

QUADRICEPS POWER & HIP STRENGTH

TABLE OF CONTENTS

1.	Background and rationale.....	2
2.	Equipment and supplies	2
2.1	Service and maintenance.....	3
3.	Safety issues and exclusions	5
4.	Preparing the room and test system for Isotonic Quadriceps Power testing.....	5
5.	Detailed measurement procedures	10
5.1	Record keeping.....	10
5.2	Administration of the Isotonic Quadriceps Power test.....	11
5.2.1	Check for contraindications	11
5.2.2	Positioning of the participant & the NORM Extremity System	11
5.2.3	Entering participant information	13
5.2.4	Selecting the test & protocol	15
5.2.5	The patient setup screen	17
5.2.6	The set anatomical zero screen	19
5.2.7	The set ROM limits screen	19
5.2.8	Weighing the limb (MaxGET; gravity correction)	20
5.2.9	Identification of Isotonic 1-Repetition Maximum (1RM) Quadriceps Muscle Strength	20
5.2.10	Isotonic Quadriceps Power test at 40% 1RM.....	24
5.2.11	Results print out and report archiving	27
5.3	Administration of Hip Strength testing	30
5.3.1	Changing from Isotonic to Isometric test software	30
5.3.2	Positioning the participant	32
5.3.3	Selecting the test in the HUMAC software	37
5.3.4	Explanation, demonstration and practice trials.....	41
5.3.5	Results print out and report archiving	45
6.	Alert values	49
7.	Quality assurance.....	49
7.1	Training and certification	49
7.2	Certification requirements	49
7.3	Quality assurance checklist.....	50
8.	Data collection form.....	51
Appendix 1	HUMAC NORM Calibration Procedure.....	52
Appendix 2	Hip Strength Calibration Procedure.....	56
Appendix 3	Transferring Data to the SF Coordinating Center	58
Appendix 4	CSMi Service Request Procedure.....	60
Appendix 5	Modifying Data in HUMAC Database for Quad Power/Hip Strength Exam	61

1. Background and rationale

In MOST we will assess concentric isotonic power of the knee extensor (quadriceps) and isometric strength of the hip abductor muscles. Muscular power is defined as the amount of muscular work per unit time. It represents the product of force and velocity (power = force x velocity). Velocity of muscle contraction declines with aging, leading to a more precipitous drop in muscular power than in strength. The higher rate of loss of power may have important functional implications, considering the importance for standing up, walking and ascending stairs. Muscle power correlates better with functional limitations in older adults than strength. Hip abductor muscle weakness alters loading of the knee joint. A better understanding of this could inform new rehabilitative approaches.

A HUMAC NORM Extremity System will be used to evaluate the concentric isotonic power of the knee extensors. Hip abduction strength will be measured in both legs using a external load cell attached to the NORM Extremity System.

The examiners responsible for strength and power testing will be trained by an experienced investigator. Computer Sports Medicine, Inc. (CSMi) performed onsite training of examiners at the time of HUMAC NORM installation. Examiner certification will require demonstration of 100% agreement with the requirements of the protocol with emphasis on the technicians understanding of safety/exclusion criteria and their efficiency and accuracy in performing the standardized test procedures. Examiners will be recertified midway through the examination cycle.

2. Equipment and supplies

Quadriceps Power

- HUMAC NORM Extremity System with Knee/Ankle Adapter and HUMAC 2015 software. The NORM Extremity System will be calibrated monthly using the manufacturer's instructions (see Section 2.1; Appendix 1 for step-by-step procedures).
- Calibration weights that come with the HUMAC NORM System
- 2-level step stool with handrail

Hip Strength

- Transducer Techniques MLP-150 load cell and foam covered curved leg attachment (Hoggan Scientific)
- CSMi HUMAC Eagle Strain Gauge Interface with cables
- Vinyl covered bolster and leg support (custom made)
- Custom made attachments for NORM Extremity System that allow translation of load cell and bolster in x, y, z directions
- HUMAC NORM Extremity System with HUMAC 2015 software including MOST modification for strain gauge calibration in the HUMAC 2015 Diagnostics panel
- 2-level step stool with handrail
- String with ball attached for seat back angle adjustment

- Tape measure for measuring thigh length

2.1 Service and maintenance

Quadriceps Power

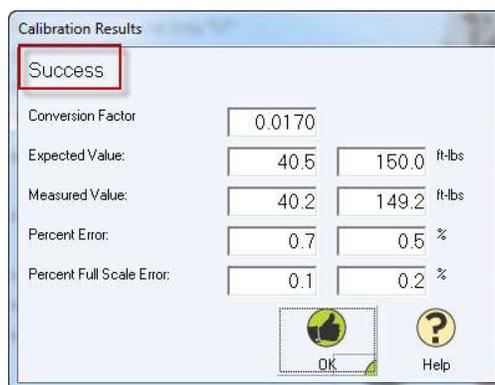
The HUMAC NORM comes with a 12-month warranty and an extended maintenance contract purchased to cover the duration of the baseline exam. The HUMAC NORM is typically a no maintenance machine.

Any computer problems are covered by Dell's next day service. Repair of the dynamometer is covered under the CSMi one-year warranty and extended service contract (48 hours after call is received by CSMi).

Calibration of the HUMAC NORM Isotonic Quadriceps Test software

Monthly calibration of the HUMAC NORM software is performed using the labeled weights provided with the system. Step-by-step instructions for calibration appear in Appendix 1. Calibrated weight values are already recorded in the software and should not be changed.

After each calibration, the HUMAC will run a verification procedure and display results. If the verification is correct, the HUMAC will display "Success" on the verification page. The calibration results are automatically stored in the HUMAC database whenever a calibration is performed, and the results are transmitted to the San Francisco Coordinating Center (SFCC) whenever a HUMAC backup file is uploaded to the SFCC. There is no need to send any additional calibration results to the SFCC.



High or low values may indicate bouncing of weights while arm is moving during calibration. If out of range (HUMAC will display "Failed"), repeat the calibration once, making sure weights move smoothly, and repeat verification. If the calibration and verification ranges are still not correct, contact CSMi using the CSMi Service Request Procedure detailed in Appendix 4.

If the CSMi Service Request System is not available, CSMi's contact information is below.

Computer Sports Medicine, Inc.

101 Tosca Drive

Stoughton, MA 02072-1505

Phone: 781-297-2034

Fax: 781-297-2039

Hip Strength

A load cell calibration factor will be entered on each NORM System when the HUMAC 2015 software is installed. Recalibration should not be needed. However, if the technician finds that the HUMAC software force readout displays *any value other than 1 kg at rest* (when no load is against the load cell), the calibration factor may need to be reset or revised. In this situation, the technician should contact Dr. Glenn Williams or CSMi using the contact information below/above. A calibration post has been provided for each site in case this situation occurs. Dr. Williams and CSMi will assist the technicians with setting the calibration factor in this event.

The hip abductor strength apparatus was custom manufactured at the University of Iowa. If breakage or malfunction occurs, contact: *removed for public release*

Obtaining and entering a new HUMAC activation code

When the software prompts the user to obtain a new software activation code, go to <http://www.csmisolutions.com>, click the Software Activation button, and fill out the web form to obtain a new activation code via email. Without a valid activation code, the HUMAC software will not have full functionality until a new activation code is entered.

After receiving a new numeric activation code in an email from CSMi:

- Start the HUMAC2015 software as an administrator by right-clicking on icon and selecting "run as administrator." If the option is grayed out or not available, then you may not have the required level of access on the computer. In that case, you will need to find a user who does have administrator level access on that HUMAC computer to log into Windows and do steps 1-3, or ask your IT department for assistance.
- Once the HUMAC software is open, go to File > Register and enter the new activation code in the empty field. Click OK to exit.
- Go to File > Preferences and review the settings to ensure they match the settings in Quadriceps Power & Hip Strength Operations Manual.

Do not upgrade the HUMAC software version without contacting the SFCC first. Upgrading the HUMAC software is different from entering a new activation code in the HUMAC software.

- For instance, if the site's local IT works on the HUMAC computer for any reason (e.g. hard drive upgrade, hard drive repair) please remind IT not to automatically try to upgrade the HUMAC software to a new version.

3. Safety issues and exclusions

The isotonic knee power and isometric hip abduction strength tests are generally safe and well tolerated. But, injury may occur in participants with pathology or if instructions for operating the machine and setting up the subject/system are not followed correctly.

Participants should not be tested if they have any of the following conditions (see data collection form for specific questions corresponding to each exclusion):

Participant Exclusions for Quadriceps Power and Hip Abductor Strength Measurements:

- Systolic or diastolic blood pressure >199/109 mm Hg respectively (from participant results report)
- History of cerebral aneurysm
- Cerebral bleeding within the past six months
- Back surgery within the previous 3-month period
- Myocardial infarction in previous 6-week period
- Cataract surgery within the previous 6-week period
- Untreated inguinal hernia
- Participant develops chest pain or dizziness while at the clinic or during test
- (Quadriceps Only) Thigh strap cannot be tightened because thigh is too large
- (Hip Only) Hip joint replacement surgery within the prior 3-month period

Side-specific exclusions – tests can be performed on unaffected side:

- (Quadriceps Only) Joint replacement surgery (hip/knee) within the prior 3-month period
- Extreme knee or hip pain that may adversely impact the subject or study results
- Extreme pain in other lower extremity joints that would be aggravated by testing
- Amputation, prosthetic device, cast or brace

Quadriceps Power and Hip Abductor Strength stopping rules:

- If the participant develops chest pain or dizziness during the test, discontinue the test
- If participant says he/she cannot continue with test due to knee or back pain, test the other side if possible

4. Preparing the room and test system for Isotonic Quadriceps Power testing

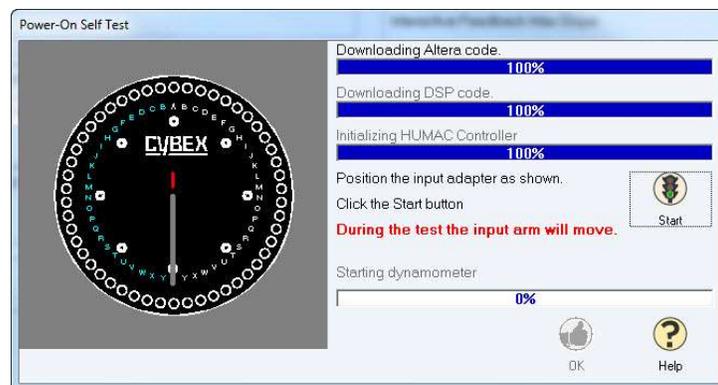
Isotonic Quadriceps Power

Ideally, the 20-meter walk and chair stand tests will be performed just before the strength and power tests to provide a warm-up. Sub-maximal repetitions will be performed during the test so it is not a problem if a warm-up is not provided.

Prior to the participant entering the room:

- Verify that the NORM seat back angle is set to 85° (this is how the machine should be left at the end of each session, so that it is ready for the next participant)
- Crank the seat back fore-aft adjustment to fit a typical subject (e.g., primarily important after testing a small statured person)

- Remove the Hip Abduction Test attachments from the chair
- Verify that the seat base is flat
- Verify that NORM dynamometer is set to an appropriate height (typically 2-4)
- If the chair is not rotated so the patient can easily get into the chair, position it correctly
- Verify that all adjustment levers are in the locked position
- Shake the chair to ensure it is locked so it doesn't "settle" loudly as the subject climbs on
- Position the step in front of the chair so the subject can easily climb onto the chair
- If this is the first test of the day, the HUMAC 2015 software will need to be loaded. This is done as follows:
 - If the HUMAC was shut down at the end of the previous day, it will need to be turned on using the switch on the left side of the NORM system.
 - When the NORM computer has started and the user has logged into the computer, s/he should double click on the HUMAC 2015 icon on the desktop to load the software.

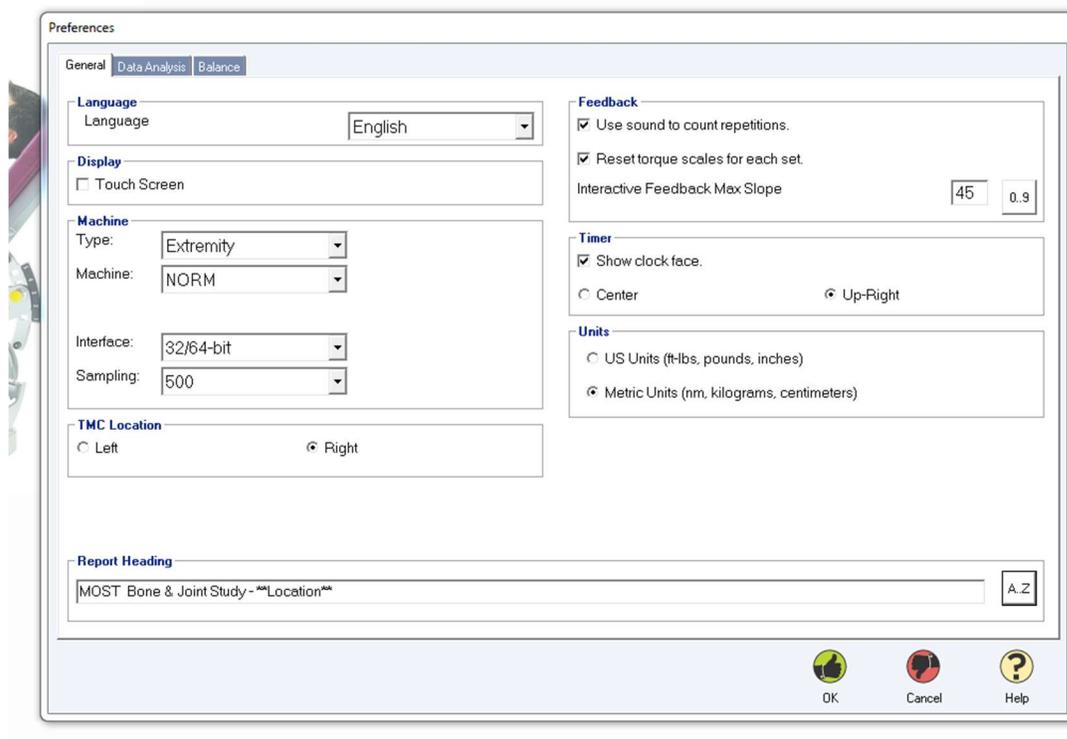


- The screen above will appear if you shut down with the NORM set to on (recommended). If you shut down with the Cable Column set to on, skip down to the next solid bullet: "Set the HUMAC 2015 software for the Isotonic Quadriceps Power test"
- This shows the HUMAC initializing and starts the dynamometer so you can record torque.
- Position the input adapter at Z (perpendicular to the floor in the 6 O'clock position) and press Start (Green traffic light at the center of the right side of the screen)
- The dynamometer will turn-on (the "humming" noise of the servo motor begin)
- Press OK (Green Thumbs Up) at the bottom of the page.

- The screen below will appear.



