbers. If this is a new biography, put in both letters and numbers. The NAME field contains the type of phantom and the phantom serial number (indicated by XXXX): Spine Phantom #XXXX Hip Phantom #XXXX Whole Body Phantom #XXXX
The PAT ID field contains the phantom serial number (indicated by XXXX): #XXXX
3. Scan each phantom on top of the pad. Ensure alignment with the scanner axis by using the laser cross-hairs.
4. Add the spine and hip phantom scan data to the QC database immediately after completing scanning and analysis. See the Hologic manual, Quality Control Chapter, section "Adding Data to QC Database". Note: the Whole Body phantom and Whole Body Air scan data can not be added to the QC database.
5. **Be sure to scan the hip phantom in Array mode, not the default Fast Array mode** (Fast Array hip scans cannot be added to the QC database). See the Hologic manual, Quality Control Chapter, section "Setting Up a New QC Plot (Graphs)". Follow the directions to set up the mean and limit lines for the hip QC plot. After the set up is done, scan the hip phantom two times a week.
6. Use the plot feature to verify that the spine and hip phantom BMD, BMC and AREA values of your scanner are within normal limits. It is best to plot at least one year of data. If the most recent scan falls outside the limits, reposition the phantom and repeat the scan. If the scan also falls outside the limits and/or the CV of the BMD exceeds 0.60%, contact both Hologic and the QA Center.
7. After the spine and hip phantom scans have been analyzed and added to the QC database, delete the scans from the hard drive. Note: the Whole Body phantom scans should be archived to the clinic optical and copied to the traveling optical disks before being deleted

from the hard drive.

8. Check the system drift weekly by pressing <R> while viewing the plot. The slope of the calculated regression line should be within the range of the standard deviation shown. If the drift is greater than the standard deviation, contact both Hologic and the QA Center.
9. Generate a printout of the daily phantom plots (BMD, BMC and AREA for hip and spine) once a week on your designated "QC day." This will facilitate detection of long-term drifts as well as short-term inconsistencies. Store these plots in a QC log book.
10. Original printouts including the scan results of the most recent phantom QC plots (BMD, BMC and AREA for hip and spine) are to be sent to the QA Center with each batch. The date range for the plots should cover the previous 12 months to the present.
11. Perform a dbArchive at least once a week and store at the clinical site. Disks may be rotated monthly.
12. Follow these procedures for the Whole Body phantom:

Scan and analyze the phantom three times a week according to the instructions provided by Hologic and Appendix A of this manual.

COPY the whole body phantom scans to the traveling optical disk, then ARCHIVE to the clinic optical before deleting scans from the hard drive.

The QA Center will retrieve the scans from the traveling optical, plot the desired variables, and notify the clinical centers of any problems.

4.2 Whole body air scan for the QDR 4500

4.2.1 DOS-based software

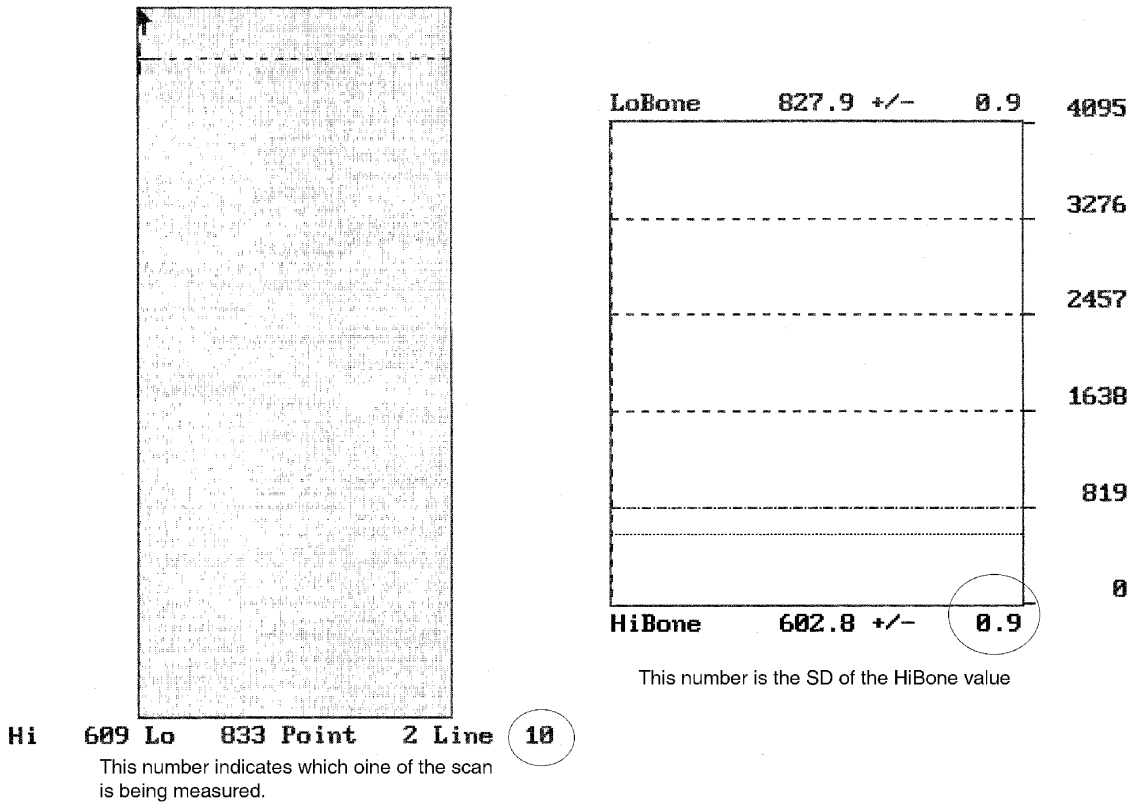
A Whole Body (WB) scan of "air" (i.e., nothing on the table but a clean pad) should be performed once a week.

