

COMPUTED TOMOGRAPHY – YEAR 16

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1. CT Scans

1.1 Background and rationale

Significance of body composition CT scan: The purpose of the CT scan is to provide a means of quantifying the muscle and fat volumes in participants in the Health ABC protocol. Issues related to this are addressed in this manual. The CT body composition image will be used to calculate:

- Subcutaneous fat volume and density at L4-L5
- Visceral fat volume and density at L4-L5
- Abdominal muscle volume and density at L4-L5
- Thigh muscle volume and density at mid-femur.
- Subcutaneous fat volume and density at mid-femur
- Intramuscular fat volume and density at mid-femur

1.2 CT body composition scan collection

Axial CT scans at the L4-L5 and mid-thigh level will be obtained on each participant during their examination using the Health ABC protocol. Once obtained, the CT scans should be put on a CD and sent to the Health ABC Coordinating Center every Friday, via express mail. It is important that the site keep a backup of any images obtained in the event that the transfer media becomes damaged during shipment.

2. CT scanner equipment specifications

2.1 Equipment information

All images should be acquired using identical software for continuity and ease of analysis during the reading process.

All CT images will be acquired on the following scanner in Pittsburgh:

- GE Imatron c150

CT image transfer to the San Francisco Coordinating Center will be via

- CD

And labeled using a

- Sharpie black pen

3. CT body composition scan acquisition

The CT body composition scans consist of a lateral abdominal scout, 3 axial images at L4-L5, an AP thigh scout, and 3 axial images at mid-thigh.

3.1 Safety

A CT exam involves the use of ionizing radiation. A statement of radiation dose is included on the consent form signed by the study participant prior to involvement in the Health ABC study. Although it is the responsibility of the Health ABC study coordinator to have the participant sign the consent form, the CT technologist should check to be sure that this has happened. A summary of approximate radiation doses for the body composition protocol follows. Note that exact doses are scanner and protocol dependent.

	Absorbed Dose (mGy)	Effective Whole Body Dose (microSv)
AP thigh scout:	0.15	15
Each mid-thigh from axial slice:	7.5	30
Extended abdominal/spine scout:	0.15	100
Abdomen, L4-L5 axial slice:	10	100

3.2 Exclusions

In the Health ABC cohort, the only exclusion criterion is the inability of the participant to lie supine.

If a participant's size is such that not all of the skin and subcutaneous fat can be captured in the CT image, the site is requested to perform the imaging anyway, using the largest display field of view available. Although a subcutaneous fat calculation cannot be made for such a participant, all other parameters will be measured.

3.3 Pre-examination procedures

All participants who arrive for CT scans should have already provided consent for this procedure. The technician responsible for performing the CT scan must confirm that the participant: (1) has already signed a consent form; (2) is not excluded based on the criterion described above; and (3) has a Health ABC participant ID number and Year 16 CT Tracking form.

The participant should change into a hospital gown for the CT examination.

All CT studies should be identified on header fields and forms, as appropriate:

- Participant's Health ABC participant ID# as their ID#
- Participant's Health ABC acrostic as their name
- Date of CT
- Exam Number
- Performing technologist's Health ABC staff ID#

NOTE that the participant ID# has the format "HBnnnn," where "nnnn" is a four digit number. The acrostic consists of the first letter of the participant's first name and the first three letters of the participant's last name. The staff ID# has the format "Bnn" where the "nn" is a two digit number. In the preceding, the "B" refers to the site's Health ABC ID#. Sites will be notified of any irregularity in header information via an e-mail stating the information received and requesting corrected information (Attachment C). Please note that CTs are only being obtained in Pittsburgh – "HBnnnn."

Participant positioning for performing body composition CT

Prepare the CT table and position the participant according to directions in Attachment G, entitled "Quick Reference for Health ABC CT Scans." Obtain all body composition axial images (first the mid-thigh, then L4-L5 axial scans).