- Set the HUMAC 2015 software for the Isotonic Quadriceps Power test as follows:
 - Select File> Preferences> General Tab (see screenshot below)
 - Set Type = Extremity
 - Set Machine = NORM
 - Set Interface = USB2 32/64-bit
 - Set Sampling = 500
 - Verify that Units = Metric



The remaining Preferences and settings for the MOST protocols are set at the time of HUMAC 2015 installation and should not need to be changed. To verify, these setting are as follows:

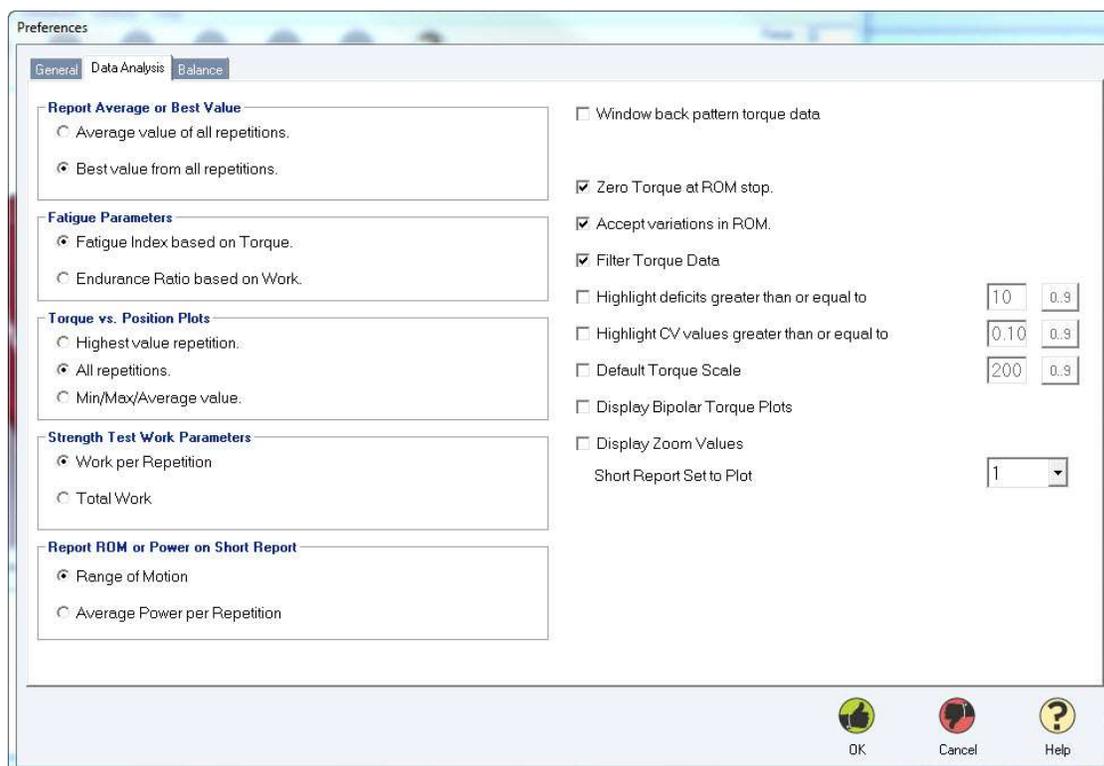
- Items on the **General Tab** (see screenshot above):

Field	Setting
Language	English
Display - Touch Screen	Off
Feedback - User sound to count repetitions	Off
Feedback - Reset torque scale for each set	Off
Feedback - Interactive Feedback (does not apply)	45
Timer - Show clock face	Checked
Location Button	Up-Right selected
Report Heading	MOST Bone & Joint Health Study - U of XXXX

- Items on the **Data Analysis Tab** (see screenshot below):

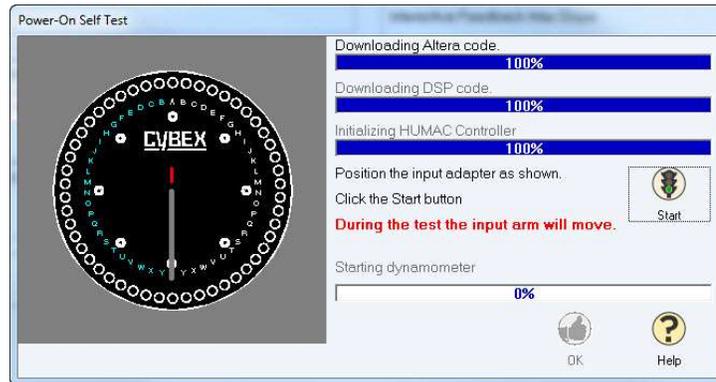
Field	Setting
Report Average or Best Value	Best Value from all repetitions

Field	Setting
Fatigue Parameters (does not apply)	Fatigue Index based on Torque
Torque vs. Position Plots	All Repetitions
Strength Test Work Parameters (does not apply)	Work per Repetition
Report ROM or Power on Short Report (does not apply)	Range of Motion
Window back pattern torque data	Off
Zero Torque at ROM Stop	On
Accept Variations in ROM	On
Filter Torque Data	On
Highlight deficits greater than or equal to	Off
Highlight CV values greater than or equal to	Off
Default Torque Scale	Off
Display Bipolar Torque Plots	Off
Display Zoom Values	Off
Short Report Set to Plot	1



- Click OK at the bottom of the screen (Green Thumbs Up sign)

- If this is not the first test of the day, and you are changing from the isometric hip abduction strength test to the isotonic knee power strength test, the Power-On Self Test screen will reappear because the servo motor needs to be turned back on and does so when you change to the NORM. This screen below will appear. In this case, follow the directions found just after the identical picture on the previous page.



- You are now ready to bring the subject into the room and begin the testing.

Note: *These steps are best performed before the subject enters the room, at the beginning of the day prior to the first test or at the end of each test just prior to leaving the room. This will aid efficiency. It is recommended that examiners close the HUMAC software with the NORM in Isotonic Test mode at the end of each day. Examiners may log out of the workstation; do not shut the computer down so it can transfer data over night.*

5. Detailed measurement procedures

5.1 Record keeping

Participant identifiers and test settings are entered into the HUMAC database via the keyboard (See Section 5.2.2, below). It is important to complete all of the required fields to allow the participant to be positively identified in the data sent to the SFCC for analysis.

Important: A one-page MOST test reports should be printed immediately after each test (i.e., a MOST Knee Power test report and MOST Hip Strength test report), and placed in the participant's chart (do not give the report to the participant). Also, make a separate electronic copy of the reports for each participant while the reports are displayed in MS Word.

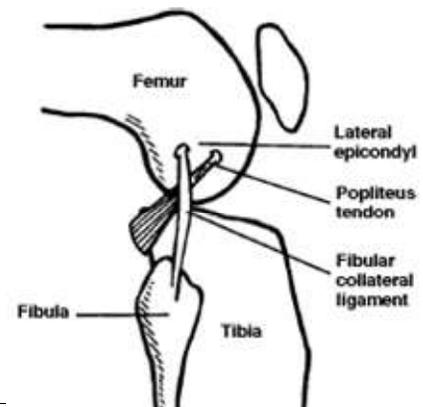
5.2 Administration of the Isotonic Quadriceps Power test

5.2.1 Check for contraindications

After introducing yourself, indicate that you need to ask a few questions to make sure this next test is appropriate for her/him. Use the questions and other criterion on the data collection form to determine if the participant is eligible for the test.

5.2.2 Positioning of the participant & the NORM Extremity System

- As the participant enters the room, ask him/her to remove his/her shoes. If easier, you can help the participant remove his/her shoes once he/she is seated in the chair.
- Explain that you're going to help the patient to climb onto and sit on the chair of the NORM using the stool, which has a handle to help them.
- Assist the patient onto the chair. Inform the patient that you are going to adjust the chair back so it fits them snugly. As you do this, check to make sure the crease of the knee (popliteal fossa) is just past the end of the chair base and the legs are positioned approximately in 90° of flexion (perpendicular to the floor). If this is not the case, have the patient scoot forward/back on the chair base.
- As you walk to the back of the chair to make adjust the seat back, check the angle of the chair back so you know where it is at.
- Adjust the chair back until the base of the upright part of the chair is snug against the patient's backside.
- Adjust the back angle to 85° as needed. As the chair back fore-aft position is adjusted, the back angle changes somewhat. It's important that the chair back is snug against the lower back of the patient. This is more important than being at 85°.
- Inform the patient that you will now move the chair into test position. This will involve rotating and sliding the chair over towards the device to their left/right. It's best to inform the patient quickly as you begin to perform the task.
- The participant will be moved to whichever side the NORM motor is on when they enter the room (the side that last subject tested was on).
- In one smooth motion, unlock the chair rotation lever and step on the chair horizontal translation pedal (monorail pedal), rotate/translate the chair smoothly into the test position.
- Using your foot to flip the chair rotation level up and especially push it back down can be helpful; some find using their hands easier. Some examiners also





find it helpful to use other parts of their body to assist in making a smooth, fluid adjustment. Experiment to find what works best for you.

- When testing the left leg, the chair is rotated to Black 40 on the chair pedestal. When testing the right leg, the chair is rotated to Teal 40 on the chair pedestal.
- The chair base fore-aft lever (under the chair) may be released at the same time as the chair rotation lever if you desire. This allows you to position the patient so the lateral epicondyle of the femur is aligned with the axis of rotation of NORM motor in one smooth action. Some people find moving in three directions at once to be somewhat unstable. Examiners are encouraged to experiment to see what works best for them. Until you are comfortable with adjust three motions simultaneously, it's recommended that you adjust the fore-aft position of the chair after the participant has been locked at the correct rotation angle. When and if you feel comfortable adjusting three motions at once you can transition to save a little time.
- As you slide the patient toward the motor, check to see if the height of the motor is about right (axis of rotation of the motor is in-line with the lateral epicondyle of femur). If there is a

significant difference in height, stop a foot or two short of the motor so you can adjust the height of the dynamometer.

- Lock the chair rotation lever (rotation should be at 40 as noted above).
- Shake the chair to make sure it is locked into place so it doesn't make a bang.
- If necessary adjust the height of the dynamometer so the angle of rotation is roughly in line with the lateral epicondyle of the femur (within an inch; don't be too concerned with being exact as the overall impact on results is fairly small and the impact of repeat adjustments on collection time is big).
- If the height was adjusted, make sure the chair base fore-aft lever is unlocked (lever is under the chair base), and step on the chair translation pedal.
- Slide the chair towards the motor and adjust the chair base fore-aft angle in one smooth motion so that the lateral epicondyle of the femur and the axis of rotation of the torque motor are in-line.
- Lock the fore-aft lever and ensure the chair translation pedal fully raised.
- Give the chair a vigorous shake. As you go to do this inform the patient that you are going to make sure the chair is locked and they may hear a bang. There's nothing to worry about, the chair is just settling into its position.
- Walk back in front of the patient and ask them to lift their leg and put it on your thigh. As you do this, bend forward and grab the knee/hip adapter and rotate it up under their lower leg making sure the Velcro straps are not stuck down under the leg.
- Adjust the length of the knee/hip adapter shaft so the shin pad lies just superior to the ankle mortise. One way to do this is to put the pads of your thumb and ring finger on the medial and lateral malleoli and adjust the shin pad so it touches your hand at the base of your index finger. If preferred, knee/hip adapter length can be adjusted with the participant's feet hanging down at 90°. Use the same approach of identifying the malleoli and adjusting the shin pad so it hits your hand and lies just above the ankle mortise.
- Secure the shin pad to the shank making sure that the strap is parallel to the pad on the opposite side. If the strap is angled in the back, the pad will rotate and the participant may feel discomfort from having more pressure on one side of the pad than the other.
- Note the length of the knee/hip adapter shaft (a ruler is etched into the front of the shaft). This number will be recorded in the software.
- Attach and tighten the thigh strap on the test leg.
- Quickly make sure all lever are locked and shake chair to ensure it is seated in grooves on last time. Let the participant know there may be a "clank" when you do this.

5.2.3 Entering participant information

- Click on Patient in the top left corner of the screen.



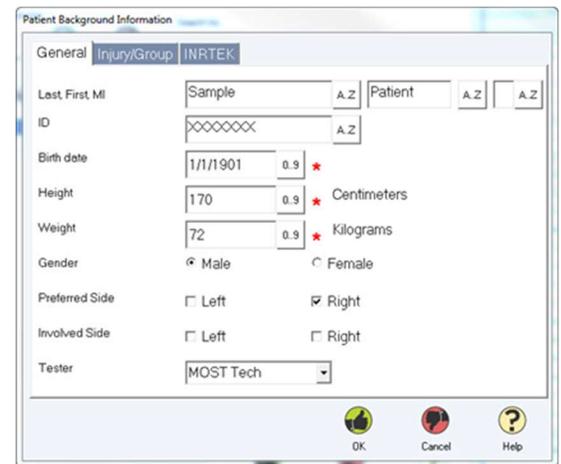
- The next screen will include a list of participants who have had tests.



- It's recommended that you enter subject codes into the database in the morning prior to when the subject arrives to save time associated with data entry. If you have done this, the participant's code should be in the list. You can edit their information by selecting "Edit", the center button in the Patients block.
- If you have not had time to enter the subject's data and this is the first time you are testing the subject, select "New" on the left side of the Patients block.
- Enter the following participant information using the HUMAC software.

Last, First, MI: Enter participant's acrostic in the Last name field (leave the First and MI fields blank)

ID: Enter MOST 7-digit ID#



- Birth date: **This is a required field (enter in January 1 and the year the participant was born in, DO NOT enter participant's real birthdate)**
- Height: **This is a required field (enter in cm from stadiometer or participant results report)**
- Weight: Enter weight in kg (from participant results report)
- Sex: Male or Female
- Preferred Side: Recorded in REDCap, not here.
- Involved Side: **Do not record**
- Tester: Enter MOST staff ID from the list

- Click "OK"
- This will return you to the main HUMAC screen, which looks like this:

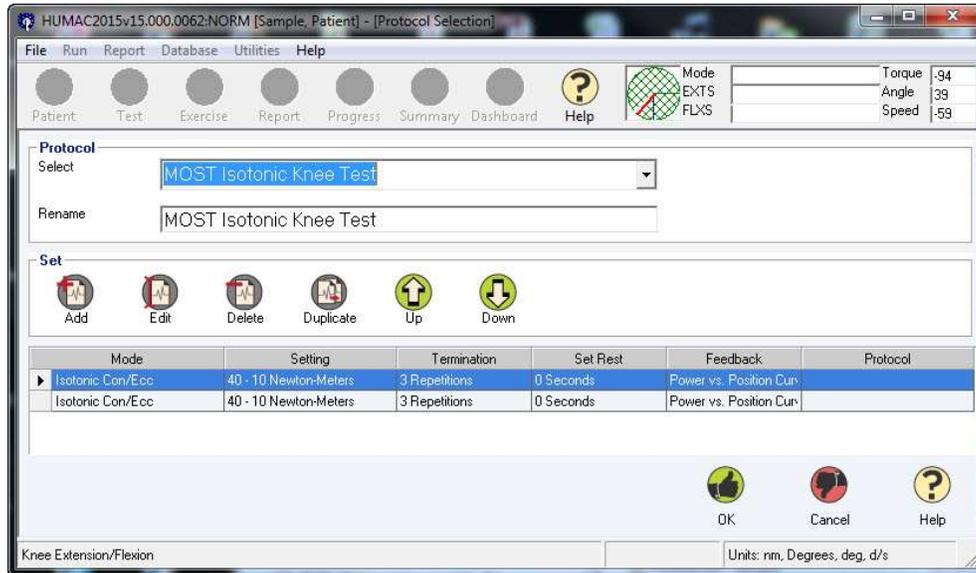


- If height, weight, and/or gender are entered into the HUMAC software incorrectly, please see instructions in Appendix 5 that describe how to change the data.

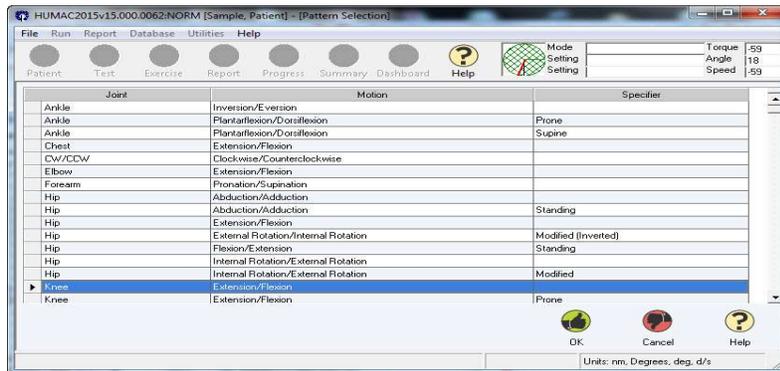
5.2.4 Selecting the test & protocol

- Click on "Test".

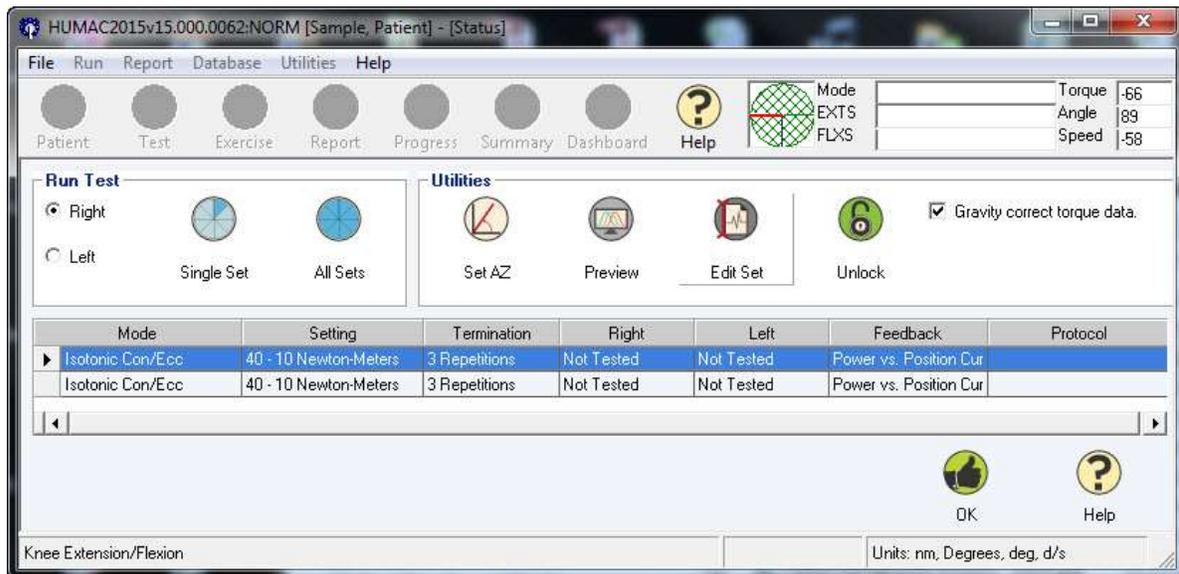
- The Pattern Selection Screen will appear:
- Select Joint=**Knee**, Motion=**Extension/Flexion**, Specifier=**Blank** (i.e., seated)
- Click “OK”
- This will bring up the Protocol Selection Screen, which looks like this:



- In the Protocol Box, select “MOST Isotonic Knee Test”, as shown above.
- A Preset Protocol will be shown, as shown above. Click “OK”.