The "air" scan will assess the proper functionality of the QDR 4500 scanner and indicate any potential problems with the x-ray beam, if present.

1. Clear the entire tabletop of any objects and clean the pad of any debris. Only the table pad should remain on the table. This is critical since the test can detect items as thin as a single piece of Scotch tape.
2. Enter a Patient Biography with **WB AIR QC SCAN** in the Name field. Enter the **system serial number** in the Pat ID field. Leave the remaining fields blank. Press <F10> when completed. Please be certain to use this biography for all future WB air scans.

3. Perform a scan by choosing “whole body” from the Scan menu. Scan the entire length of the table. Do not interrupt the scan; perform a complete scan.
4. With the air scan selected, <ESC> to the Main Menu. Choose the UTILITY option and press <ENTER>. Then choose SERVICE and then PLOT. A blank image will appear. Press the <PgDn> key once to move to line 10.

The image will appear along with a graph. At the bottom of the graph, an indicator of the reference wheel segment that produced the data will appear along with an attenuation value +/- a SD (Standard Deviation). See diagram below.



For example:

HiBone 602.8 +/- 0.9

The last value, 0.9, is the value we want to record. It represents the SD of the air values across a scan line. The value should not exceed 2.0 units. Use the <DOWNARROW> key to view (9) additional lines to obtain a better estimate of the SD. Record all 10 SD values for HiBone for lines 10 through 19 on the worksheet on the next page. Please make photocopies of the worksheet for your use.

| |
|---|
| WHOLE BODY AIR QC SCAN WORKSHEET |
|---|

| | |
|------------------|----------------|
| Clinical Center: | Serial Number: |
|------------------|----------------|

| <i>LINE</i> | <i>SEGMENT</i> | <i>SD</i> |
|--------------------|-----------------------|------------------|
| 10 | HiBone | |
| 11 | HiBone | |
| 12 | HiBone | |
| 13 | HiBone | |
| 14 | HiBone | |
| 15 | HiBone | |
| 16 | HiBone | |
| 17 | HiBone | |
| 18 | HiBone | |
| 19 | HiBone | |

| | |
|-------|------------|
| Date: | Signature: |
|-------|------------|

5. Press the <ALT><PRINTSCREEN> keys to obtain a hard copy of the plotted data. If this does not work on your scanner, do not print the data. COPY the WB AIR QC SCAN to your traveling optical and archive to the clinic opticals. Delete the air scan from your hard disk.
6. **IMPORTANT:** In the event that the SD exceeds the limit of 2.0 units, immediately fax the worksheet to Russell Scott at UCSF (FAX: 415-514-8150).

4.3 Cross-calibration of scanners

In order to assess accurately the absolute variations in scanner performance between clinical centers, a set of study phantoms will be circulated and scanned at each clinical center during the first few months of the study. The set includes a Hologic hip, spine and block phantom. A detailed protocol will accompany the phantoms.

Additionally:

1. Iowa sends whole body phantom to UAB.
2. UAB scans/analyzes once a day for ten days.
3. Copy scans to disk and make printouts.
4. Send disk/printouts to UCSF.
5. UAB sends whole body phantom back to Iowa and Iowa does same for 10 days. Then Iowa follows usual protocol.

4.4 Machine, software, and service problems

If your machine needs to be repaired or if any adjustment has to be made that possibly might affect your data:

1. Do a dbArchive before any work is done on your QDR.
2. If possible, contact the QA Center before the repairs or adjustments are made to find out whether additional measures are required.
3. Perform [*baseline: 5*] [*follow-up: 10*] scans of the Hologic daily QC spine phantom before (if possible) and after the repairs or adjustments are made.
4. Perform [*baseline: 5*] [*follow-up: 10*] scans of the Hologic daily QC hip phantom before (if possible) and after the repairs or adjustments are made.
5. Send the repair technician's notes and a copy of the completed Hologic Repair/Service/Upgrade Log to the QA Center with the data transfer sent every (*baseline*) or every other (*follow-up*) month. The log should contain complete information on all repairs and upgrades done on your machine. Please keep a repair log with your machine.

4.5 Hardware/software change control

Unauthorized hardware/software changes must be avoided. If for any reason you think you have to change the hardware/software, or your Hologic service representative recommends a hardware/software change, contact the QA Center before any changes are made.

Future hardware/software upgrades will be checked by the QA Center in conjunction with Hologic technical support personnel to assure that the upgrade will not adversely affect the study. Authorized upgrades must be cleared by the QA Center before installation at the clinical centers.

Record hardware/software upgrades on the Hologic DXA Repair/Service/Upgrade Log.

5. Data management

5.1 Hard copies of scans

1. The clinical center is responsible for maintaining original hard copies of all scans performed during the study. Keep the original printouts in the participant's scan printout folder. The following printed reports are needed for each scan:

Hip: Print the standard report

Whole body: Print the BMD and body composition reports (2 pages).