Order of Exams

1. Position the spine phantom on the CT table so that the spine phantom will be in the FOV for the thigh CT scans. A position for the phantom under the legs is best.
2. Position the participant on the phantom, but do not raise the participant's legs with a cushion.
3. Obtain the thigh scout(s) and axial images.
4. Position the cushion under the participant's legs.
5. Re-position the spine phantom so that it can be seen in the FOV for the abdominal images.
6. Obtain the extended abdominal/spine scout(s)
7. Localize and obtain the abdominal, body composition images at the L4-L5 disc space.

3.4 Thigh at mid-femur image

Remember to position the spine phantom so that it is in the FOV under the participant's legs.

CT scanning parameters for mid-thigh body composition scan

An AP scout including the entire femur should be obtained. The femoral length is to be measured using the right leg as done previously, unless otherwise indicated on the Data from Prior Visits Report from the Health ABC clinic, in cranial-caudal dimension, and the mid point determined as illustrated in Figure 3. The scan plane chosen must be recorded electronically on the scout images shipped to the Health ABC Coordinating Center. The acquisition at mid-thigh will include three (3) 10 mm slices centered on the midthigh: a 10 mm thick slice 15 mm above the midpoint, a 10 mm slice at the midpoint, and a 10 mm slice

15 mm below the midpoint. The entire circumference of both thighs are included in the field of view.

Problems:

Participant's femur does not fit within the field of view of the scout. For some participants, a single scout image will not display an image of the entire femur.

1. On some scanners, two slightly overlapping scouts can be obtained and the center of the femur determined from combining the information on the two scouts.
2. In some instances the scout field is shortened because the table extension limit is reached. In that instance one can shift the participant on the table between the abdominal and the thigh imaging. It is not critical that the table positions for the thigh and the abdominal images be correlated.
3. However, if neither of these techniques are possible, perform the thigh scout such that the top of the femur (medial edge of the greater trochanter as defined in Figure 3, Point 1) is visible as close to the top of the scout as possible. Locate the center of the line between this Point 1 and the bottom of the scout following the central axis of the femur. When we receive the image on site, we will record the distance between Point 1 and the scan plane so that this distance can be used in any subsequent imaging studies on this participant.

How to position the scan at mid-thigh (Refer to diagram on p. 12):

1. **Draw a line between the medial surface of the greater trochanter and the center of the intercondylar notch (Point 1 and Point 2).**
2. **Find the midpoint of this line.**
3. **Set the scanner to obtain 3 slices (10mm thick), with the first 15 mm above the measured midpoint of the femur, the second at the midpoint, and the last 15 mm below the measured midpoint of the femur.**

Scout

- Level: To include proximal through distal femur.
May require two scout images.
- Plane: AP
- mA: 40-100
- kVp: 120 -140
- speed: Normal

Axial images

- Level: Mid femur (see Figure 3)
- mAs: 200-250
- kVp: 120
- Slice: 10 mm
- Scan FOV: Largest.
- Display FOV: Variable - Image must contain all skin and subcutaneous tissue of both thighs. If in doubt, use largest available FOV.

3.5 Abdominal imaging

REMEMBER TO RE-POSITION THE SPINE PHANTOM SO THAT IT IS IN THE FOV FOR THE ABDOMINAL SCANS AND DOES NOT NEED TO BE FURTHER MOVED.

CT scanning parameters for body composition abdominal scans

A lateral scout (parameters below), covering T4 through the upper sacrum should be obtained. Note that this is an extended scout compared to the normal scout that you might perform. The L4-L5 disc space should be located on this scout by counting the (non rib-bearing) lumbar vertebrae. In general, the disc space closest to the iliac crest is L4-L5. In the unusual event that there are six non rib-bearing lumbar vertebrae, the interspace closest to the iliac crest should be considered to be L4-L5. See Figure 2.