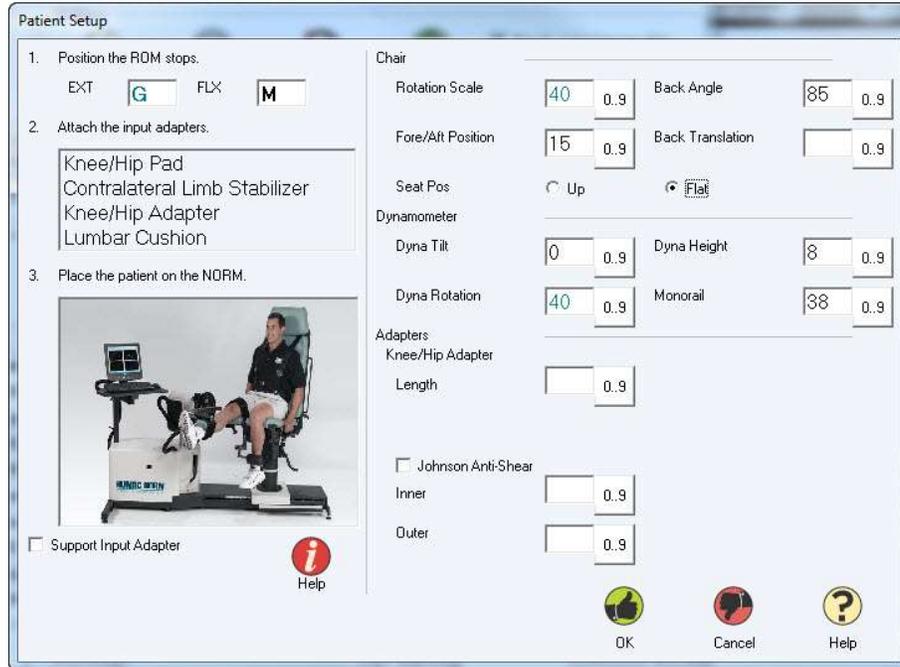
- This will bring up the “Test Status” screen, which looks like this:



- In the Run Test block, select the side you are testing first and then choose “**Single Set**” by clicking on button with a single shaded piece of the pie.

5.2.5 The patient setup screen

- The Patient Setup screen allows entry of participant and NORM Positioning.

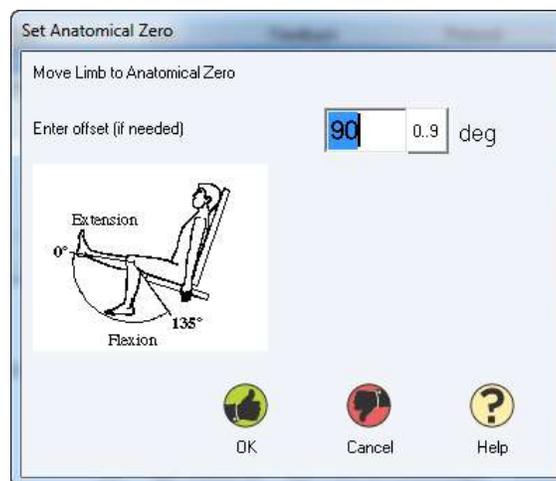


Field	Setting	Notes
Position the ROM Stops	Right Side - Teal G/Black M Left Side - Black G/ Teal M	Side Specific. Do this to confirm correct side is selected
Chair Rotation Scale	Right Side - Teal 40° Left Side - Black 40° Default, do not change	Chair is always set to 40, but the color differs by side. The dynamometer and chair rotation are the same color
Back Angle	85° - Default, do not change	At conclusion of Isometric Hip Test, return back angle to 85°
Fore/Aft Position	No need to record	Adjusted to align knee axis with dynamometer shaft axis
Back Translation (Fore-Aft)	No need to record	With participant sitting upright – use crank to adjust in until bottom of seatback touches the base of the participant's spine.
Seat Position	Flat, do not change	Leave seat bottom flat to expedite testing
Dynamometer Tilt	0°, Default, do not change	Always leave Dynamometer tilt at 0 to expedite testing
Dynamometer Height	No need to record	Adjusted to align axes of rotation. Usually 2, 3, or 4.

Dynamometer Rotation	Right Side - Teal 40° Left Side - Black 40° Default, do not change	<i>Dynamometer is always set to 40; color differs by side. Dynamometer and chair rotation are the same color</i>
Monorail	No need to record	<i>Adjust as needed to align knee axis with dynamometer axis</i>
Knee/Hip Adaptor Length	Record This Length	<i>Etched on front of shaft</i>

5.2.6 The set anatomical zero screen

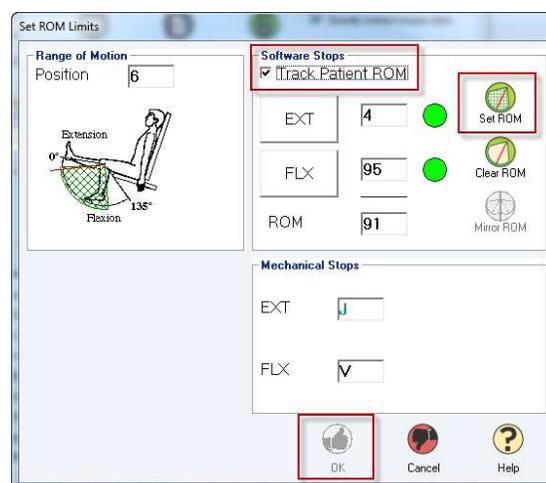
- This screen sets the movement reference for the test.
- Position the participant's knee in 90° of flexion. The knee typically will lie close to 90° when the patient sits with his/her legs relaxed over the end of the chair base as long as (s)he is positioned correctly on the chair and (s)he has 90° of motion.
- Enter 90 in the offset block & click "OK".



5.2.7 The set ROM limits screen

The HUMAC NORM requires that knee range of motion is recorded and mechanical ROM Safety stops are set.

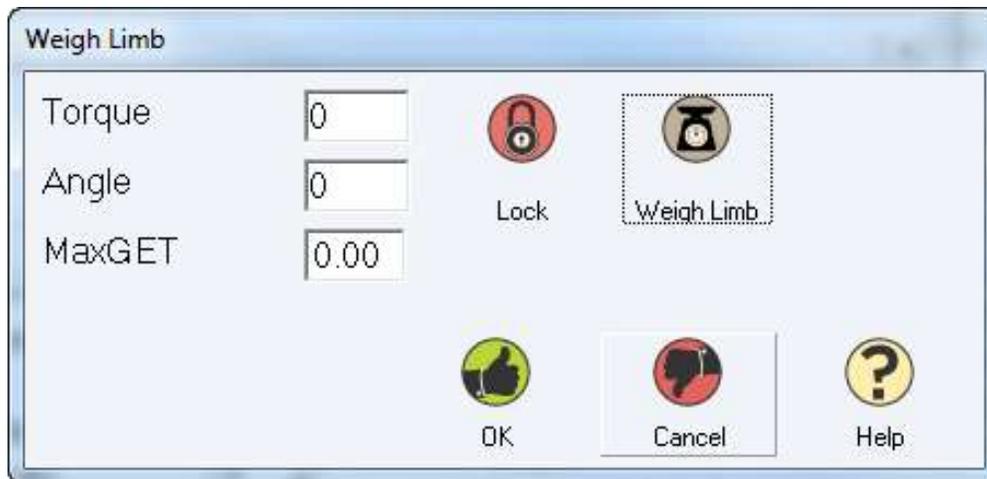
- Check **Track Patient ROM**
- Instruct the participant to straighten his/her leg as much as possible (**the participant does this independently**).
- HUMAC will record the range of motion (ROM) end points.
- Click "Set ROM" (top right hand button)
- Position the Extension (EXT) and Flexion (FLX) ROM Stops on the dynamometer to the Black and Teal positions noted in the Mechanical Stops block (safety precaution)
- Click "OK"
- Note: The University of Iowa saves endpoints at the height of extension so that the flexion value remains at 90° while the University of Alabama at Birmingham saves endpoints after



coming back to rest from a full extension, causing up to 10° to be added to flexion endpoint (up to 100° total for flexion).

5.2.8 Weighing the limb (MaxGET; gravity correction)

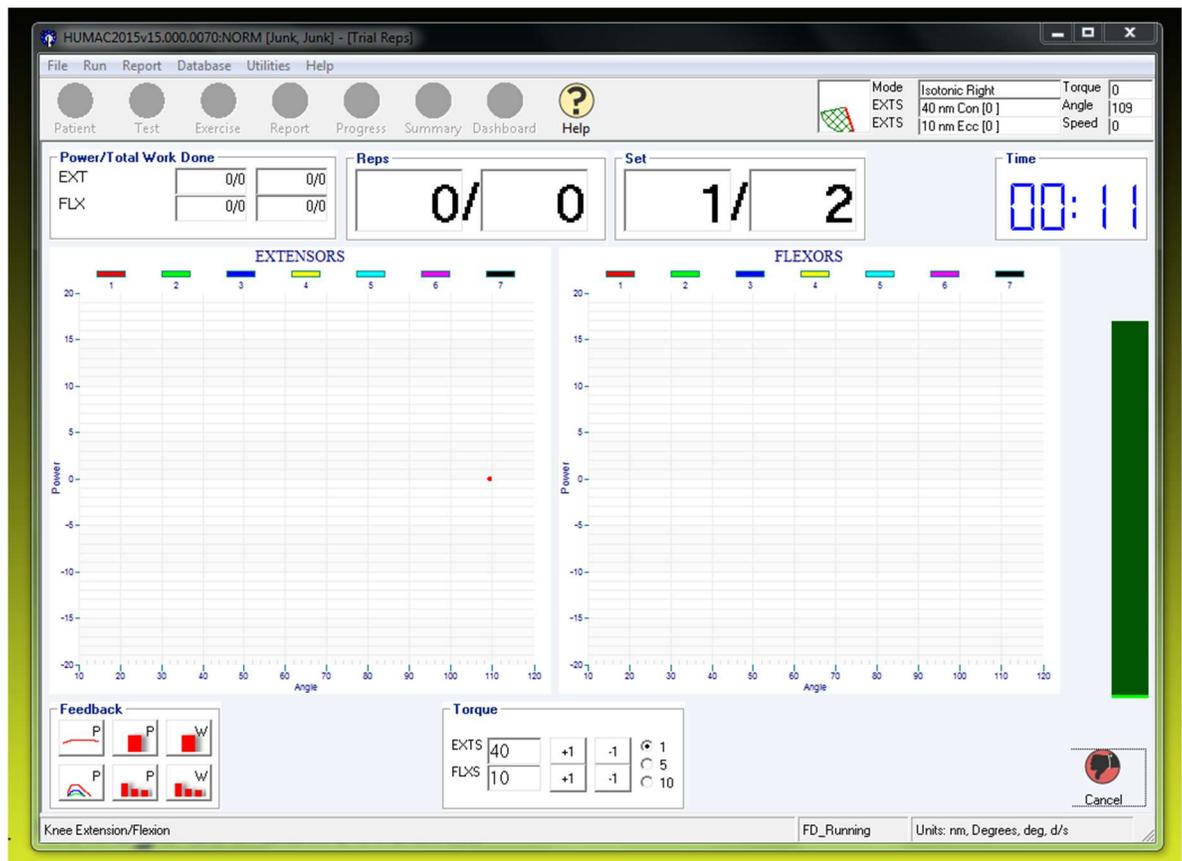
- The screen should now look like this:



- The next step is to weigh the limb to correct for the force of gravity on the leg.
- Ask participant to fully extend his/her leg.
 - Script: “*Mr./Mrs. XXXX, I want you to straighten your knee as much as possible.*” Demonstrate straightening your knee as you give the instruction.
- The examiner should support the leg at the end of the participant’s active range of motion as they click on the Lock button. The leg should be as close to straight out as possible. If it is not possible to fully extend the leg passively, then place the leg as close to full extension as possible.
- The HUMAC NORM will now hold limb in the extended position.
 - Script: “*OK. Now I want you to completely relax your leg so we can weigh it. Your leg needs to be totally relaxed so it is completely “limp” and “heavy”.*” It’s often helpful to have the participant close his/her eyes while they do this.
- Confirm that the leg looks relaxed. MaxGET values are typically between 18 and 30, but may be higher with heavier people.
- Select Weigh Limb. The HUMAC NORM will record Torque, Angle and MaxGET. Prepare to Select “OK”. The HUMAC NORM will release leg when OK is pressed. The examiner should support the leg and help participant slowly lower his/her leg when OK is pressed. The NORM provides some resistance so the leg will not fall as dead weight. Still, it’s best to support the participant’s leg as it lowers.

5.2.9 Identification of Isotonic 1-Repetition Maximum (1RM) Quadriceps Muscle Strength

- 1RM is identified so we can set the load used in power testing to 40% of the participant's 1RM, which is the most common load used when testing power.
- The examiner's goal is to identify 1RM in as few trials as possible. Ideally, 3 or 4.
- After the examiner has weighed the limb, a window will pop-up indicating that the participant needs to move his/her knee to a flexion angle that is greater than the angle set when setting the ROM limits (e.g., if knee flexion was set to 90°, move to 95°).
- Moving to a more flexed angle will start the test. A screen like the one below will appear.



- The first step is to estimate the participant's 1RM and enter 50% of that value in the EXTS cell in the Torque block at the center of the bottom of the page. The starting value will be about 30 Nm for the average woman and 40 Nm for the average man. Values for old women and men are typically 5 to 10 Nm lower.
- The buttons to right of the cell used in the step above (labeled +1 and -1 in the example above) are used to incrementally increase or decrease the load by 1, 5, or 10 Nm. The desired increment is selected using the buttons to the left of the numbers 1, 5, and 10 at the right side of the Torque box.
- Optional: If the examiner determines it would be helpful to the participant, instruct the participant to move the load through her/his range of motion to get a "feel" for the task.

- Script: “Slowly straighten your knee so you can feel how heavy the load is and what it feels like to move against the machine”.
- [Subject moves partially through the range]. Acknowledge they did what you wanted and any comments by nodding “yes”.
- Give the participant instructions on performing the test.
 - Script: “To perform this test, we want you to push out, straightening your knee as FAST and HARD as you can. Keep pushing FAST and hard until your knee is completely straight. We are testing how powerful you are so it’s important that you straighten your leg as FAST and HARD as you can.”

As you give this instruction, demonstrate a fast kick to reinforce that we want him/her to straighten his/her knee. Hold the end position for a second or two to reinforce that we want them to hold until we say stop.

- Script: “During the test, hold onto the handles and pull your buttocks firmly into the chair” [point to the handles and then act like you pulling yourself down into the chair while giving this instruction]. “We want you to pull straight up on the handles; hard enough that you are tight to the chair; do NOT use the handles to rock backward, pushing your shoulders into the chair” [in the air, act as though you are forcefully rocking back into the chair while pulling on the handles while shaking your head “No”]. “Don’t think about pulling on the handles too much. We want you to focus on straightening your knee as FAST and HARD as you can.”
- Script: “I will tell you when to push. Do NOT hold your breath during the test. If you have pain while pushing out, please tell me so we can adjust the test and stop if necessary. Do you have any questions?”

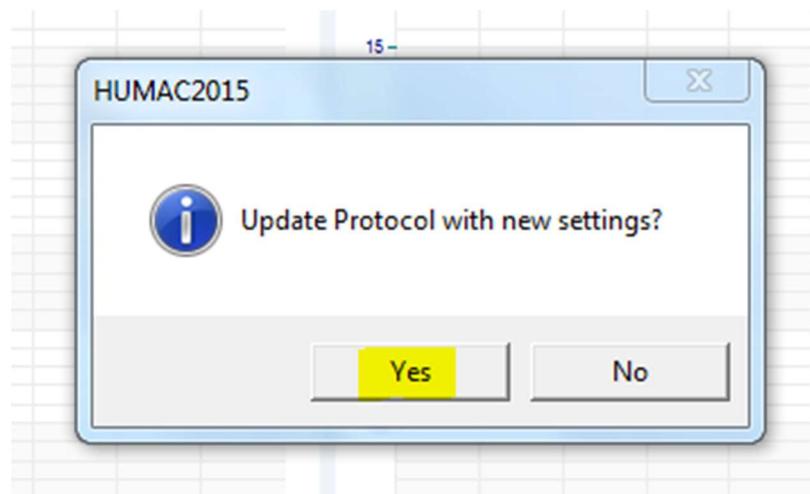
Participant either asks a question or says/signals “No”.

- Script: “Remember, push out as FAST and HARD as you can.”

NOTE: FAST is emphasized first. There is good evidence that saying FAST first leads to better results than saying HARD first when performing tests where velocity is important.

- Ask the participant if (s)he is ready and then start the maximal trial with the 50% load (estimated)
 - Script: “Ready? PUSH!”
- Note the range on the screen. If the load was about 50% the participant should have moved through the full ROM set when setting up the test. Remember this position in case the submaximal repetition gets erased (this can occur occasionally).
- The examiner needs to make a judgment on how easy the load was for the participant. If there was no slowing or hesitation during the movement and the subject moved through the full ROM, the examiner can safely make a large jump in the load as an estimate of 1RM (80% to 100%; i.e., to 50 or 60 Nm if the initial load was 30 Nm). If the movement was slower, then the adjustment should be smaller.
- During each repetition, the examiner should watch the knee to see if it straightens fully, observe the velocity at which the knee rotates, and listen to the tone of the dynamometer. All of these will provide feedback, in addition to the digital display, on whether the participant moved through the full ROM and-or is close to/above/below 1RM.
- Repeat the test with the first guess at 1RM load:
 - Script: “This one is going to be harder than the last one. Remember, push out as FAST and Hard as you can and keep pushing until I tell you to stop.”