5.2 Electronic scan archive

Each clinical center works on a four optical disk system, two clinic opticals and two traveling opticals. Both clinic optical disks and one traveling optical are updated at the end of each day. The other traveling optical may be in transit between the QA Center and clinical center. Please be sure to re-archive any scans that you reanalyze after you have completed the reanalysis. In order to use the optical disks efficiently, do not save or archive scans individually. Saving scans in batches (e.g., at the end of a day) will ensure the longevity and efficient usage of the optical disk space. The QDR software will give a warning message when optical capacity has been reached. Fill side A of the disk first then fill side B. (See the Hologic User's Manual for detailed instructions.) One clinic optical should be a dedicated MOST optical, used only for archiving scans acquired for MOST.

Scans to be archived **each day** to the clinic opticals and traveling optical disks include:

1. All new participant scans acquired since the last archive was performed;
2. All scans that have been reanalyzed since the last archive. Note that if a scan needs to be restored and reanalyzed for any reason, it will need to be re-archived.

Clinic opticals will remain at the clinical center at all times. The traveling opticals will be sent back and forth between the clinical center and the QA Center.

The clinical centers are responsible for following the archive schedule and for keeping the optical disk archives safe until the end of the study.

5.3 Transfer of data to the MOST DXA Quality Assurance Center

Baseline:

The following items are to be sent to QA Center once a month:

1. BATCH RECORD FORM (see Appendix B).
 - a. Assign a number to each batch of BMD data, beginning with the first batch of BMD materials sent. Start with the clinic code initials then a 3-digit sequential batch number, from 001 - 999. For example, the first batch from Birmingham will be numbered B001, the second batch B002 etc. For Iowa the first batch will be numbered I001, the second batch I002 etc.

The following are the clinical center codes that will be used for the MOST study:

Birmingham B

Iowa City I

- b. Complete a Batch Record Form, indicating the number and which materials are included in the batch, and send it along with the batch materials. Keep a copy.
2. QC PRINTOUT. Send a printout of the most recent plots of the QC database (spine - BMD, BMC, and AREA) and (hip – BMD, BMC, and AREA). Include at least a year's worth of data in the plot. The plots are reviewed at the QA Center and problems are reported back to the clinical center.
3. PARTICIPANT SCAN LOG and DXA HOLOGIC BIOGRAPHY INFORMATION forms. Send a copy of the written Participant Scan Log covering participants scanned since the last data transfer. Use the log sheet to “flag” individual scans for review at the QA Center. Include a copy of the DXA Hologic Biography Information form for each participant listed on the Participant Scan Log.
4. SCANS FOR REVIEW. Send **original printouts of flagged whole body and hip scans, certification scans, and any scans requested for review by the QA Center. Please write directly on the printout the reason the scan was flagged, requested, or being sent (e.g., Certification).** These scans will be triaged visually based on the original printouts and analyzed on the Hologic workstation if necessary.

5. REANALYZED SCANS. Send original printouts of all scans that have been reanalyzed according to the QA Center instructions since the last data transfer. Attach the annotated printouts sent by the QA Center that indicated the problems requiring reanalysis. You **MUST** also send back the reanalyzed scan images on the traveling optical.
6. TRAVELING OPTICAL DISK. Send electronic copies of all scans acquired and reanalyzed since the last data transfer. Archive scans using the <COPY> feature. Do not archive the scans individually, as this will use up the disk space rapidly.
7. HOLOGIC DXA REPAIR/SERVICE/UPGRADE LOG with a copy of the Hologic service report, if service has been done. This form only needs to be sent for months where service or upgrades were performed.
8. DB ARCHIVE or System Backup. **An archive of the participant database (dBarchive in DOS-based software and System Backup in Windows- based software) will be sent at the end of the visit. This means one time at the completion of the visit unless otherwise instructed by the QA Center.**

Please include the following on the disk label:
"MOST DB ARCHIVE"

Clinic name

Date of Archive

If more than 1 disk, label each disk as above and 1 of 3, 2 of 3, etc.

Please note: The QA Center will use the most recent scan data for participants whenever there are multiple analyzed scans from the same date in the data base. Please notify us if there are exceptions to this.

Pack the materials carefully. The optical disk should be placed in a plastic bag and then wrapped in plastic bubble wrap to avoid damage. Batches containing the optical disk should be sent via FedEx/UPS.

The materials in the batch should be bundled separately by type.

Ship these items monthly to the following address. Be sure to put a personal name in the first line:

DXA Coordinator
MOST DXA Quality Assurance Center
SF Coordinating Center
185 Berry Street, Lobby 4, Suite 5700
San Francisco, CA 94107-1762
Telephone: (415) 514-8096

Follow-up:

The following items are to be sent to QA Center by the 1st of every other month (February, April, June, August, October):

1. QC PRINTOUT. Send a printout of the most recent plots of the QC database (spine and hip -BMD, BMC and AREA). The plots are reviewed at the QA Center and problems are reported back to the clinic.
2. PARTICIPANT SCAN LOG. Send a copy of the written participant scan log covering participants scanned since the last data transfer. Use the log sheets to “flag” individual scans for review at the QA Center.
3. SCANS FOR REVIEW. Send original printouts of certification scans, “flagged” scans, random sample scans, and any scans requested for review by the QA Center. Please write directly on the printout the reason the scan was flagged, requested or being sent. These scans will be triaged visually based on the original printouts and analyzed on the Hologic workstation if necessary.
4. TRAVELING OPTICAL DISK. Send electronic copies of all scans acquired and reanalyzed since the last data transfer. Archive scans using the <COPY> feature. Do not archive the scans individually, as this will use up the disk space rapidly.
5. REANALYZED SCANS. Send original printouts of all scans that have been reanalyzed according to the QA Center instructions since the last data transfer. Attach the annotated printouts sent by the QA Center that indicated the problems requiring reanalysis. You **MUST** also send back the reanalyzed scan images on the traveling optical.
6. Copy of the Hologic Repair/Service/Upgrade Log (with a copy of the Hologic service report), if service has been done.
7. DBARCHIVE. **An archive of the participant database (dbArchive) will be sent at the end of each visit (i.e., after the last participant has been scanned at Follow-up Visit).**

Please include the following on the disk label:

“MOST Follow-up Visit DB ARCHIVE”

Batch #

Clinic name

Date of Archive

If more than 1 disk, label each disk as above and 1 of 3, 2 of 3, etc.