A series of abdominal images comprising the abdominal volume at L4-L5 during suspended respiration, (parameters below) should be obtained. For suspended respiration, the participant should breathe in, let the air out until it stops naturally, and stop breathing. The participant should not forcefully exhale. Participants should relax their abdomen and make no attempt to “pull it in.” Care must be taken to include the skin and all subcutaneous tissues on this image as illustrated in Figure 1.

How to position the abdominal scan correctly (Refer to Figure 2):

1. Draw a line along the inferior face of L4.
2. Draw a line along the anterior face of L5. This line should meet the first line.
3. The angle created by the line on the inferior face of L4 and the superior face of L5 is called the *angle of lordosis*.
4. The scan position should bisect this angle midway between L4 and L5.

Scout:

- Level: Approximately T4 through upper sacrum. You **must** include upper sacrum even if you have to exclude T4. This may require two scout acquisitions.
- Plane: LAT
- mA: 100
- kVp: 140
- Speed: Slow speed to provide the lowest noise scout.

Axial abdominal images for body composition:

- Level: L4 - L5 disc space.
- mAs: 300 - 360
- kVp: 140
- Slice: 10 mm (display on the image)
- Scan FOV: Largest available.
- Display FOV: Variable - Image must contain all skin and subcutaneous tissue. If in doubt, use largest available FOV.
- Algorithm: Standard

3.6 Image storage

All images should be double archived: once on a CD to be sent to the Health ABC Coordinating Center and once on media to be stored at the imaging site at full resolution.

3.7 Post scanning quality check for body composition images

Prior to completing the examination, all images should be checked for the following:

- Scout films cover the desired areas and a set has been created with scan planes marked at the endpoints and midpoint of the acquired volume of scans.
- Axial images were obtained at L4-L5 and at mid thigh, with any possible deviation from protocols explicitly noted.
- All skin and subcutaneous fat are visible on the axial images.
- There is no perceptible participant motion artifact in the image.
- If applicable, recorded that no thigh scans were done due to bilateral prostheses.

Axial abdominal images showing movement artifacts from breathing. Although the goal is still to obtain these images during suspended respiration, if the images show artifact from breathing, the participant should NOT be re-imaged. The primary data loss in this instance will be the area of the anterior rectus muscles and it is felt that this information is not beneficial enough to warrant the additional dose from re-imaging.

4. CT scan image shipment

4.1 Image shipment

Images to be shipped include all scouts (with and without scan planes marked) and scans. Scans from the Pittsburgh site will be transferred via CD. Each individual participant's set of images should be transferred to a CD, labeled by writing with a Sharpie pen directly on the CD. **Do not use paper labels.** Include the following information in the CD:

Health ABC – in title
Health ABC Participant ID#
Acrostic
Date of image
CT exam #

Note: There should only be one participant's set of images per CD.

All CD's should be sent via 2-day express mail every Friday to:

Felix Liu
Health ABC Coordinating Center
University of California, San Francisco
185 Berry St., Lobby 5, Suite 5700
San Francisco, CA 94107-1762

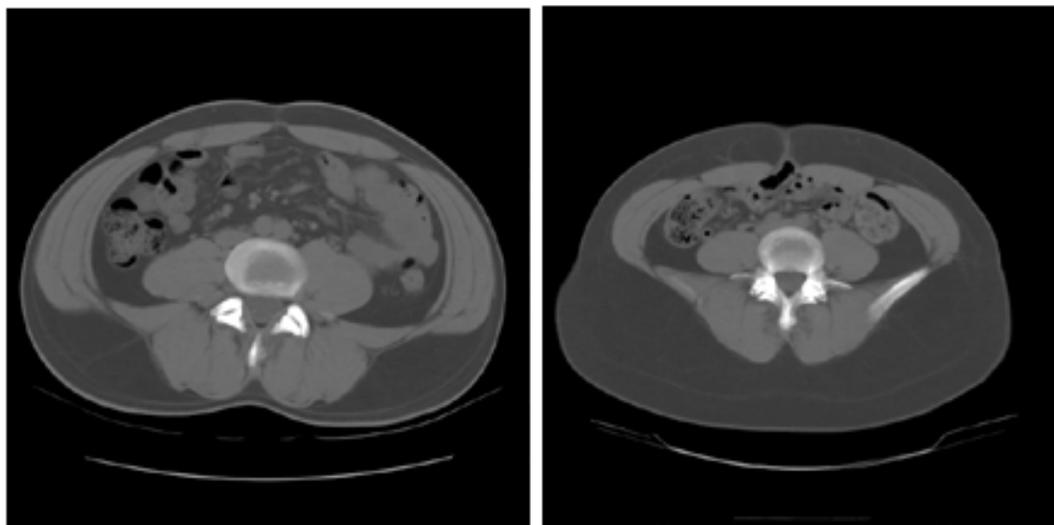
The site CT coordinator will be notified if a weekly mailing has not been received.