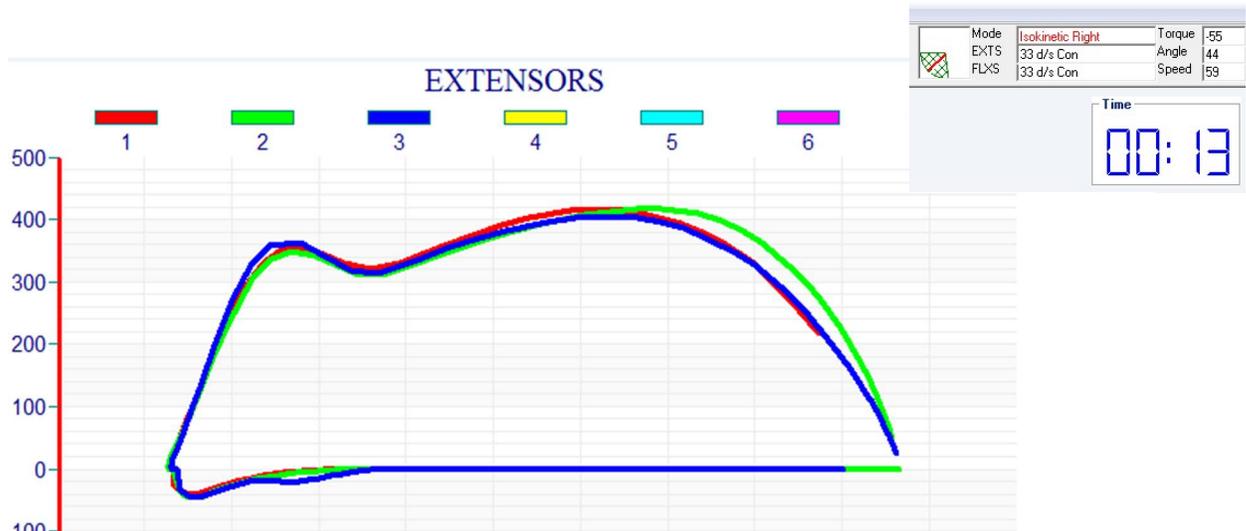
- Script: “Ready? PUSH! Good job! You can stop. We’re going to give you 30 seconds rest and then try another one”
- Provide a minimum of 30 seconds rest unless the participant reports the load was easy.
- Adjust the load higher if the subject made it through the full ROM (within 10° of full extension, visual and auditory feedback support the conclusion). Use a 10 Nm or larger jump if it seemed like the load was easy and a 5 Nm increment if the load seemed close.
- Adjust the load down if the subject did not make it through the full ROM (>10° from full extension and/or visual and auditory feedback indicate (s)he failed to complete the test). Lower the load by 10 Nm or more if it seemed like the load was much too heavy. Use a 5 Nm reduction if the participant almost completed the trial.
 - Script: “OK. Ready for the next one? This one is going to be a little bit harder/easier. Push out as FAST and Hard as you can. Ready? PUSH! Good job!”
- Repeat this process until the 1RM load is identified. Again, this should be able to be accomplished in 3 to 4 tries. If not, the increments upward/downward are too small or the first guess was way off. When the initial guess is way off, make a large jump in load. If the participant complains of pain, ask:
 - Script: “Does it hurt enough that you want to stop?”Determine how severe the pain is and decide if testing should continue. If necessary, discontinue testing on that leg and go on to test the other leg.
- When 1RM is identified, enter the value into REDCap on the iPad, which will calculate the 40% 1RM load to be used in power testing.
- Use the buttons in the Torque Control box at the bottom of the screen to set the load to the 40% 1RM value displayed in REDCap.
- **Ask participant to** move through the range of motion with **this lighter load** to familiarize him/her with the lighter load. Remind him/her that the aim will still be to push out as FAST and Hard as possible just like before.
- Click “Cancel” (lower right hand corner).
- The following pop-up window will appear:



- Click “Yes”. This copies the 40% load into the test protocol.
- The participant is now be ready to begin the Isotonic Quadriceps Power Test.

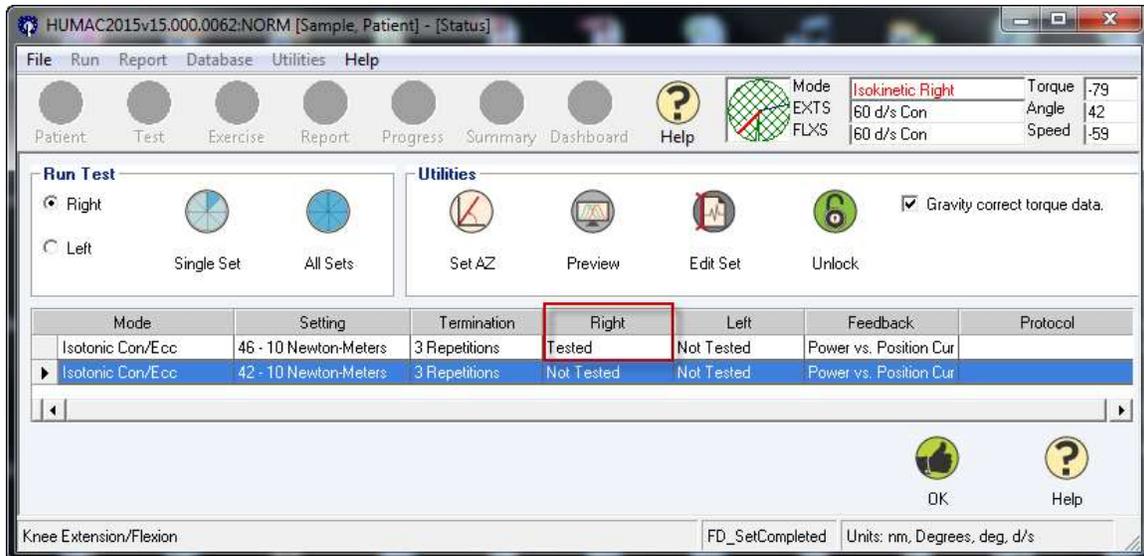
5.2.10 Isotonic Quadriceps Power test at 40% 1RM

- **Script:** “Ok, we’re almost done with the first test on this leg. Like before, we want you to push out as FAST and Hard as you can. Use the handles to pull your buttocks firmly into the chair, but focus on pushing out FAST and HARD. Once again, I will tell you when to start and stop pushing. Keep pushing as HARD as you can until I tell you to stop. We’ll give you 30 seconds rest between each repetition. Are you ready to begin?” If participants ask how many repetitions they are doing, say “We are doing a total of three repetitions, one at a time. Please wait for my instruction before pushing.”
- **Script:** “Begin when I say Push”. [Make sure the patient is flexed further the set ROM]. When ready say: “PUSH! Good job! You can stop pushing and rest for 30 seconds. We’ll do another one just like that after you rest.”
- The feedback screen will look something like this during the test:

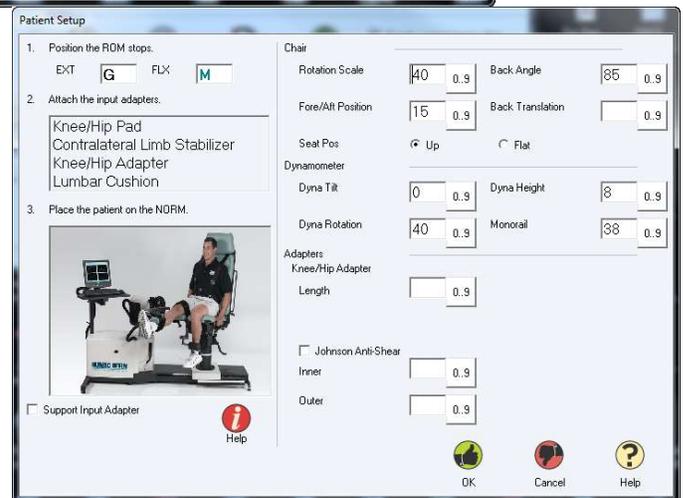
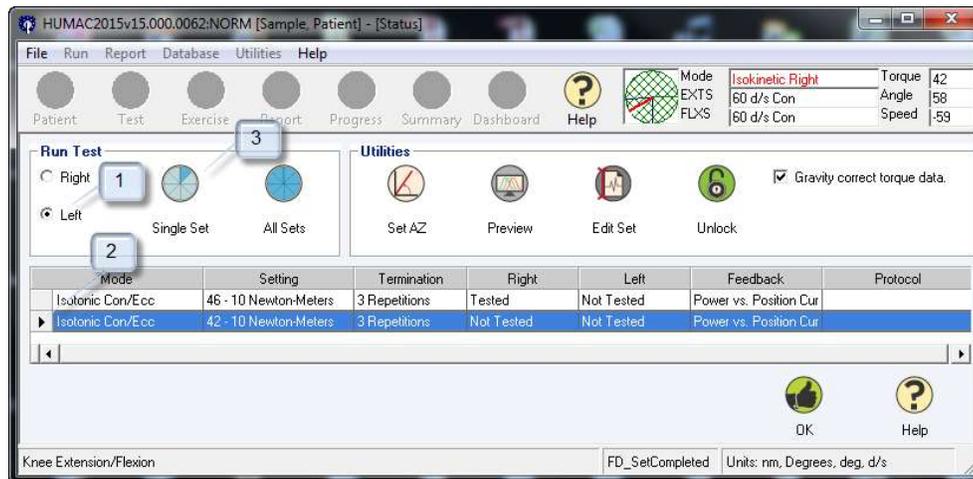


- Use the timer in the upper right corner of the screen to time the rest periods. Give at least 30 seconds between repetitions.

- After the third repetition, ask the participant:
 - **Script:** “Did you have any pain during the test?” [If so] “Did pain during the test affect your ability to do this test?”
- Record the participant’s answer on the data collection form/iPad.
- When testing of the first leg is complete, the HUMAC will return to the Test Status Window.
- The example screenshot below shows that the right side has been tested.

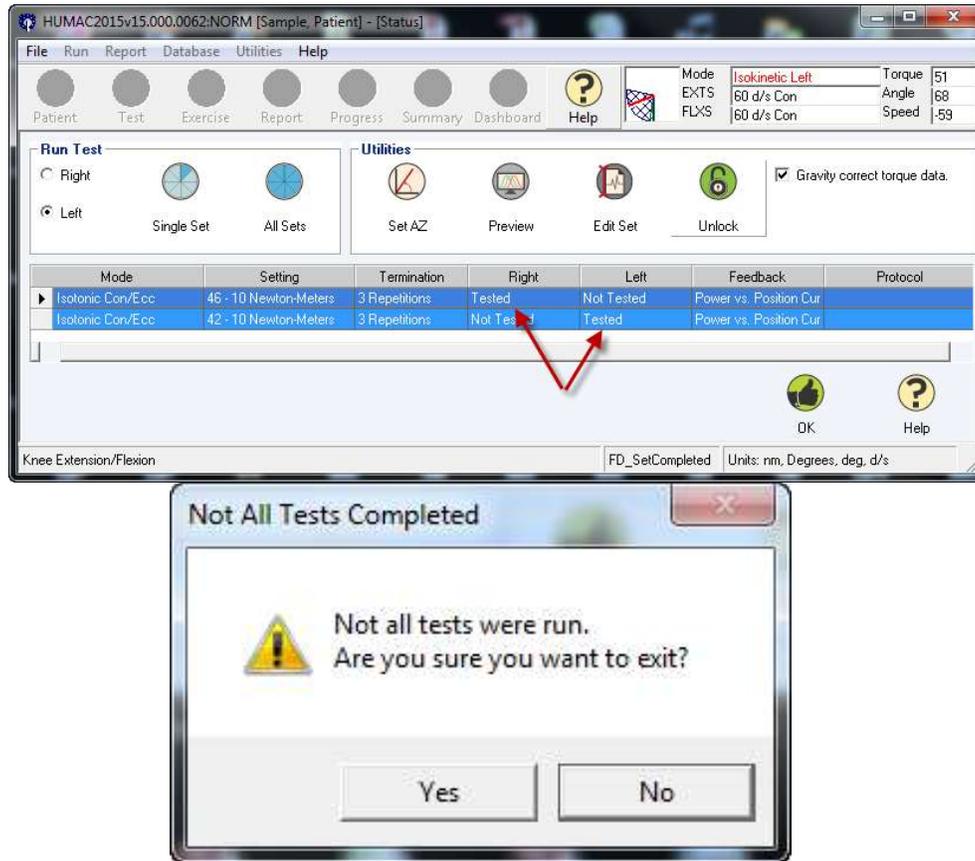


- Set up the participant to test the other side (see figures below).
 1. On the Test Status Screen select the button for the side to be tested second
 2. Select the row for the test that has not been tested (typically, first row is right side, second left)
 3. Select Single Set (this will release software ROM stops and open the Patient Set-up for the other side)
 4. Click “OK”
 5. Note: Examiners should make sure that they have the second option selected after switching to second side tested. This will affect how the Narrative report displays power data.



- Adjust the HUMAC NORM to test the second side
1. Move the Mechanical ROM Stops to Black G & Teal G (if left side)
 2. Remove shin pad strap from participant
 3. Move thigh strap to the other thigh.
 4. Slide the chair away from the dynamometer head
 5. Raise the Chair Pedestal Clamp, rotate to Teal 40° (if right) or Black 40° (if left) and lock in place
 6. Rotate dynamometer head to 40° on other side while putting downward pressure on the dynamometer to maintain dynamometer height and lock in place
 7. Slide the chair back so the axes of rotation are aligned
 8. The shin pad attachment may have to be rotated depending on subject alignment.
 9. Attach the shin pad strap making sure that the strap and the pad are parallel to avoid unbalanced pressure on one side of the pad which can be uncomfortable
- **Follow same testing procedures used to test the first side (see previous pages).**

- When the third test repetition on the second side the screen below will appear



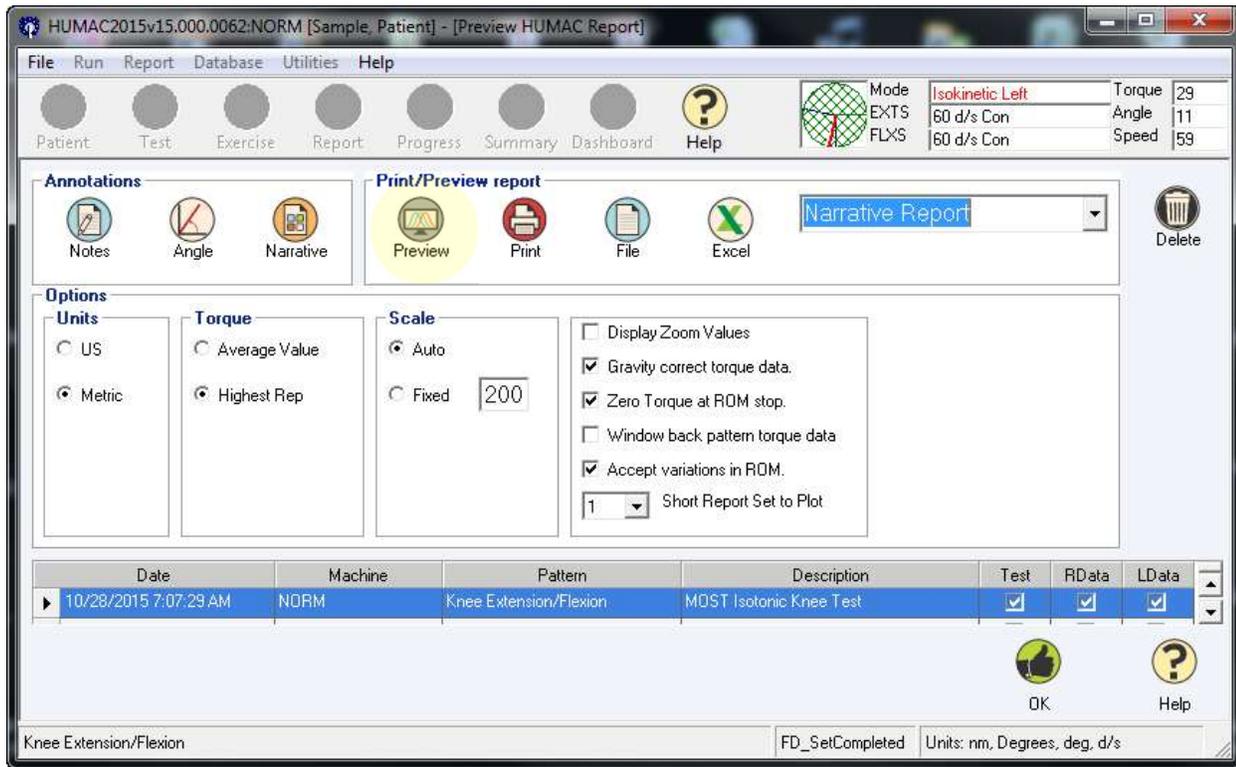
- You should see "Tested" once under the first and second in different rows as above
- Click "OK"
- The following pop-up window will appear