Diskette Label for DB Archive

| | |
|-----------------------------|------------|
| MOST | DB Archive |
| Date _____ | |
| Clinic _____ | |
| Batch # _____ | |
| Diskette No. _____ of _____ | |

Please note: The QA Center will use the most recent scan data for participants whenever there are multiple analyzed scans from the same date in the data base. Please notify us if there are exceptions to this.

Pack the materials carefully. The optical disk should be placed in a plastic bag and then wrapped in plastic bubble wrap to avoid damage. Batches containing the optical disk should be sent via FedEx/UPS.

Assign a number to each batch of BMD data, beginning with the first batch of BMD materials sent. Start with batch number 001. The batch number should be the clinic identifier followed by this 3-digit number. For follow-up use the next sequential number (e.g., if the last baseline batch number was 057, the following batch number will start with 058).

Complete a BMD Batch Checklist, indicating the number and which materials are included in the batch, and send it along with the batch materials.

The materials in the batch should be bundled separately by type. Ship these items every other month on or about the 1st month (February, April, June, August, October) to the following address:

DXA Coordinator
MOST DXA Quality Assurance Center
SF Coordinating Center
185 Berry Street, Lobby 4, Suite 5700
San Francisco, CA 94107-1762
Telephone: (415) 514-8096

5.4 Return materials sent by the MOST DXA Quality Assurance Center

The QA Center will return the following items to the clinical center after review:

1. Annotated printouts of flagged scans, random sample scans, and any other requested scans are returned to the clinical center with explicit instructions for reanalysis, as necessary. The clinic then reanalyzes the problem scans according to the QA Center's recommendations. The reanalyzed scan is then saved and re-archived and the database at the clinical center is automatically updated. An original printout of the reanalyzed scan is sent to the QA Center with the next data transfer to verify compliance.
2. Traveling optical.
3. Any recommendations for service, additional phantom scans, etc., as necessary based on the quality control data.

Appendix A Hologic Whole Body Phantom Protocol

I. Phantom Assembly

Before lifting or transporting the phantom, break it down into its individual components. Use care, the impact force of a phantom component dropped from table height can cause severe injury, particularly if the impact is delivered through one of the phantom's beveled edges. Having another person help move the phantom components is strongly recommended.

A thin, gray PVC sheet is attached to the large white plastic piece that contains the two plastic locating pins. This HDPE/PVC combination is the bottom layer (base) of the phantom. Position it on the scanner table such that the PVC is on the bottom (i.e., the gray PVC is in contact with the table pad and the two plastic locating pins project out of the plane of the table towards the ceiling).

Place the large white plastic piece on top of the phantom base, using the locating pins as a guide. The piece should be placed such that the beveled edge forms a "V" with the base.

Next, place the medium size white plastic pieces on the phantom, again forming a "V" with the two beveled edges of the middle pieces. Then place the small white plastic pieces on top, forming another "V" with the small pieces. The final assembly will form a pyramid (see Figure 1, side view). This is the only valid configuration for the phantom measurement. All other configurations including adding materials to the phantom, removing pieces of the phantom, scanning the phantom upside down, etc. violate the intended use of the phantom and may produce invalid results.

II. Phantom Positioning

Carefully position the whole body phantom in the center of the scanner table with the head of the phantom at the head of the table. Allow 24" (61cm) of empty air space at the head of the table. Carefully position the phantom parallel with the long axis of the table, using the table pad markings as a guide. When properly centered, there will be a constant 3.5" (8.9 cm) gap between the side of the phantom and the front and back limits of the QDR 4500 scanner table (see Figure 1).

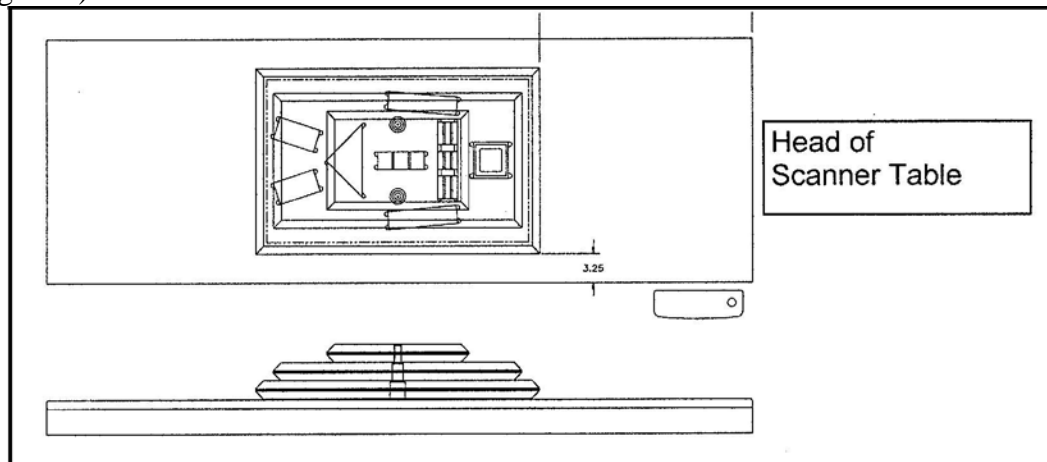


Figure 1. Layout of Whole Body Phantom positioned on the QDR 4500 scanner table. Also shown, the fully assembled phantom viewed from the side. (Note that the amount of empty space between the side of the phantom and the sides of the table will vary depending upon scanner model).