Weekly submissions should include images of all of the following for each participant undergoing scans each the week:

1. Abdominal scans
2. Mid-thigh scans
3. All scouts in DICOM format
4. Screen captures of scan localizer screens.

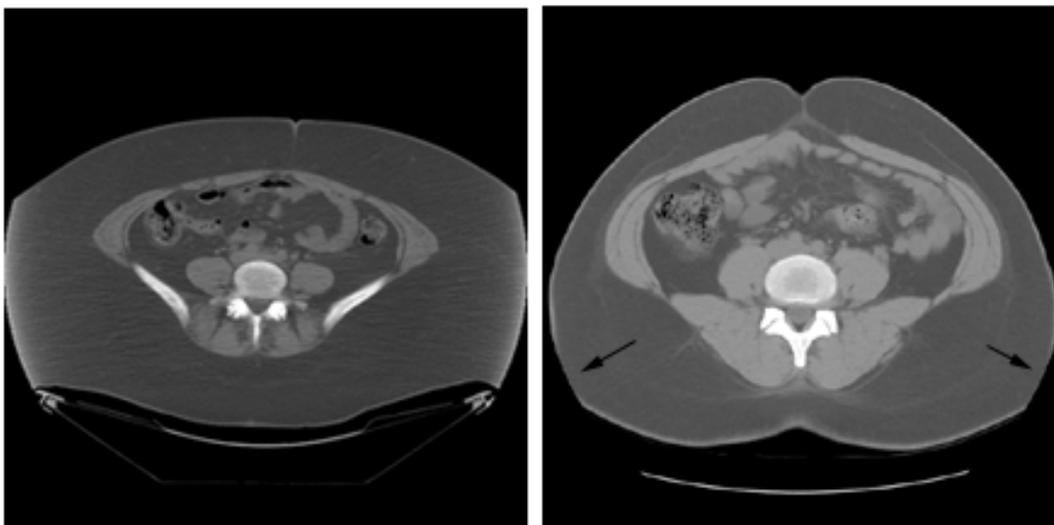
4.2 Shipment notification

Once a package is sent to the Coordinating Center, send an e-mail to Felix Liu (fliu@psg.ucsf.edu) notifying him of the expected arrival date and the express mail tracking number. Remember there should only be one participant's images per CD.



Average patient, DFOY of 40 has been chosen. Image fills the FOY, but no fat has been cut off.

Larger patient, maximum DFOY has been chosen. Image fills the FOY, but no fat has been cut off.



Very large patient. Maximum DFOY has been chosen but not all subcutaneous fat is visible. Acquire all images anyway and transmit to center.

Large patient. DFOY chosen is too small. Re-reconstruct image with larger DFOY.

Figure 1 - Selection of Display Field of View (DFOY).