- Click "Yes"

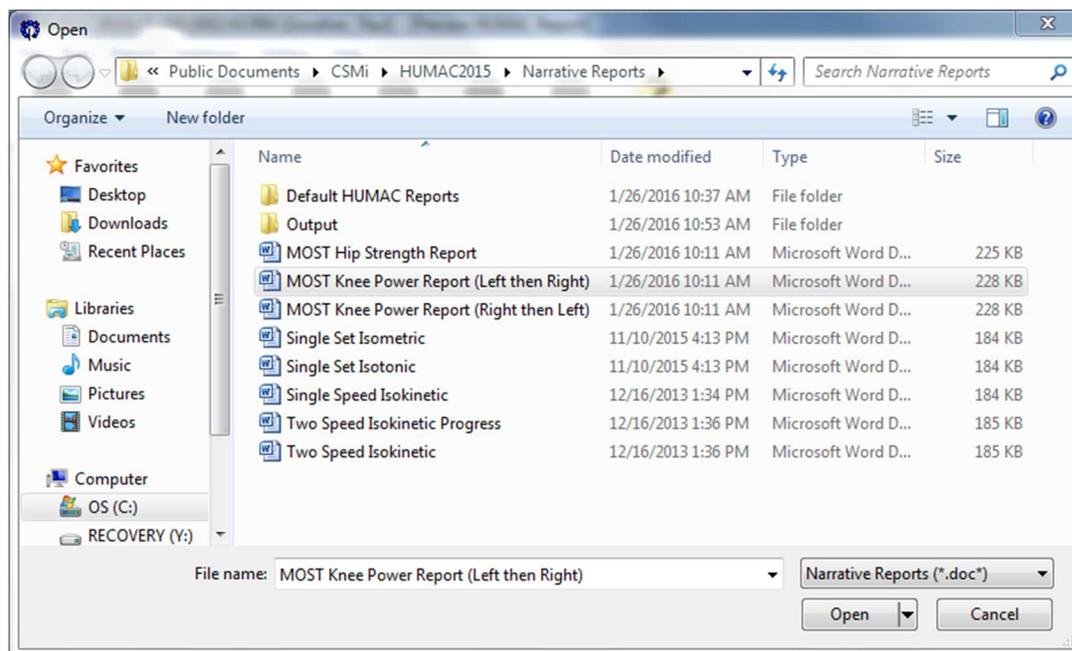
5.2.11 Results print out and report archiving



- The “Preview HUMAC Report” screen will appear (see figure below)

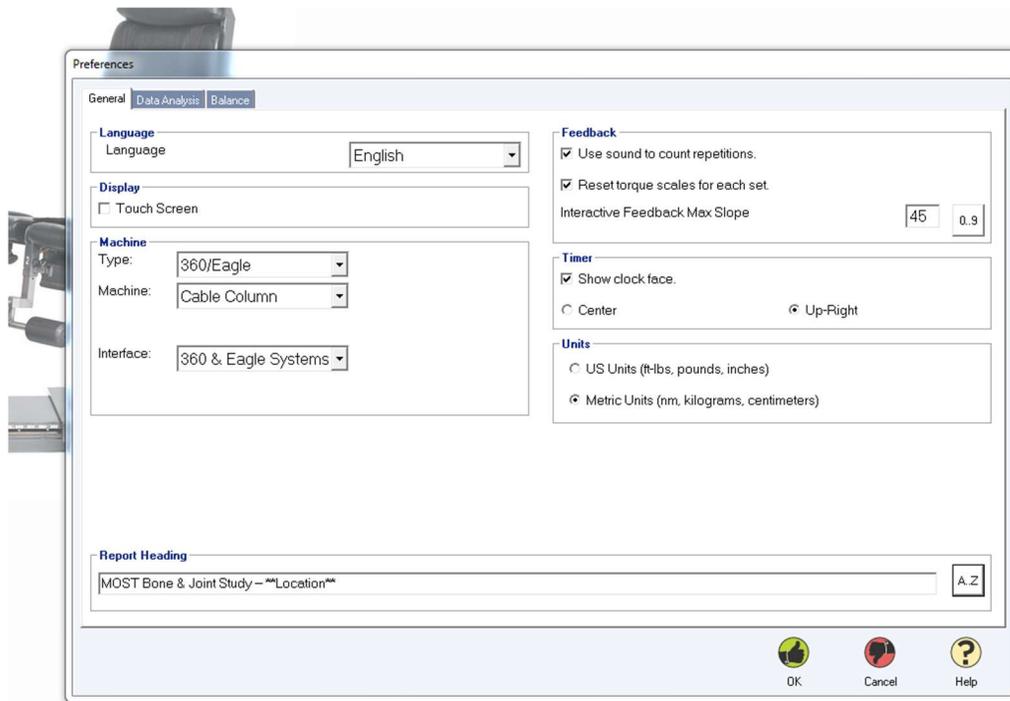


- Highlight the row of the MOST test that was just performed
- In dropdown menu to the right of the Excel button, select “Narrative Report” (see figure above)
- Click on the Preview button in the Print/Preview report block (see figure above)
- This will bring up a Narrative Report selection window as below



- Select the “MOST Knee Power Report (Left then Right).docx” or “MOST Knee Power Report (Right then Left).docx”, whichever is applicable for that exam session.
- Microsoft Word will start and the MOST Report will appear on the screen with results from the exam pre-filled.
- Print the report and place in the participant’s clinic chart. Do not give report to participant.
- While the participant report is still open in MS Word, also save a separate electronic copy of the report.
 - In Word, go to File>Save As menu. A new window should open in the Narrative Reports folder.
 - Create a dated subfolder for the week in the computer’s C drive: C:\HUMACNORM\YYYYMMDD. This is the same folder where a copy of the hip strength reports will be saved.
 - Find and open the weekly folder (C:\HUMACNORM\YYYYMMDD), and then name the report “MOST Knee Power Report (Left then Right) MXnnnnn.docx” or “MOST Knee Power Report (Right then Left) MXnnnnn.docx” (depending on which side was started with) X denotes the first letter of the clinic and nnnnn is the numerical part of the MOSTID, and save it. All of the reports for exams in the same week should go into that subfolder. Ever week, create a new dated subfolder to hold the report files for that week.

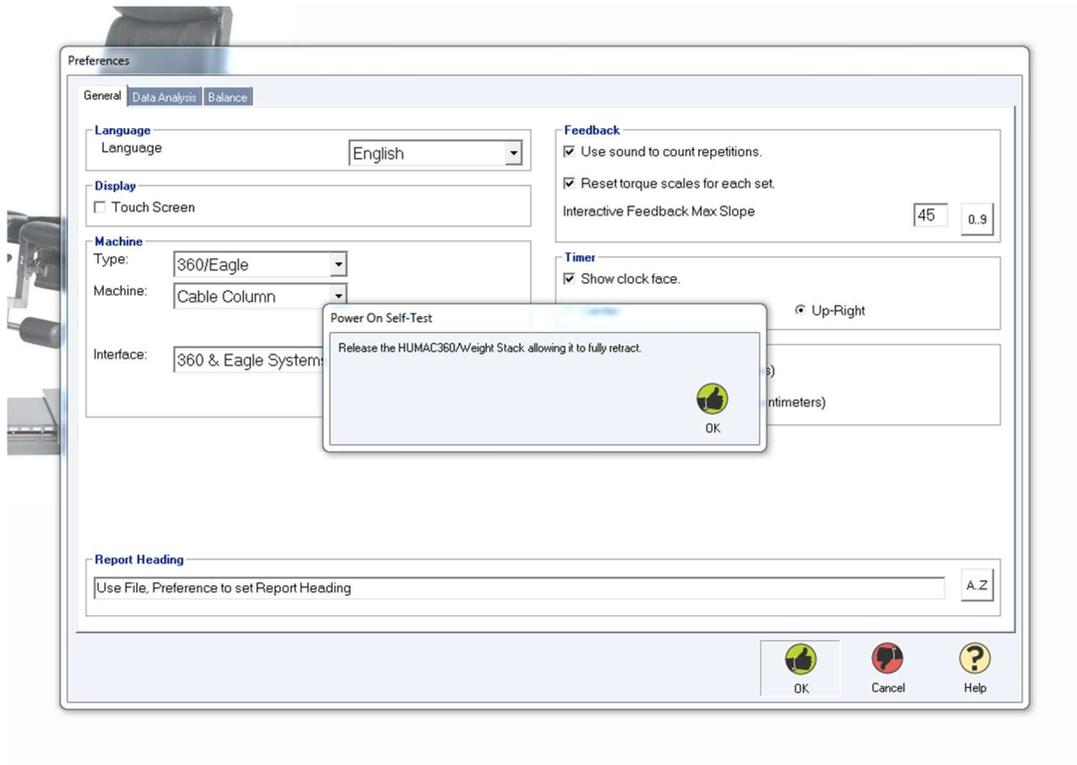
Ensure the most recent version of the “MOST Knee Power Report (Right then Left).docx” and “MOST Knee Power Report (Left then Right).docx” are in the Narrative Reports folder (C:\Users\Public\Documents\CSMi\HUMAC2015\Narrative Reports) and are named correctly (“MOST Knee Power Report (Right then Left).docx” and “MOST Knee Power Report (Left then Right).docx”).



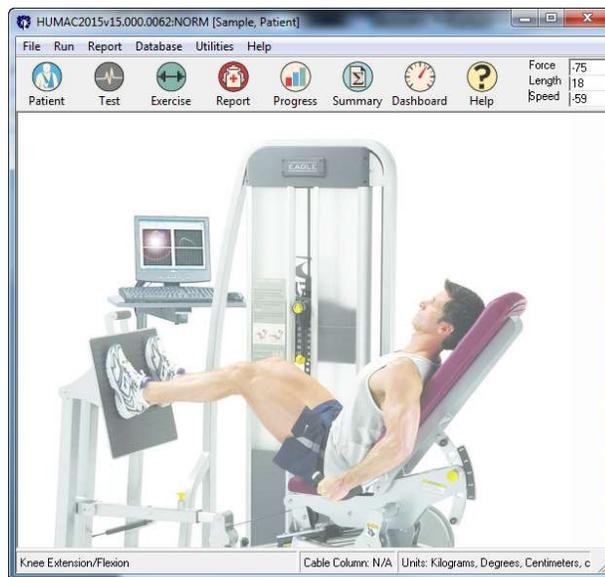
5.3 Administration of Hip Strength testing

5.3.1 Changing from Isotonic to Isometric test software

1. Select File> Preferences (see screenshot below)
 2. Set Type = 360/Eagle
 3. Set Machine = Cable Column
 4. Set Interface = USB
 5. Verify that Units = Metric
- The following pop-up window will appear.
 - Verify that the load cell is unloaded and click “OK”.



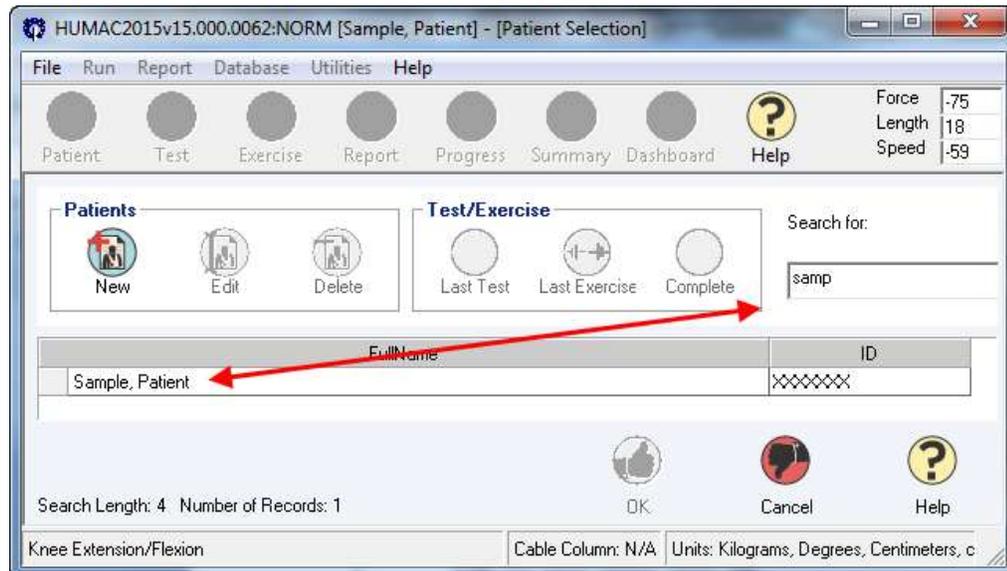
- The HUMAC Software will return to the Main Menu.



IF THE PARTICIPANT INFORMATION NOT ALREADY ENTERED (it typically will be) from HUMAC Software Select File Preferences.

- Select Patient to open the Patient Selection Window.

- Type the Participant's acrostic or ID in the Search for window.



- Highlight Name and Select OK to Return to the Main Menu.
- Next step: Prepare the participant and NORM chair for the Hip Abduction Strength Test

5.3.2 Positioning the participant

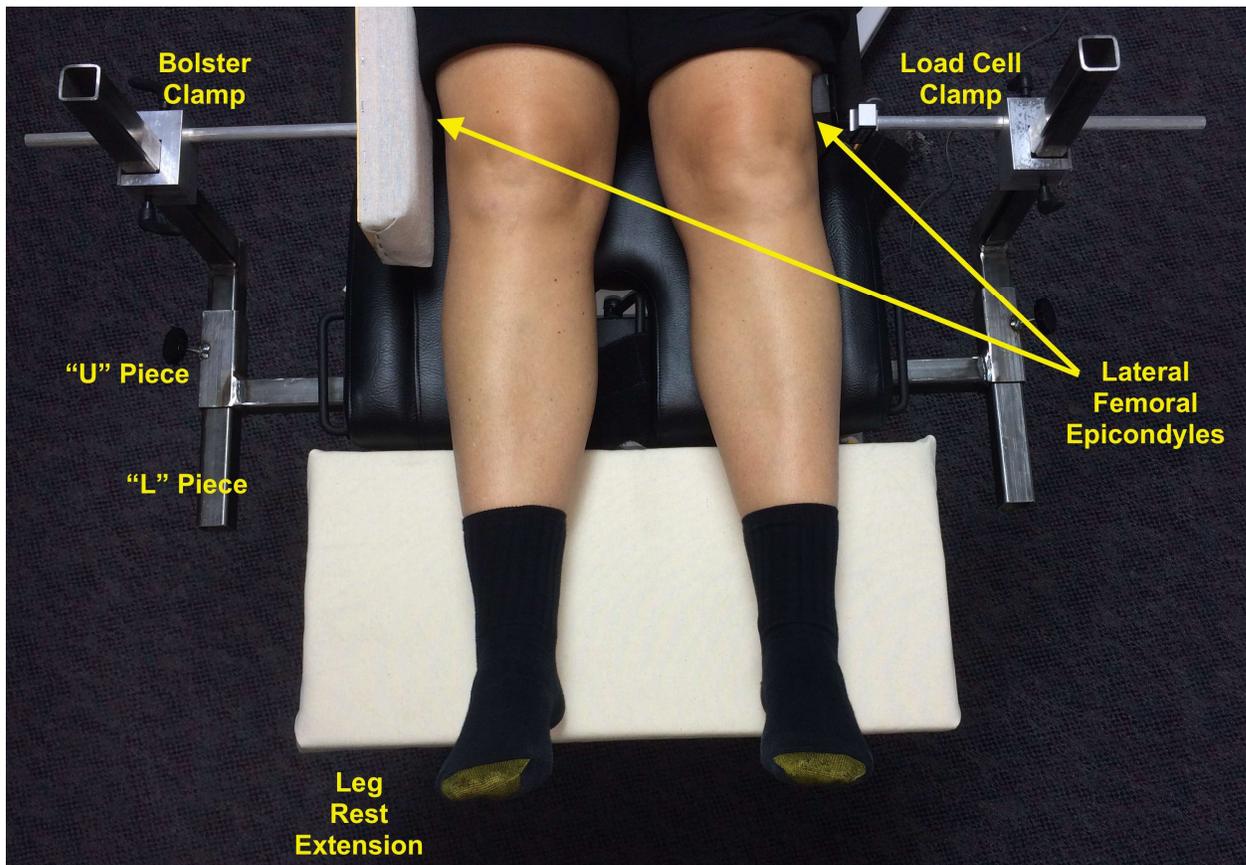
The participant is already in the chair, as this is done immediately following quadriceps power testing.

1. Remove seat belt; unstrap knee and tuck strap under the table (out of the way).
2. Step on Monorail Pedal and slide chair to furthest position away from dynamometer
3. Give chair a tug to make sure it is locked.
4. Rotate chair to correct position (will be specific to the UI and UAB testing rooms)
5. Insert “U” and “L” pieces bilaterally, and lock U pieces using the NORM chair handscrews.
6. Instruct the participant to lean forward so his/her back is not touching the Seat Back.
7. Rotate the Seat Back Tilt Crank so the Seat Back Setting is 0 (all the way back)
8. Have participants slide their bottom back in the chair as far as they can and remind them “Please remain sitting. Don’t lay back yet.”
9. Lift either Seatback Handle and recline the Seat Back to 15°. MOST ball on string will just barely touch the floor at 15° of seatback recline.
10. Assist the participant to lie down on the now lowered back and scoot their bottom into the crease between the seat bottom and the seat back.
11. The participant should be positioned so that his/her buttocks (approximately the level of the greater trochanter) is in the gap between the seat bottom and the seat back.
12. Insert the additional leg rest extension from the inner portion of the “U” pieces in insertions #1 & #3.