III. Data acquisition - Scanning the whole body phantom

1. Make sure that the phantom is centered, is parallel to the long axis of the table and is correctly oriented with respect to the head of the table.
2. Enter **Whole Body Phantom #XXXX** in the Name field of the Patient Biography (where **XXXX** is the phantom serial number, including any letters, found on the phantom label). Enter **#XXXX** in the Pat ID field of the Patient Biography (where **XXXX** is the phantom serial number, including any letters, found on the phantom label).
3. Remove all artifacts from the table surface. Extraneous objects in the scan field will interfere with the measured results in an unpredictable fashion.
4. Select the standard Adult Whole Body scan mode commonly employed at your facility. Accept the default scan length and scan width. Perform a complete scan of the entire table surface including the phantom. Do not interrupt the scanner during the measurement.
5. Carefully inspect the scan image to ensure that the phantom was (i) centered, (ii) parallel to the long axis of the scanner table and (iii) the phantom's head appears at the top of the image. If the scan image appears satisfactory, proceed to the analysis section. If not, carefully reposition the phantom according to the instructions in Section II and repeat the scan.
6. After receipt of the whole body phantom, scan the phantom four (4) times a day for the first week (20 scans). This will allow the setting of a consistent mean for monitoring performance and comparison purposes. Note that the whole body phantom scans can NOT be added to the QC database. The QA Center will plot and check the data and notify the clinical centers of any problems.
7. After the first 20 scans are performed, scan the phantom three times a week.

IV. Analysis

A. General Comments

The goal of the analysis is to carefully delineate the various body regions in a standard and reproducible fashion, so that measured results will reflect instrument performance, not variations in analysis techniques. Of particular importance are the placement of the head ROI cutline and the cutlines that delineate the ribs, since these two regions affect global body composition and BMD. It is essential that the baseline measurement is technically adequate and that the analysis is performed by direct comparison to the sample analysis on the Hologic diskette labeled: "SAMPLE ANALYSES: WB PHANTOM" or "Whole Body Phantom Analysis Template". Use the sample scan for your model of scanner (see Table 1).

B. Specific Instructions - Hologic QDR systems

Follow the instructions in Sections II and III of Appendix A to acquire a technically adequate scan of the Whole Body phantom. Restore the appropriate scan from the Hologic diskette labeled “SAMPLE ANALYSES: WB PHANTOM” or “Whole Body Phantom Analysis Template” to the analysis workstation (see Table 1 for the correct scan to restore for your QDR model). Select the newly acquired WB Phantom scan. Then use the Compare feature to register the ROI cutlines of the sample scan to the newly acquired scan of the WB Phantom. Once the ROI’s have been matched as nearly as possible, complete the analysis and print the first and last pages of the report.

Archive the baseline measurement for safekeeping but do not delete it from the analysis workstation. All future whole body phantom measurements will be compared to the initial baseline measurement. After the initial measurement, the sample scan restored from the sample diskette should be deleted. Archive Whole Body Phantom scans to both the clinic and traveling opticals, then delete the scans from the hard drive.

Table 1. Scans to restore for a given QDR model number.

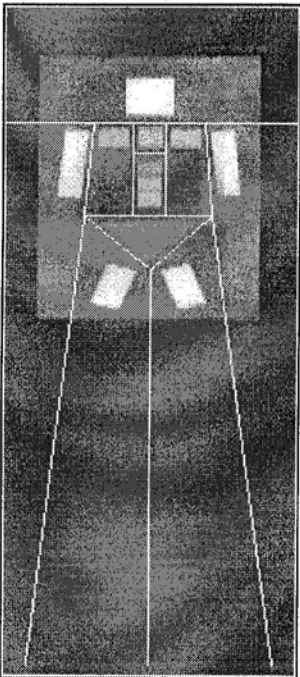
| QDR MODEL NUMBER | WB PHANTOM SCAN (RESTORE FROM SAMPLE DISK) |
|-------------------------------|---|
| 1000W, 1500, 2000 Pencil beam | 1000/1500/2000 Pencil WB Phantom |
| 2000 Fan Beam | 2000 Fan WB Phantom |
| 4500W | 4500W WB Phantom |
| 4500A | 4500A WB Phantom |

V. Interpretation of measured values

The phantom measurements should be printed out, placed in a logbook/file and kept at the clinic center. The QA Center will plot selected variables periodically from the scans sent on the traveling optical and notify the clinic center of any problems.