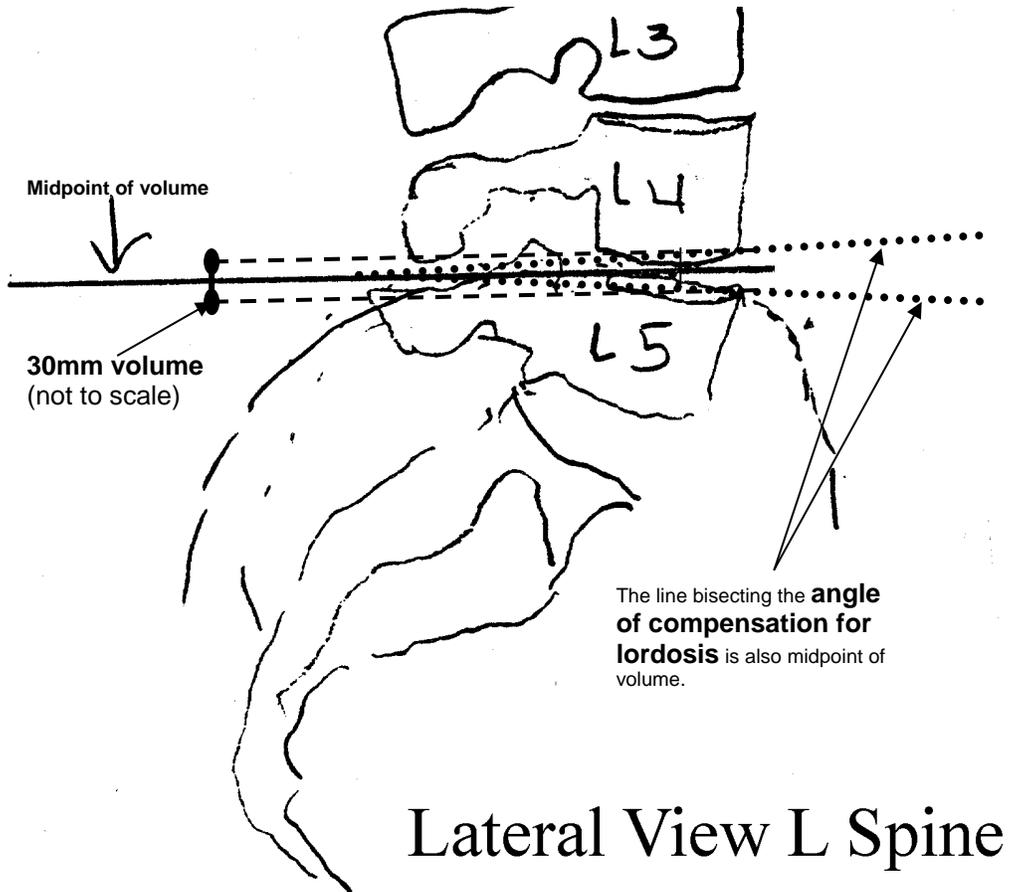