13. Insert the Load Cell apparatus into the HUMAC NORM onto the “L” piece on the side to be tested.
14. Confirm the Load Cell USB Cable is plugged into the front of the HUMAC NORM CPU USB Port
15. The wide Velcro belt should be snugly secured around the participant at the level of the anterior superior iliac spines (ASIS).
16. Align the Load Cell apparatus with the lateral femoral epicondyle. Participant should not be touching the Load Cell.
17. Adjust position of the legs so that they are about shoulder width apart and with the toes pointing up towards the ceiling (not rotated out to the side, unless the participant is truly unable to maintain this position).
18. Note: the University of Iowa places the load cell on the lateral femoral epicondyle (LFE) while the University of Alabama at Birmingham places the load cell just superior to the LFE. The MOST investigators determined each site should continue doing what they are doing for consistency.
19. Optional: if applicable, say script
 - Script: *“During the tests, your hands will hold onto this velcro belt or the foam handles here.”*







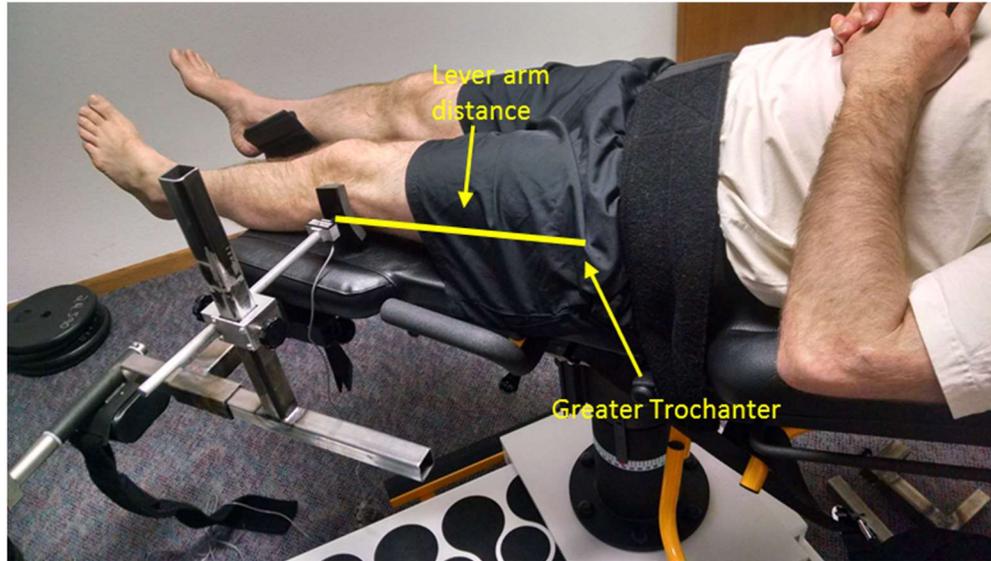
On leg **not** being tested

1. Palpate lateral femoral epicondyle (just superior to the bend of the knee).
2. Adjust position of "L" piece so that the bolster is in line with the lateral femoral epicondyle. Tighten handscrew.
3. Adjust vertical position of the bolster clamp to the height of the lateral femoral epicondyle. Tighten handscrew.
4. Adjust slide position of the slide bar with the bolster to just compress the lateral leg and hold the leg securely in place. Tighten handscrew.

On leg being tested

1. Palpate the lateral femoral epicondyle (just superior to the bend of the knee)
2. Adjust position of "L" piece so that the load cell interface is in line with the lateral femoral epicondyle. Tighten handscrew.
3. Adjust vertical position of the load cell clamp. Should be about the height of the lateral femoral epicondyle. Tighten handscrew.
4. Adjust slide position of the slide bar with the load cell to just compress the lateral leg so that when the subject tries to slide the leg to the side, the leg does not move. Tighten handscrew.
5. Palpate the greater trochanter. Measure distance in cm from the superior facet of the greater trochanter to the position of the center of the load cell to determine the distance from the hip

to the point where the load cell is measuring the force. This only needs to be done on the first side tested.



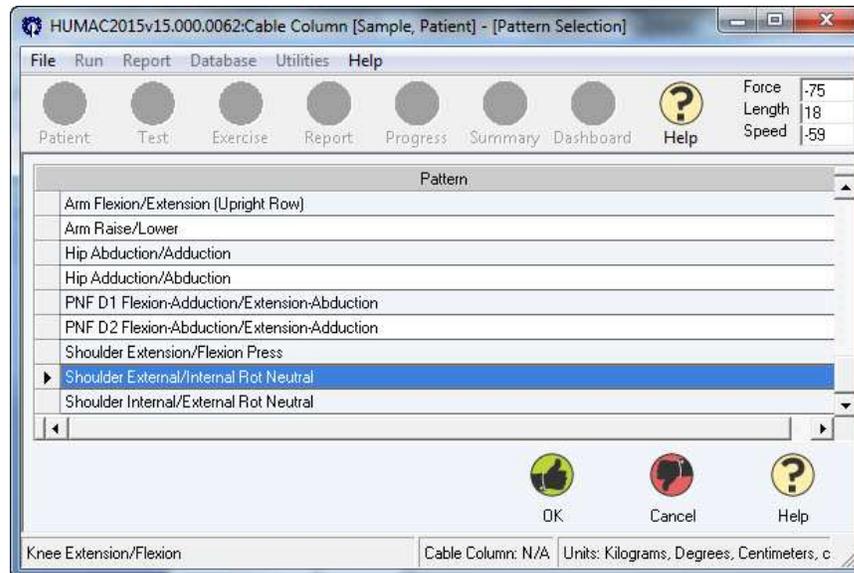
6. Record measurement on the REDCap form (thigh length).

5.3.3 Selecting the test in the HUMAC software

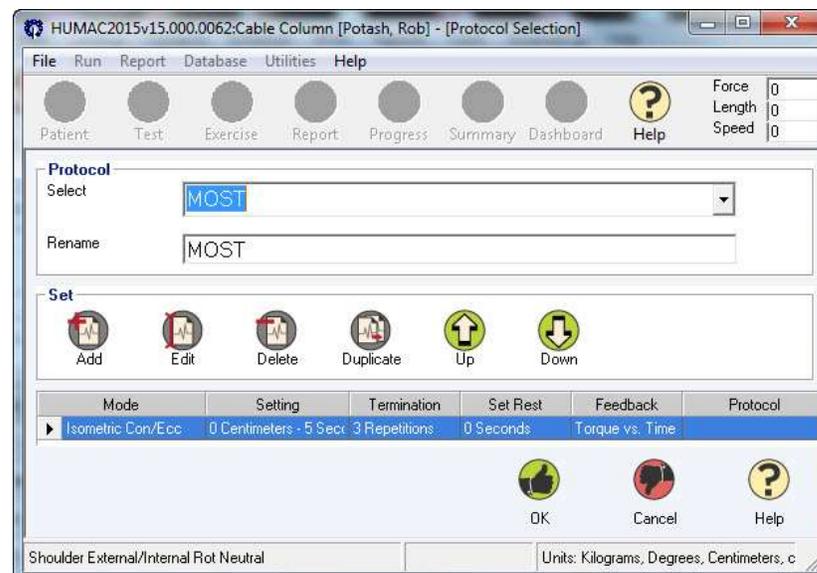
- From the main page select Test



- The next screen to appear is below:

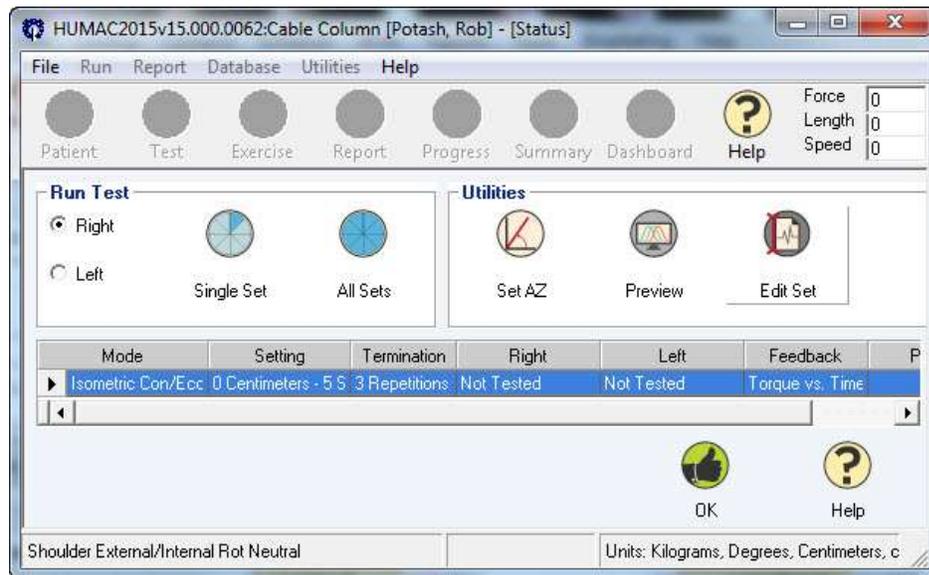


- Highlight Shoulder External/Internal Rot Neutral (this is the software setting for the strength test). Select OK.
- The next screen to appear is below:

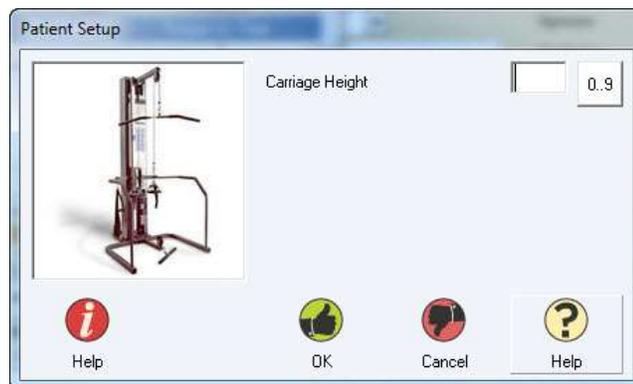


- The HUMAC will Display MOST Protocol. Press OK.

- The next screen to appear is below:



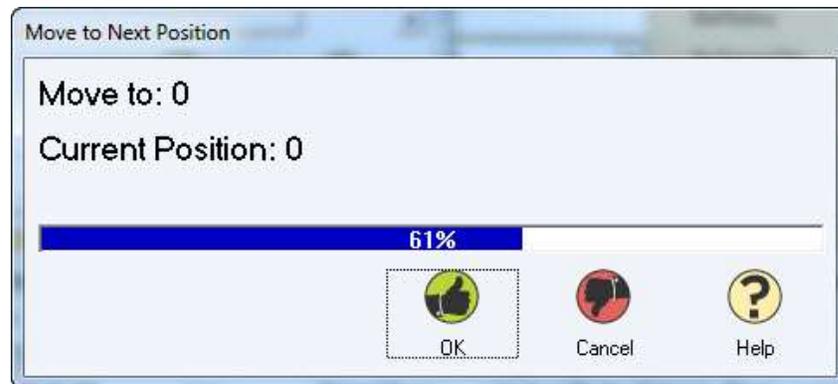
- Select Right Radio Button. Select Single Set.
- The next screen to appear is below:



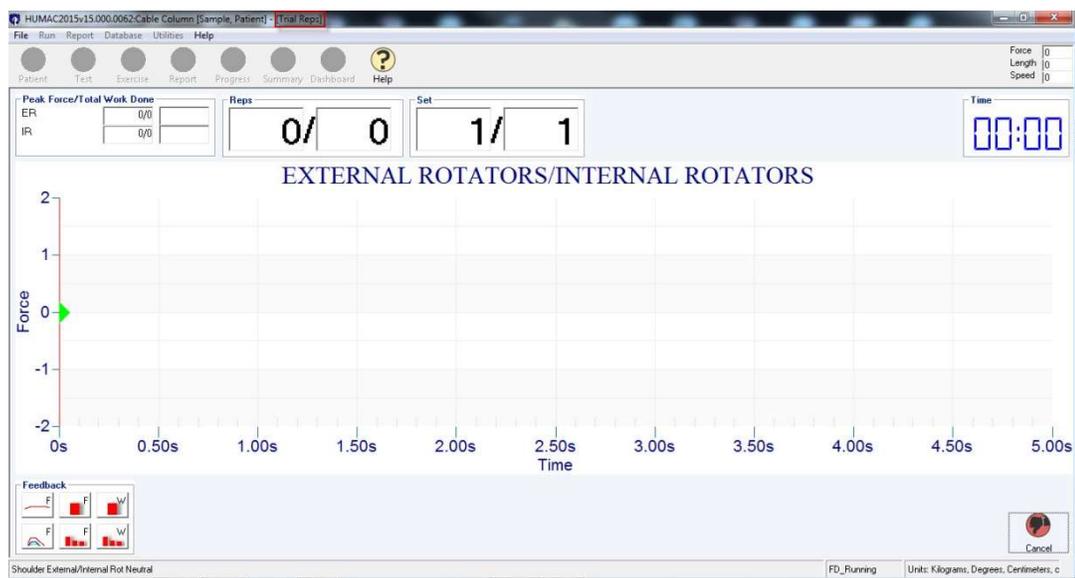
- Select OK.
- The next screen to appear is below:



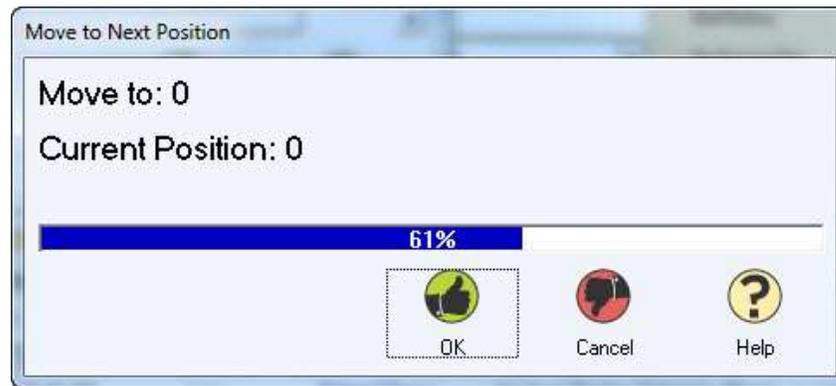
- Verify the participant is relaxing on the table, not moving or pushing out on the load cell
- Select OK.
- The next screen to appear is below:



- The next screen to appear is below:



- There are unlimited trial reps available to instruct Participant. Select Cancel when ready to start test.
- The next screen to appear is below. Let the bar decrease to 0%:



Note: the installation default a 5-second trial so that the entire 3-second muscle contraction is captured from beginning to end. This pre-programmed parameter should appear once a test is selected.

5.3.4 Explanation, demonstration and practice trials

The participant should now be correctly set up to begin testing the first side.

Explain the test procedure to the participant and have him/her practice abducting the limb against the load cell on the first side to be tested. Have the participant push against the load cell at ~50% effort for practice trials until he/she feels comfortable with the task.

Examiner positioning during the trials: while it is unlikely to move, for examiner safety reasons, do NOT stand with your body directly in line with the rod attached to the load cell or the bolster.

- **Script:** *“During this test you will push your leg out to the side, pushing as hard as you can. You will continue to push for about 3 seconds as I encourage you. First you’ll do a few practice trials, at about 50% effort to become accustomed to how it feels.*

When pushing, please straighten your knee and then push straight out to the side. Do not bend your knees or rotate your legs. Just keep your toes pointed up and push straight out to the side.”

Once you are comfortable, you'll do the test 3 times, without lifting your leg or your body."

"Do not hold your breath during the test. I'll tell you when to start and stop pushing. If you experience any pain, tell me and we will adjust or stop the test."

"Do you have any questions?"

"OK. Now let's do the practice push. Push out toward me into this device at about half effort. Ready, begin."