Please note a correction to the Biography in the following printout. The phantom serial number should be in the ID field: I.D.: #001

HOLOGIC



A0530970J Fri May 30 13:51 1997
 Name: WHOLE BODY PHANTOM #001
 Comment:
 I.D.: Sex: F
 S.S.#: - - Ethnic:
 ZIP Code: Height: ' "
 Operator: Weight:
 BirthDate: / / Age:
 Physician:
 Image not for diagnostic use

TOTAL BMC and BMD CV is < 1.0%
 C.F. 1.023 1.008 1.000

| Region | Area (cm ²) | BMC (grams) | BMD (gms/cm ²) |
|---------|----------------------------|----------------|-------------------------------|
| L Arm | 113.48 | 132.56 | 1.168 |
| R Arm | 112.29 | 134.78 | 1.200 |
| L Ribs | 41.01 | 36.69 | 0.895 |
| R Ribs | 42.21 | 39.91 | 0.946 |
| T Spine | 31.06 | 33.46 | 1.077 |
| L Spine | 71.67 | 77.02 | 1.075 |
| Pelvis | 130.21 | 105.48 | 0.810 |
| L Leg | 89.19 | 119.73 | 1.342 |
| R Leg | 93.17 | 123.91 | 1.330 |
| SubTot | 724.29 | 803.54 | 1.109 |
| Head | 127.02 | 311.82 | 2.455 |
| TOTAL | 851.31 | 1115.36 | 1.310 |

HOLOGIC

oJun 13 11:33 1997 [327 x 150]
 Hologic QDR-4500A (S/N 3006)
 Whole Body U8.20a:3

Appendix B Study Forms

The following forms should be available:

MOST DXA Bone Density form as provided by the MOST Coordinating Center (Do NOT photocopy)

***(Baseline only)* DXA Hologic Biography Form- to go with participant to DXA clinic (Photocopy as needed)**

DXA Participant Scan Log (Photocopy as needed)

DXA Batch Record Form (Print form from MOST website)

Hologic DXA Repair/Service/Upgrade Log (Print form from MOST website)

Whole Body Air QC Scan Worksheet (Photocopy as needed)

***(Follow-up only)* Excessive Bone Loss Form**

***(Follow-up only)* Excessive bone loss alert letter**

Master copies of the forms will be provided with this manual. Photocopy these forms at your clinical center as needed (except the MOST DXA Form or Repeat DXA Form). Always keep a copy of any form you send to the QA Center.

MOST DXA Form

DXA

Bone Density Form



| MOST ID # | Acrostic | Date Form Completed | | | Staff ID# |
|------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| <i>Office Use Only</i> | | Month | Day | Year | |

① Have you ever had a hip surgery for joint replacement or fracture repair?
 Yes No Refused

Yes → Scan right hip

On which side did you have hip surgery?
 Right Left Both

Right → Scan left hip
 Left → Scan right hip
 Both → Do NOT scan either hip

② Do you have any metal objects or implants in your body, such as a pacemaker, staples, screws, plates, breast implants etc.?
 Yes No Don't Know Refused

a. Flag scan for review by DXA Reading Center.
 b. Indicate the location of the artifacts. (Sub regions are those defined by the whole body scan analysis, e.g., left breast implant is in left ribs, left hip replacement is in pelvis and left leg.)

| Sub regions | Hardware | Other Artifacts |
|--------------------|-----------------------|-----------------------|
| i. Head | <input type="radio"/> | <input type="radio"/> |
| ii. Left arm | <input type="radio"/> | <input type="radio"/> |
| iii. Right arm | <input type="radio"/> | <input type="radio"/> |
| iv. Left ribs | <input type="radio"/> | <input type="radio"/> |
| v. Right ribs | <input type="radio"/> | <input type="radio"/> |
| vi. Thoracic spine | <input type="radio"/> | <input type="radio"/> |
| vii. Lumbar spine | <input type="radio"/> | <input type="radio"/> |
| viii. Pelvis | <input type="radio"/> | <input type="radio"/> |
| ix. Left Leg | <input type="radio"/> | <input type="radio"/> |
| x. Right leg | <input type="radio"/> | <input type="radio"/> |

③ Have you had any of the following in the past ten days?

| | Yes | No |
|--|-------------------------|-----------------------|
| a. Barium enema | <input type="radio"/> * | <input type="radio"/> |
| b. Upper GI X-ray series | <input type="radio"/> * | <input type="radio"/> |
| c. Lower GI X-ray series | <input type="radio"/> * | <input type="radio"/> |
| d. Nuclear medicine scan | <input type="radio"/> * | <input type="radio"/> |
| e. Other tests using contrast ('dye') or radioactive materials | <input type="radio"/> * | <input type="radio"/> |

**Examiner note: If 'Yes' to any responses above, reschedule bone density measurement so that at least 10 days will have passed since the tests were performed.*

④ Was a bone density measurement obtained for . . .

a. Whole body? Reason:

Yes No

Last 2 characters of scan ID #:

Date of scan: / /

b. Hip? Reason:

Yes No

Metal in hip
 Severe degenerative disease
 Other (Please specify: _____)

Last 2 characters of scan ID #:

Date of scan: / /

Which hip was scanned? Right Left



Repeat DXA Bone Density Form



Draft

| MOST ID # | Acrostic | Date Form Completed | | | Staff ID# |
|---|---|---|---|---|---|
| <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| <i>Office Use Only</i> | | Month | Day | Year | |

① Was the hip scan repeated?

Yes No

a. Date scan performed: / /
Month Day Year

b. Last 2 characters of Scan ID#:

c. Reason (**Mark only one**):

- Original scan unacceptable (e.g. corrupted)
- Scan lost
- Other (**Please specify:** _____)

d. Which hip was scanned? Right hip Left hip

② Was the whole body scan repeated?

Yes No

a. Date scan performed: / /
Month Day Year

b. Last 2 characters of Scan ID#:

c. Reason (**Mark only one**):

- Original scan unacceptable (e.g. corrupted)
- Scan lost
- Other (**Please specify:** _____)



Draft



DXA Bone Density
Follow-up Visit



| | | | | | |
|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| MOST ID # | Acrostic | Date Form Completed | | | Staff ID# |
| <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| | | Month | Day | Year | |

1. Have you ever had a hip surgery for joint replacement or fracture repair?

Yes No Refused

Scan right hip

On which side did you have hip surgery?