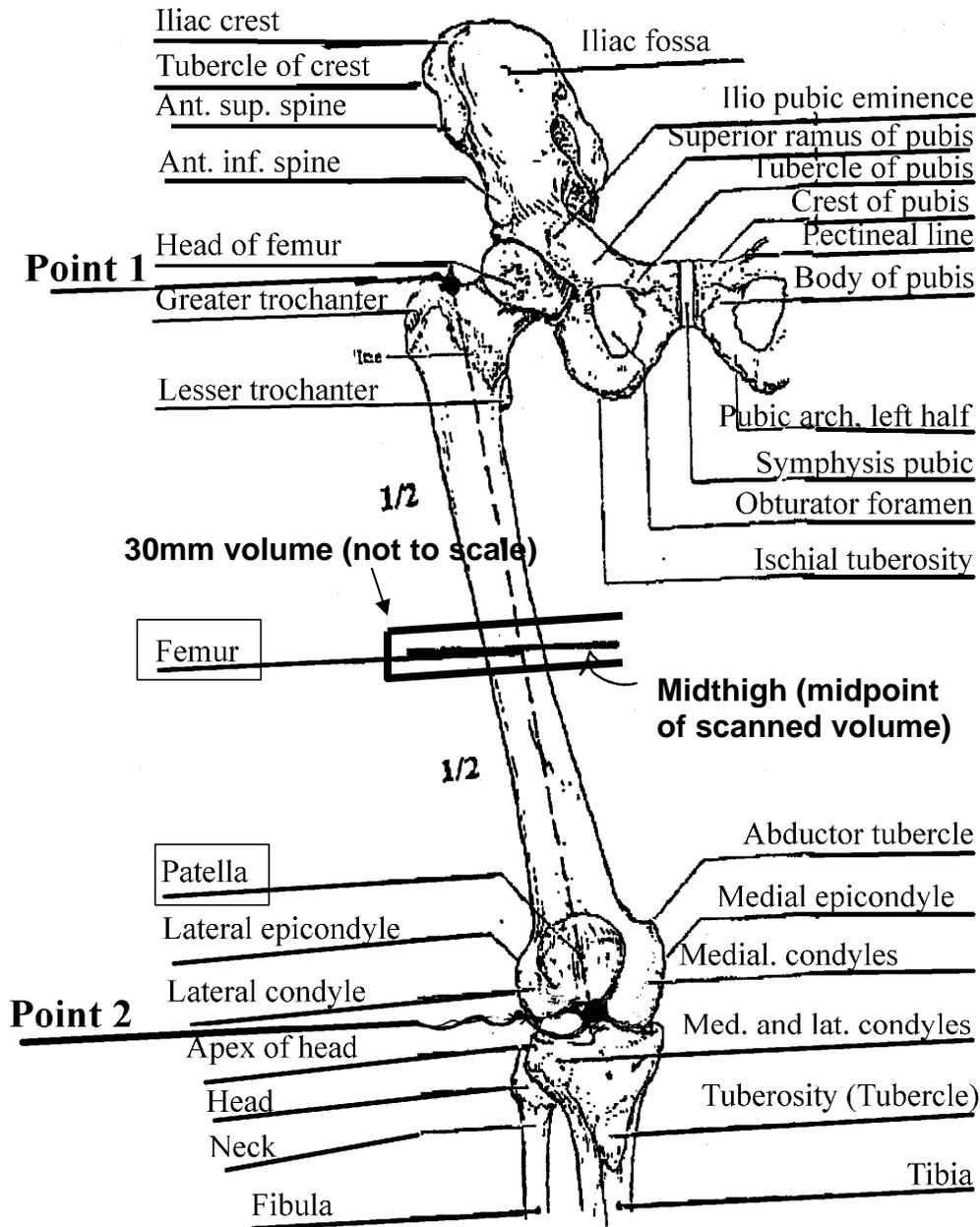