Note: If examiner notices that participant is digging their heels into the foot rest, explain to them:

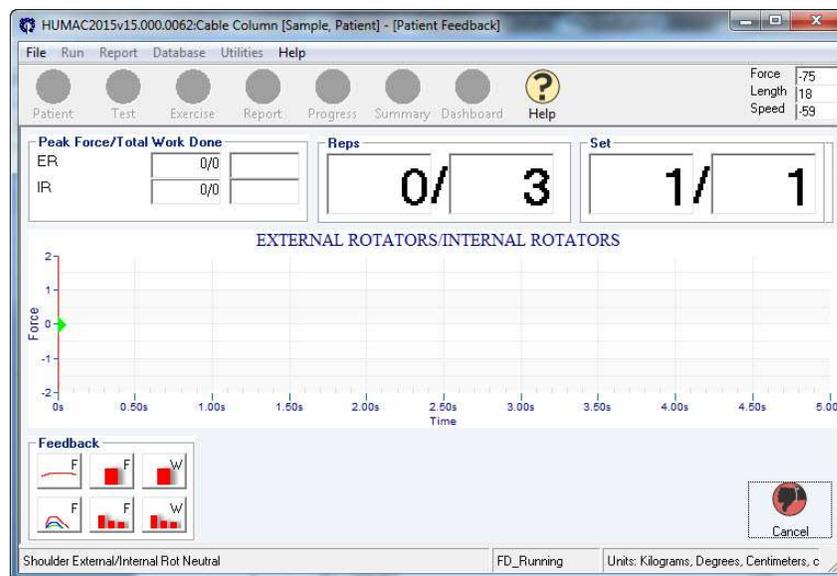
- **Script:** *"It is important not to dig your heels into the foot rest. If your knees are straight, then your heels might actually come off of the foot rest. This is a good thing."*

If the participant complains of pain during the practice, ask:

- **Script:** *"Does it hurt enough that you want to stop?"*

If the participant complains of pain during the practice trials, determine how severe the pain is and whether testing should continue. If the load cell interface, bolster and other devices touching the participant cannot be adjusted to make the participant comfortable, then discontinue testing that side and go on to test the other side.

- Once the participant has practiced and is comfortable with the testing procedure, tell her that she is now ready for the strength testing.



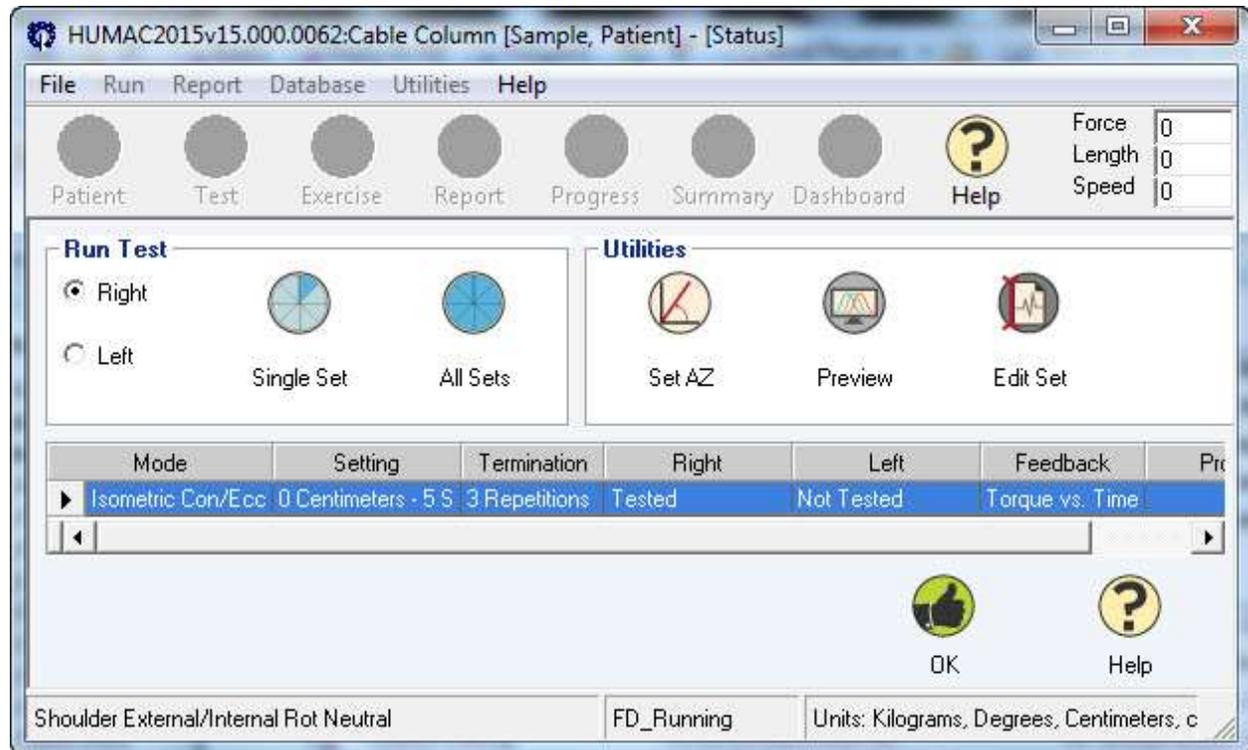
Staff Monitoring: During the testing, clinic staff should pay attention to the following:

- Legs should not be lifting off the table.

- Knees should not be bent when pushing.
 - Leg being tested should not be moving out to the side much either (if it is, the original positioning wasn't good and the test is not being conducted isometrically).
 - Leg should not be externally rotating (as that would test the hip flexors, rather than the abductors).
- Script: *“OK. Now we’re ready for the actual test. Do you have any questions before we begin? OK. This time you will do three repetitions with a rest period after each one. Remember that it is important for you to push as hard as you can on each test and not to lift your leg. You will have a break of at least 15 seconds between each test.”*
- “Are you ready for the first test? Begin. **Push! Push! Push! Push!** Great! Good effort! After you rest a moment we’ll do another repetition of the test on this side.”*
- “OK, are you ready to do another repetition? Great. Ready, Begin. **Push! Push! Push! Push!** Great! We will rest again and do one more repetition on this side.”*
- “OK, are you ready to do the last repetition on this side? Great. Ready, Begin. **Push! Push! Push! Push!** Great!”*
- Script (at the end of the three trials): *“Did pain during the exam affect your ability to do this test?”*

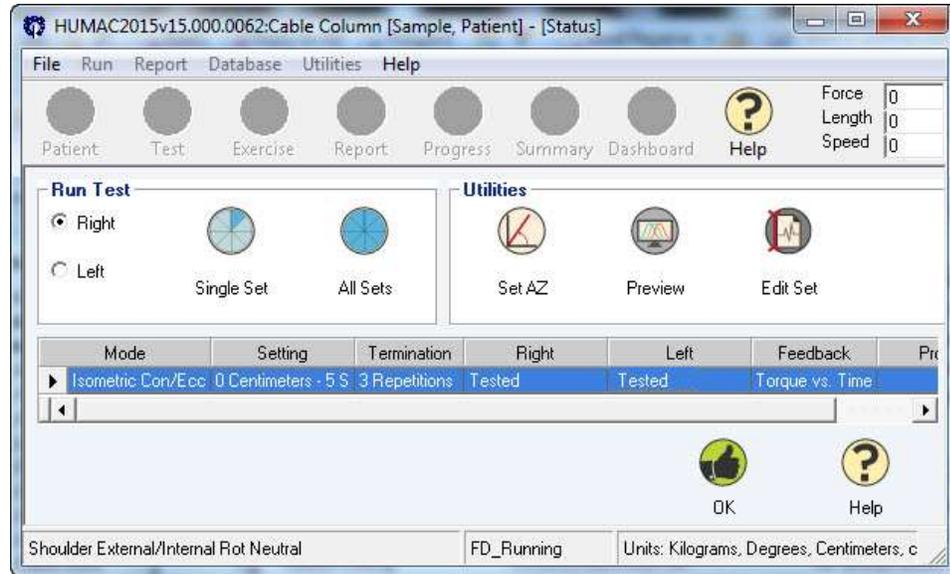
Record the participant’s answer on the data collection form.

- After the 3 repetition the next screen to appear is below:



The example Test Status Screen above shows the Right Side has been tested.

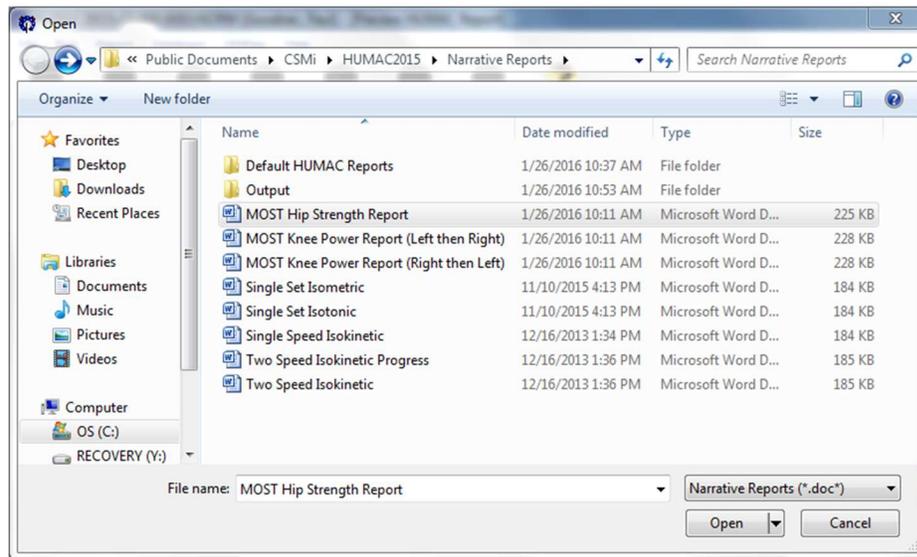
- To test the other side, follow the instructions beginning with #12 on Page 30:
 1. Slide the load cell and bolster away, loosen the clamps and remove them from the L piece.
 2. Then attach each of them to the positions for testing the second side.
- On the HUMAC screen:
 1. Select the radio button for the other side from HUMAC Test Status Screen
 2. Select Single Set - Repeat procedure performed for the first side
- Once both side have been tested the following screen will appear:



The Test Status screen shows both sides have been tested. Select OK

5.3.5 Results print out and report archiving

- Highlight the test that was just performed
- Click on the Preview button in the Print/Preview report block (see figure above)
- This will bring up a Narrative Report selection window as below
- The next screen to appear is below:



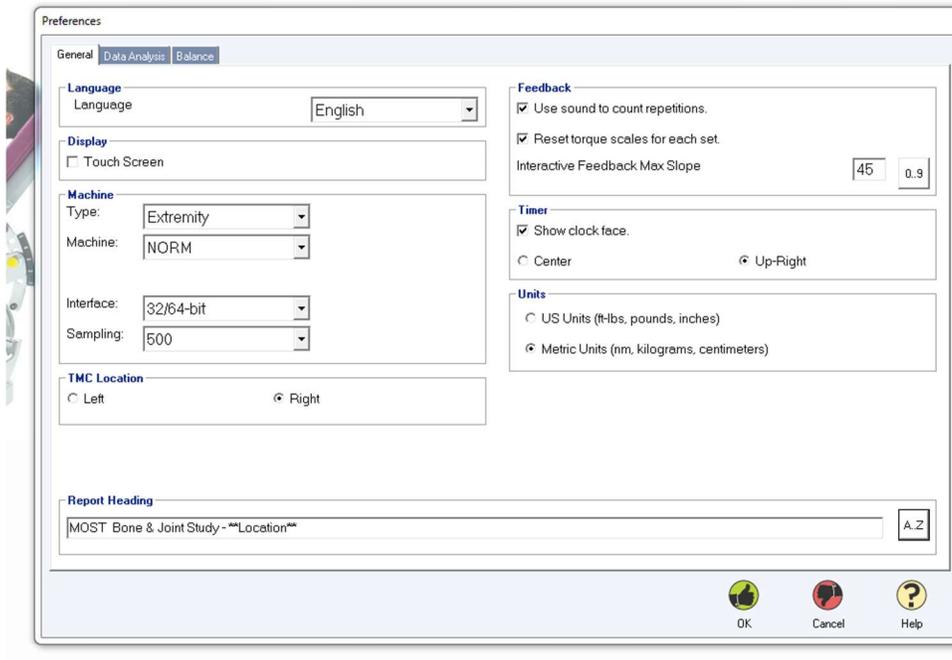
Ensure the most recent version of the “MOST Hip Strength Report.docx” is in Narrative Reports folder (C:\Users\Public\Documents\CSMi\HUMAC2015\Narrative Reports) and is named correctly (“MOST Hip Strength Report.docx”).

- Select the “MOST Hip Strength Report.docx”
- Microsoft Word will start and the MOST Report will appear on the screen with results from the exam pre-filled.
- Print the report and place in the participant’s clinic chart. Do not give report to participant.
- While the participant report is still open in MS Word, also save a separate electronic copy of the report.
 - In Word, go to File>Save As menu. A new window should open in the Narrative Reports folder.
 - Find and open the weekly folder (C:\HUMACNORM\YYYYMMDD) (see section 5.2.11 form more information), and then name the report “MOST Hip Strength Report MXnnnnn.docx” where X denotes the first letter of the clinic and nnnnn is the numerical part of the MOSTID, and save it. All of the reports for exams in the same week should go into that subfolder. The following week, create a new dated subfolder.

SET HUMAC NORM BACK TO ISOTONIC TEST

- After completing all the testing:
- Loosen screw and slide load cell away from leg.
- Loosen screw and slide bolster away from leg.
- Remove load cell and Bolster, making sure load cell wire is clear of the area.
- Remove table that was supporting the legs.
- Remove Velcro from over the pelvis.
- Assist patient to sit up (NOT roll over).
- Have patient slide forward.
- Raise back of table up to ~85.
- Patient should now be sitting comfortably. Allow patient a few seconds to accommodate to that position.
- Loosen screw and remove L / U pieces on each side. (Consider doing this in one step.)
- Rotate chair so that the patient is facing the door.
- Place step stool appropriately.
- Have patient stand up and step off step stool.
- Set the HUMAC 2015 software for the Isotonic Quadriceps Power test as follows:
 - Select File> Preferences> General Tab (see screenshot below)
 - Set Type = Extremity
 - Set Machine = NORM
 - Set Interface = USB2 32/64-bit

- Set Sampling = 500
- Verify that Units = Metric



The remaining Preferences and settings for the MOST protocols are set at the time of HUMAC 2015 installation and should not need to be changed. To verify, these settings are as follows:

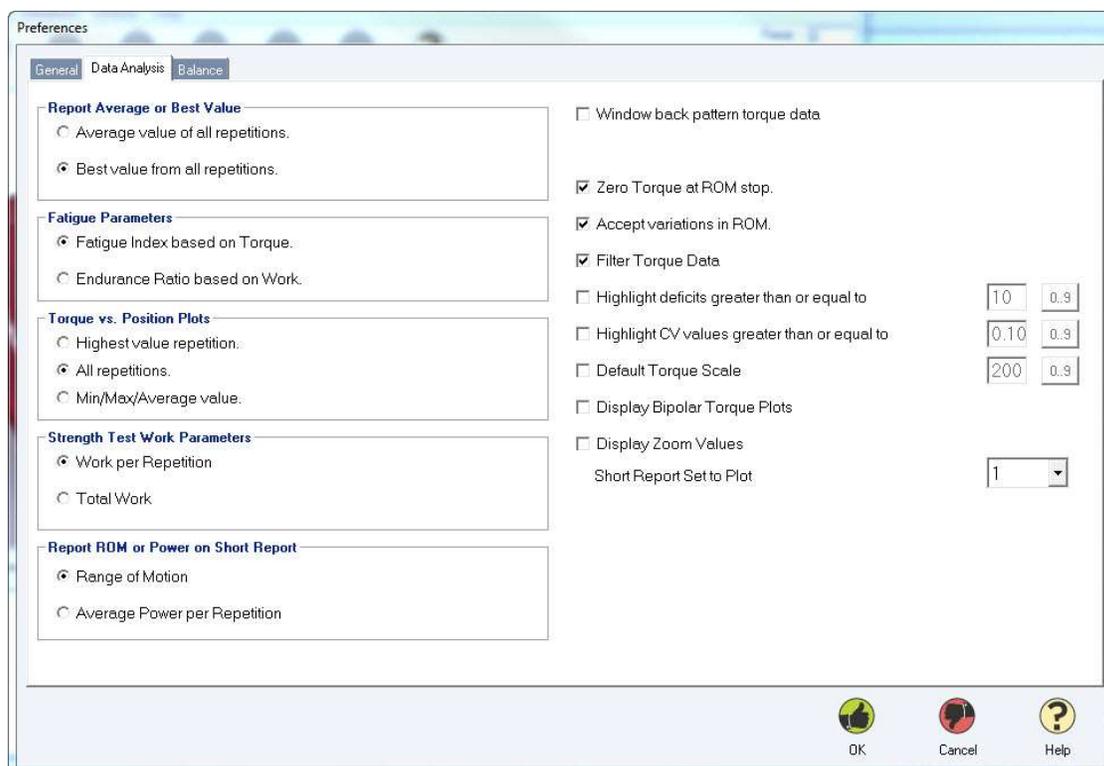
- Items on the **General Tab** (see screenshot above):

Field	Setting
Language	English
Display - Touch Screen	Off
Feedback - User sound to count repetitions	Off
Feedback - Reset torque scale for each set	Off
Feedback - Interactive Feedback (does not apply)	45
Timer - Show clock face	Checked
Location Button	Up-Right selected
Report Heading	MOST Bone & Joint Health Study - U of XXXX

- Items on the **Data Analysis Tab** (see screenshot below):

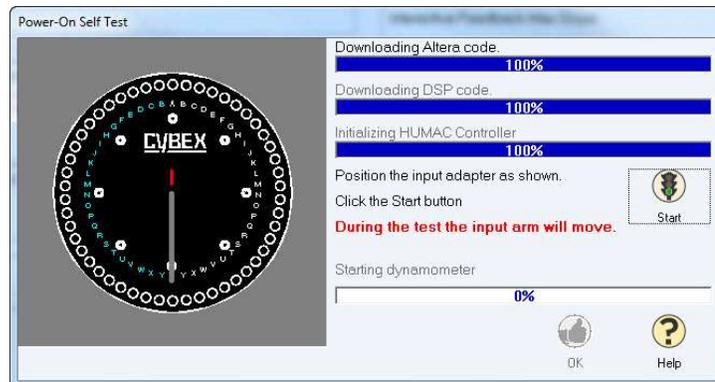
Field	Setting
Report Average or Best Value	Best Value from all repetitions
Fatigue Parameters (does not apply)	Fatigue Index based on Torque

Field	Setting
Torque vs. Position Plots	All Repetitions
Strength Test Work Parameters (does not apply)	Work per Repetition
Report ROM or Power on Short Report (does not apply)	Range of Motion
Window back pattern torque data	Off
Zero Torque at ROM Stop	On
Accept Variations in ROM	On
Filter Torque Data	On
Highlight deficits greater than or equal to	Off
Highlight CV values greater than or equal to	Off
Default Torque Scale	Off
Display Bipolar Torque Plots	Off
Display Zoom Values	Off
Short Report Set to Plot	1



- Click OK at the bottom of the screen (Green Thumbs Up sign)

- The Power-On Self Test screen will reappear because the servo motor needs to be turned back on and does so when you change to the NORM. Follow instructions in the window.