Right Left Both

Scan left hip Scan right hip Do NOT scan either hip

2. Do you have any metal objects or implants in your body, such as a pacemaker, staples, screws, plates, breast implants etc.?

Yes No Don't Know Refused

a. Flag scan for review by DXA Reading Center.

b. Indicate the location of the artifacts. (Sub regions are those defined by the whole body scan analysis, e.g., left breast implant is in left ribs, left hip replacement is in pelvis and left leg.)

| Sub regions | Hardware | Other Artifacts |
|--------------------|-----------------------|-----------------------|
| i. Head | <input type="radio"/> | <input type="radio"/> |
| ii. Left arm | <input type="radio"/> | <input type="radio"/> |
| iii. Right arm | <input type="radio"/> | <input type="radio"/> |
| iv. Left ribs | <input type="radio"/> | <input type="radio"/> |
| v. Right ribs | <input type="radio"/> | <input type="radio"/> |
| vi. Thoracic spine | <input type="radio"/> | <input type="radio"/> |
| vii. Lumbar spine | <input type="radio"/> | <input type="radio"/> |
| viii. Pelvis | <input type="radio"/> | <input type="radio"/> |
| ix. Left leg | <input type="radio"/> | <input type="radio"/> |
| x. Right leg | <input type="radio"/> | <input type="radio"/> |

3. Have you had any of the following in the past ten days?

| | Yes | No |
|--|-------------------------|-----------------------|
| a. Barium enema | <input type="radio"/> * | <input type="radio"/> |
| b. Upper GI X-ray series | <input type="radio"/> * | <input type="radio"/> |
| c. Lower GI X-ray series | <input type="radio"/> * | <input type="radio"/> |
| d. Nuclear medicine scan | <input type="radio"/> * | <input type="radio"/> |
| e. Other tests using contrast ('dye') or radioactive materials | <input type="radio"/> * | <input type="radio"/> |

**Examiner Note: If 'Yes' to any responses above, reschedule bone density measurement so that at least 10 days will have passed since the tests were performed.*

4. Was a bone density measurement obtained for . . .

a. Whole body? Reason:

Yes No

Last 2 characters of scan ID #:

Date of scan: / /

b. Hip? Reason:

Yes No

Metal in hip
 Severe degenerative disease
 Other (Please specify:)

Last 2 characters of scan ID #:

Date of scan: / /

Which hip was scanned? Right Left



MOST DXA HOLOGIC BIOGRAPHY INFORMATION**Instructions**

Study Coordinator: Fill out this form completely with the official study information. Make 2 photocopies. Keep the original and send 2 copies to the DXA lab with the study participant.

DXA operator: Create or modify the Hologic Biography from this form. Do NOT scan the participant if you do not receive this form for every visit. Keep one copy and send one copy with the Participant Scan Log to QA Center.

1. Visit (circle one): Baseline Visit Visit _____
2. Study Coordinator: Include a copy of MOST DXA Form with header filled out. The DXA operator must complete the MOST DXA form and return to the Study Coordinator for scanning to the UCSF Coordinating Center.
3. Acrostic _ _ _ _
4. DXA ID number. M followed by clinic letter (B or I) then 5 digit number with NO separators:

 M _ _ _ _ _
5. Birth date: Month_____Day_____Year_____
6. Sex (circle one): Male Female
7. Weight to nearest pound _____ lb.
(To convert: 2.2 times kg = pounds, and round-up if needed.)
8. Height: _____ feet _____ inches
(To convert: mm divided by 25.4 = inches.)
48 inches = 4 feet
60 inches = 5 feet
72 inches = 6 feet
9. Ethnicity _____

Form completed by: _____
 Print Name **Initials** **Date**

MOST DXA Participant Scan Log

Circle CLINIC: Birmingham Iowa
VISIT: Visit 1 Visit _____

Circle

| Date of Scan | * DXA ID # Ex: MI00010 | Acrostic Ex: JSMI | Scan Type | Hologic Scan File number Ex: A06010201 | Comments/Reason for Flag |
|--------------|---------------------------|----------------------|------------|---|--------------------------|
| | | | Hip | | |
| | | | Whole Body | | |
| | | | Hip | | |
| | | | Whole Body | | |
| | | | Hip | | |
| | | | Whole Body | | |
| | | | Hip | | |
| | | | Whole Body | | |
| | | | Hip | | |
| | | | Whole Body | | |
| | | | Hip | | |
| | | | Whole Body | | |
| | | | Hip | | |
| | | | Whole Body | | |
| | | | | | |

*Use the same DXA ID# that was assigned to the MOST study participant at the baseline visit.