Figure 2 - Location of Abdominal Scan Plane



Location of the mid-thigh scan: Measure the distance between the medial edge of the greater trochanter (Point 1) and the intercondyloid fossa (Point 2). Choose the plane lying midway between these points (Scan Plane).

Figure 3 - Location Mid-Thigh Scan Plane

Attachment A: CT Facility for the Health ABC Study Checklist

SITE: _____ Date: _____

I. Imaging Protocol Issues

- _____ Review exclusion criteria.
- _____ Discuss participant preparation and positioning.
Review guidelines in the manual.
- _____ Discuss labeling of CD with appropriate information.

Health ABC Study
Health ABC Participant ID#
Acrostic
Date of image
CT exam #
- _____ Discuss what images are required and imaging parameters.
- _____ Discuss how to identify imaging levels.
- _____ Discuss how to choose appropriate fields of view.
Review procedure if participant is too large.
- _____ Discuss training of additional CT technologists.

II. Image Transfer and Storage Protocols

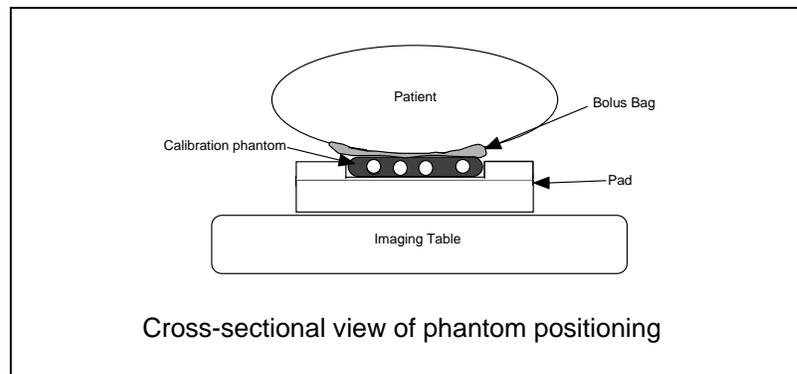
- _____ Confirm protocol for retaining local backup of images.
Site procedure:
- _____ Confirm schedule for mailing of CDs to Health ABC Coordinating
Center.

Schedule:
Contact person:

Attachment B: Quick Reference for Health ABC CT Scans

Introduction: An outline of the general procedure for performing body composition CT scans follows:

- Place spine CT phantom in proper position on the CT table for the thigh and thigh content scans (this page).
- Position the participant (this page).
- Perform the thigh scout and thigh axial image (main manual).
- Move and re-position the phantom so it will be in the FOV for both the abdomen and spine.
- Acquire the extended scout and L4-L5 body composition image (main manual).

Phantom and participant positioning:

The participant will be scanned supine, feet first in the scanner. Before placing the participant on the table, place the blue foam pad on the participant table and put the phantom inside the recessed area in the pad. The end of the phantom, marked “top”, should point toward the head of the participant. Align the centerline of the phantom with the laser light on the scanner. The long axis of the phantom should be centered on the table’s longitudinal line. Smooth out the gel in the blue gel bags evenly. Cover the phantom with the gel bags. These bags must remain centered on the phantom to prevent air gaps between the participant and the phantom. Be very careful in positioning the participant on the phantom to assure the gel bags do not move. Place an additional pad or rolled sheet just below the blue pad so that the participant will have something to sit on prior to lying down on the blue pad and phantom. This avoids having the participant place all of their weight on the lower end of the blue pad which can cause the misalignment of the phantom.

You may now place the participant on the table. The bottom of the phantom should be at the level of the anterior superior iliac spine (ASIS). This will assure that the phantom will cover L1 to L4.

At this point proceed to the main manual to obtain the thigh and abdominal body composition CT images. Elevate the legs on a large cushion to reduce the lordotic curve in the back. This also ensures no air gap between the phantom and the participant. Position the participant’s arms over the head. You may support the arms with cushions if necessary.



HABC Enrollment ID #	Acrostic	Visit Year
H [] [] [] [] [] [] [] []	[] [] [] [] [] [] [] []	● 16

YEAR 16 CT TRACKING

4. Which scans were obtained?
(Note: Mark only one in each category.)

a. Thigh scout(s)	<input type="radio"/> one scout	<input type="radio"/> two scouts		<input type="radio"/> not obtained
b. Thigh scans	<input type="radio"/> one scan	<input type="radio"/> two scans	<input type="radio"/> three scans (protocol)	<input type="radio"/> not obtained
c. Extended abdominal/spine scout(s)	<input type="radio"/> one scout	<input type="radio"/> two scouts		<input type="radio"/> not obtained
d. Abdominal scans (at L4-L5)	<input type="radio"/> one scan	<input type="radio"/> two scans	<input type="radio"/> three scans (protocol)	<input type="radio"/> not obtained

5. Were any of the CT scans NOT obtained?

Yes

No

STOP

a. Why weren't the Year 16 CT scans done?
(Note: Mark all that apply.)

- Participant did not show up for appointment
- Participant refused
- Participant cannot lie supine
- Participant concerned about radiation exposure
- CT stopped at participant's request
- Equipment failure
- Other (Please specify: _____)