DXA Batch Record Form



DXA Batch Record Form

Batch Number: _____ Date Batch Mailed: ____/____/____
 [B or I-001(Sequentially to 999)] Month Day Year

Circle City: Birmingham, Iowa MOST Staff ID #: _____

Contents

QC Plots - Hip & Spine (BMD, BMC, Area) No Yes → Date Printed: ____/____/____
 Month Day Year

Participant Scan Log & Hologic Biography Forms No Yes

Flagged Hip and Whole Body Printouts No Yes → Number: _____

Reanalyzed Scan Printouts No Yes → Number: _____

Other Scans (Specify: _____) No Yes → Number: _____

Traveling Optical No Yes

Repair/Service/Upgrade Log & Hologic Service Report (if service performed) No Yes

DB (System) Archive Disk No Yes → Date Archived: ____/____/____
 [Send once at end of visit for 1 time total: after all participants have been scanned at visit 1]
 Month Day Year

Certification Scans: No Yes
 Please printout & mark 'Certification'. We need 10 of each scan type (i.e. hip, whole body) from each staff. Can be split between batches.

| MOST Staff ID | Number of Scans | Scan Type |
|---------------|-----------------|-----------|
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |

MOST DXA Forms Version 1.0 6.03.02 pjm (PM65)

DXA Repair/Service Log



Hologic DXA Repair/Service/Upgrade Log

Instructions: Please complete this log thoroughly and attach a copy of the Hologic service report. Send copy with monthly DXA data transfer. Keep one copy with your scanner in your own repair log.

| | |
|---|--|
| Clinic City: _____ | |
| Date problem(s) encountered: _____ / _____ / _____ <small>Month Day Year</small> | QDR System Serial #: _____ |
| Describe problem: _____ _____ | |
| Were there hardware/software changes or upgrades? <input type="checkbox"/> Yes, please describe: _____ <input type="checkbox"/> No | |
| Was the Hologic operational during the problem period? <input type="checkbox"/> Yes <input type="checkbox"/> No | |
| <div style="border: 1px solid black; padding: 5px;"> <p>Did problem affect scans? <input type="checkbox"/> Yes <input type="checkbox"/> No Please describe, including time period: _____ _____</p> </div> | <div style="border: 1px solid black; padding: 5px;"> <p>How long was the Hologic out of service? _____ days</p> </div> |
| Describe the action taken: _____ _____ | |
| Was the problem resolved? <input type="checkbox"/> Yes <input type="checkbox"/> No → Explain: _____ | |
| <p>Date problem resolved: _____ / _____ / _____ Please describe how problem was resolved: _____ _____</p> | |
| Was a recalibration of the Hologic necessary? <input type="checkbox"/> Yes <input type="checkbox"/> No | |
| Were phantom scans performed after the repair or the recalibration? <input type="checkbox"/> Yes <input type="checkbox"/> No | |
| <p>Did you notice a change in the phantom values? <input type="checkbox"/> Yes <input type="checkbox"/> No</p> | |

MOST DXA Forms Version 1.0 6.03.02 pjm (PM65)


Whole Body Air QC Scan Worksheet

| |
|---|
| WHOLE BODY AIR QC SCAN WORKSHEET |
|---|


| | |
|------------------|----------------|
| Clinical Center: | Serial Number: |
|------------------|----------------|

| LINE | SEGMENT | SD |
|-------------|----------------|-----------|
| 10 | HiBone | |
| 11 | HiBone | |
| 12 | HiBone | |
| 13 | HiBone | |
| 14 | HiBone | |
| 15 | HiBone | |
| 16 | HiBone | |
| 17 | HiBone | |
| 18 | HiBone | |
| 19 | HiBone | |

| | |
|-------|------------|
| Date: | Signature: |
|-------|------------|


 Draft

Excessive Bone Loss Form


 MOST

| MOST ID # | Acrostic | Date Form Completed | Staff ID# |
|-----------|----------|--|-----------|
| | | <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center;"> </div> / <div style="border: 1px solid black; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center;"> </div> / <div style="border: 1px solid black; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center;"> </div> </div> <div style="display: flex; justify-content: space-around; font-size: small; margin-top: 2px;"> Month Day Year </div> | |

Suspected Excessive Bone Loss Checklist
(Examiner Note: Please make sure that this form is accompanied by all of the items listed below.)

- Printouts of the baseline and all follow-up scans of the hip
- Printouts of the "rate of change" report(s) you created for the hip
- Copies of baseline and all follow-up scans of the hip on floppy disk

To be filled out by the UCSF DXA QA Center

- Yes, we can confirm excessive bone loss.
The scans are technically correct and the analyses are performed appropriately.
- Yes, we can confirm excessive bone loss.
However, the scans were not analyzed properly. Please reanalyze the scan(s) following our instructions and inform the participant of the correct bone loss %.
- The scans provided indicate possible excessive bone loss.
However, a second scan of the site was not performed in this participant. Excessive bone loss can only be confirmed after you have obtained a second scan of the region where bone loss is suspected. A repeat measurement may or may not confirm excessive bone loss.
- After scan review we cannot confirm bone loss.

Comments _____

Signature of UCSF DXA QA Reviewer: _____

Date of review: / /
 Month Day Year

Version 1.0, 12/1/06



Excessive bone loss alert letter

December 30, 2006

Jane Doe
1234 Market Street
Birmingham, AL 35201

Dear Ms. Doe:

During your last clinic visit for the MOST study, we repeated measurements of your hip bone density. Analysis of the results indicated that you have lost bone in the hip at a rate greater than 2% per year since your baseline measurement was made.

This loss is greater than average for a person your age and may indicate an increased risk of fracture. This bone loss may also be related to other health conditions, or could result from use of certain medications.

We have enclosed both copies of your hip scan, your baseline measurement and your last measurement. We suggest that you consult with your personal doctor to find out why this is occurring, and we would be happy to forward these results to your doctor.

If you do not have a source of medical care, we can provide you with the name of a doctor who specializes in treating osteoporosis in Birmingham.

Thank you for your time and interest in the MOST study. Please do not hesitate to call us if you have questions at (_____) _____ and ask for _____.

Sincerely,

Cora Beth Lewis, M.D.
MOST Principal Investigator