6. Alert values

There are no alert values. When the testing is completed, thank the participant.

7. Quality assurance

7.1 Training and certification

Quadriceps Power

The HUMAC NORM vendor, CSMi, provided on-site training at one or both field centers, covering basic machine operation and the fundamentals of testing, as well as study-specific procedures. Operators should practice on other staff members and themselves until reliable measurements are achieved. It is especially useful to practice on volunteers who are not knowledgeable about what to expect. Training should include:

- Observe measurement by experienced examiner
- Read manufacturer's user's guide and MOST OM with goal of understanding
 - the proper use of equipment
 - the proper calibration and adjustment of equipment
 - exclusions and safety considerations
 - detailed testing procedures
- Practice on colleagues and "naive" volunteers
- Attend training session

7.2 Certification requirements

Quadriceps Power

- Complete training requirements

- Recite exclusion criteria
- Demonstrate calibration and adjustment of HUMAC NORM
- Perform test on two volunteers under the observation of clinic QC officer or designated HUMAC NORM expert.

Hip Strength

- Complete training requirements
- Recite exclusion criteria
- Demonstrate calibration and adjustment of load cell
- Perform test on two volunteers under the observation of clinic QC officer or designated expert(s)

7.3 Quality assurance checklist

Quadriceps Power

- Know frequency of calibration and verification
- Exclusion questions asked from data collection form
- Blood pressure from participant results report checked to determine if testing contraindicated
- Recite two stopping rules
- Patient background information correctly entered on computer screen
- Correct test pattern and protocol entered on computer screen
- Identify warm-up exercises
- Locates femoral lateral epicondyle
- Participant positioning correctly determined
- Positioning parameters correctly entered on screen and data collection form
- Correct instructions given while demonstrating procedure
- Correct instructions given for practice trials
- Correct instructions given for 3 test trials
- Standard level of encouragement (motivation and feedback) offered to participant
- Key points from script stated and clearly delivered
- Results for extension and flexion correctly recorded on data form
- One page MOST report printed and placed in participant's file
- Reviews form for completeness
- Form correctly filled out
- Correctly saves a copy of the MOST Knee Power Report to the weekly folder
- Data archived and transferred properly

Hip Strength

- Exclusion questions asked from data collection form
- Blood pressure from participant results report checked to determine if testing contraindicated
- Recite two stopping rules
- Participant information correctly entered on computer screen
- Correct test pattern and protocol entered on computer screen
- Locates femoral lateral epicondyle
- Participant positioning correctly determined
- Correct instructions given while demonstrating procedure
- Correct instructions given for practice trial
- Correct instructions given for 3 test trials
- Standard level of encouragement (motivation and feedback) offered to participant
- Key points from script stated and clearly delivered
- Results correctly recorded on data form
- One page MOST report printed and placed in participant's file
- Reviews form for completeness
- Form correctly filled out
- Correctly saves a copy of the MOST Hip Strength Report to the weekly folder
- Data archived and transferred properly

8. Data collection form

Please see the Overview of the 144-month Follow-up Visit Operations Manual for an overview of the data collection forms, information on whether each form is in REDCap or TELEForm, and where the forms can be accessed on the study website.

Appendix 1 HUMAC NORM Calibration Procedure

Calibration

Calibration, in general, is a process for adjusting or "fine tuning" the accuracy of the gradations of a measurement system.

- The NORM System is capable of measuring from 0 to 500 ft-lbs (678 Nm.) of torque and attaining speed of up to 500 deg/sec.
- The weight calibration procedure makes use of the principle that *A quantity of weight on an input arm set to a specific, pre-determined length will generate a known amount of torque when it falls.*
- During the Torque calibration, a quantity of weight (100 lbs) is "dropped". The long adjustable arm is set to a specific length. The system is shown the amount of torque is should "read" when the specific quantity of weight is dropped.
- Following the weight-drop, the system adjusts its internal conversion factors.

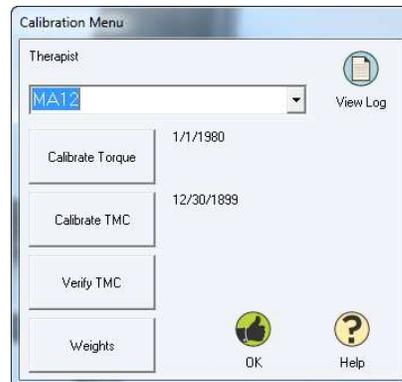
Initial calibration of the NORM System is performed by CSMI personnel during installation. Thereafter, to ensure its measurement accuracy, the NORM System should be calibrated monthly. Torque calibration should also be performed after any reinstallation of software, or anytime new or updated software is installed.

To begin the HUMAC calibration procedure, see menu at top of screen:



Pull down "Calibration" from the Utilities menu.

Select the Staff ID# in the space labeled "Therapist." You'll have to edit the Therapist list.



The HUMAC Calibration menu allows you to calibrate and verify the HUMAC NORM Torque.

Choose Calibrate Torque

Dynamometer Calibration Setup

The parts and accessories listed below are needed to perform the torque calibration.

- **The Calibration Weights:** Weights, totaling 100 lbs. are needed. Four 25-lb. weights are included with the NORM System. The calibration weights are certified at CSMi and their actual weights recorded on the side of each plate.
- **The Knee/Hip Adapter:** In the calibration process, this accessory will be connected directly to the dynamometer input arm and hold the specified weights.

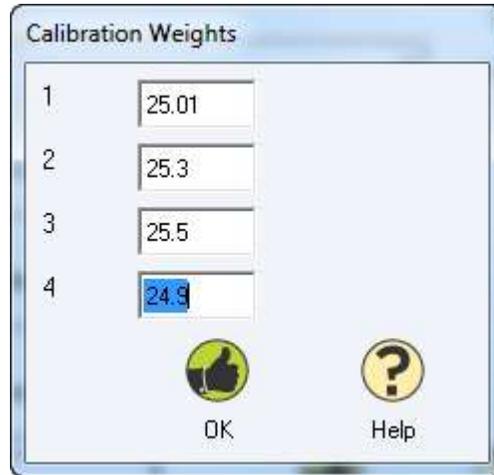
***Note:** The original CSMi/NORM dynamometer torque calibration procedure assumed a calibration torque of 150 ft-lbs, which ignores the torque of the input adapter. The actual value with the weights and input adapter is 154.5 ft-lbs. We suggest using the value of 154.5 ft-lbs which results in more accurate torque data reporting. Use the HUMAC Preferences form to select which calibration value you want to use.*

Calibration Weights

CSMi weights are weighed and their weights recorded directly on the weight. The CSMi weights have “CAP 25” etched on one side of each plate.

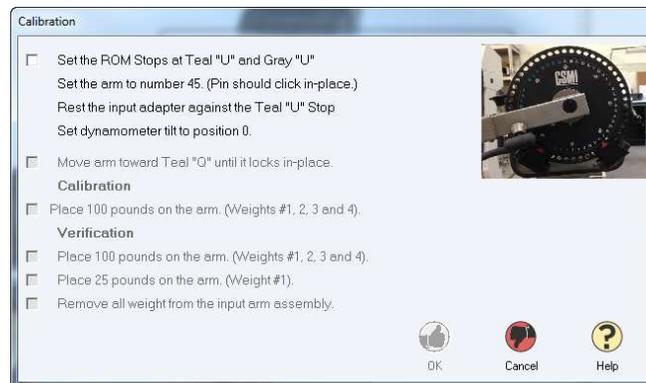
Entering the Weight Values

1. From the **Utilities** menu, select **Calibration**.
2. From the **Calibration** form, click the **Weights** button.
3. From the Calibration Weights form, enter the value written on the side of each weight in the corresponding field and click the OK button. ***Note:** When performing a Calibration or Verification with the CSMi weights, you should use the numbered weights as indicated on the HUMAC Screen.*

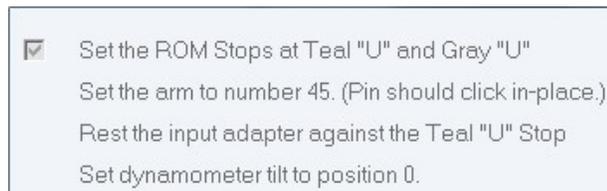


Select OK to return to calibration menu

From the **Calibration Menu**, click **Calibrate Torque**.



1. Setup the dynamometer for the calibration. Only the Knee/Hip Adapter should be installed on the dynamometer input arm. Rest the input adapter against (above) the Teal “U” stop. Click the box when the dynamometer is positioned correctly.



2. Raise the input adapter toward the Teal “Q” stop until the arm locks into isometric mode, then click the box.

Move arm toward Teal "Q" until it locks in-place.

- Carefully load 100 pounds of weight onto the Knee/Hip adapter. After the weights are loaded, make sure the monitor and keyboard are clear of the dynamometer, stand clear of the dynamometer input arm, and check the box. The arm will go through one cycle from the Teal "Q" to the Gray "Q" and back to the Teal "Q".

Calibration

Place 100 pounds on the arm. (Weights #1, 2, 3 and 4).

- After the arm reaches the Teal "Q" it will stop moving. The calibration is now complete. Click the Checkbox to begin the verification.

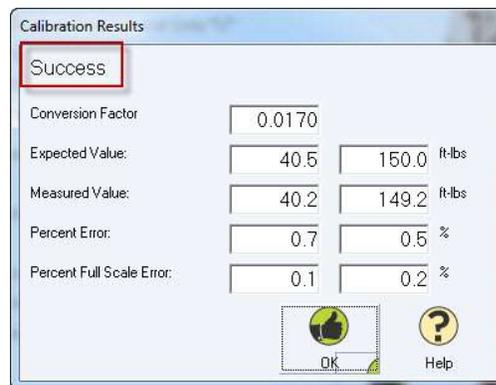
Verification

Place 100 pounds on the arm. (Weights #1, 2, 3 and 4).

- The arm will go through one cycle from the Teal "Q" to the Gray "Q" and back to the Teal "Q". After the arm reaches the Teal "Q" it will stop moving. Remove weights #2, 3, and 4 and click the Checkbox to begin the 25 pound verification.

Place 25 pounds on the arm. (Weight #1).

- Remove all weights from the input arm. Select OK. The HUMAC will display the verification results for the CW and CCW directions.

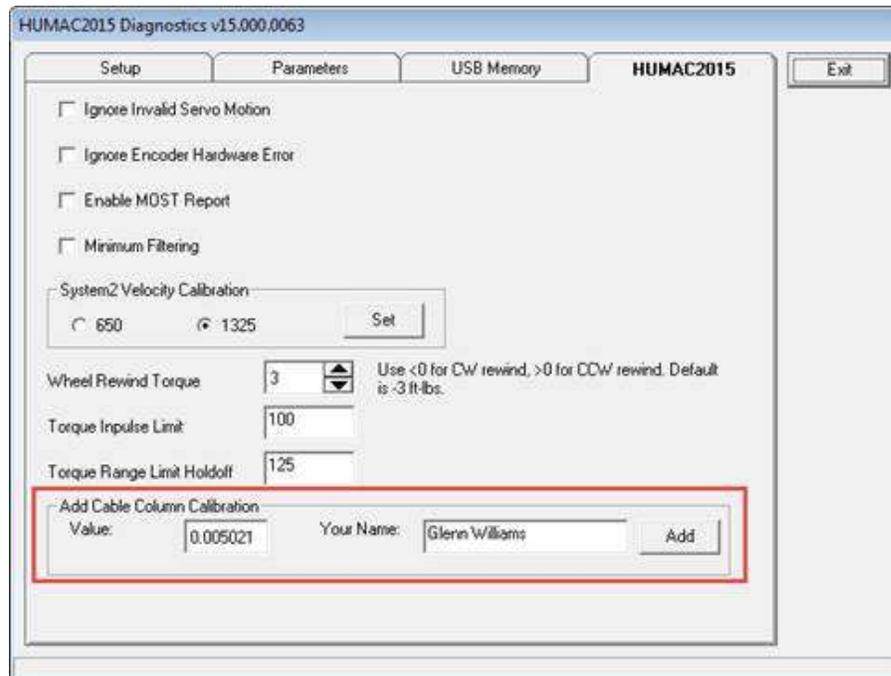


Note: If the HUMAC reports Verification Error, you should repeat the calibration and verification procedures. If the HUMAC reports an error a second time, contact CSMI Technical Support.

You've completed the calibrations. These will automatically be recorded on the Calibration Log.

Appendix 2 Hip Strength Calibration Procedure

The hip strength calibration procedure is performed once, and should not need to be repeated.



However, if the circumstance arises where re-calibration is necessary please follow the instructions below.



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 Stoughton, MA 02072 USA
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 (Web) www.csmisolutions.com

1. MOST Force Sensor Calibration

- 1.1. Start the HUMAC Program.
- 1.2. From the **FILE, PREFERENCES** menu, select the following:

- 1.3. Click the **OK** button to save your settings.
- 1.4. From the **UTILITIES** menu, select **SENSOR TEST**.
- 1.5. Record the **TORQUE** value with no weight on the sensor. This is the **OFFSET** value.
- 1.6. Place 100 pounds on the sensor (or the highest weight you are comfortable placing on it) and record the torque value. This is the **MAX** value.
- 1.7. Compute the **GAIN** as $(WEIGHT) / (MAX-OFFSET)$.
- 1.8. Exit the HUMAC Program.
- 1.9. From the **START** menu, select **HUMAC2015, UTILITIES, SETTINGS**.
- 1.10. Enter **"CSMIDIAG"** as the password and click the **OK** button.
- 1.11. Enter the **GAIN, OFFSET**, and **YOUR NAME**.
- 1.12. Click the **OK** button.

Appendix 3 Transferring Data to the SF Coordinating Center

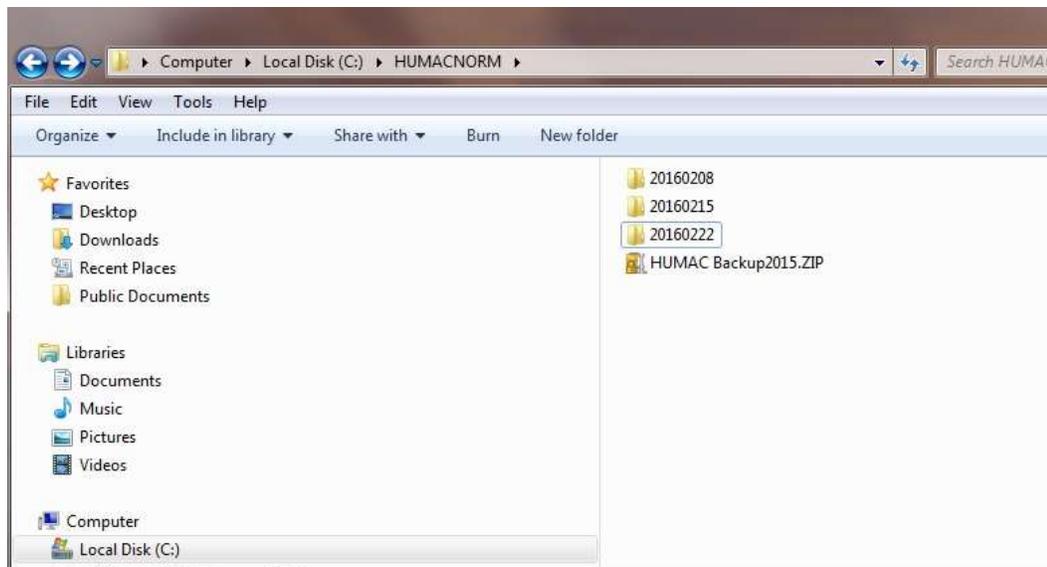
Transferring the HUMAC NORM data to the SF Coordinating Center (SFCC) should occur automatically once the operator saves the desired files to the specified “back up” folder. There is separate software installed which will automatically detect new files and subfolders in the “back up” folder and will automatically send the new or newly changed files and subfolders to the SFCC.

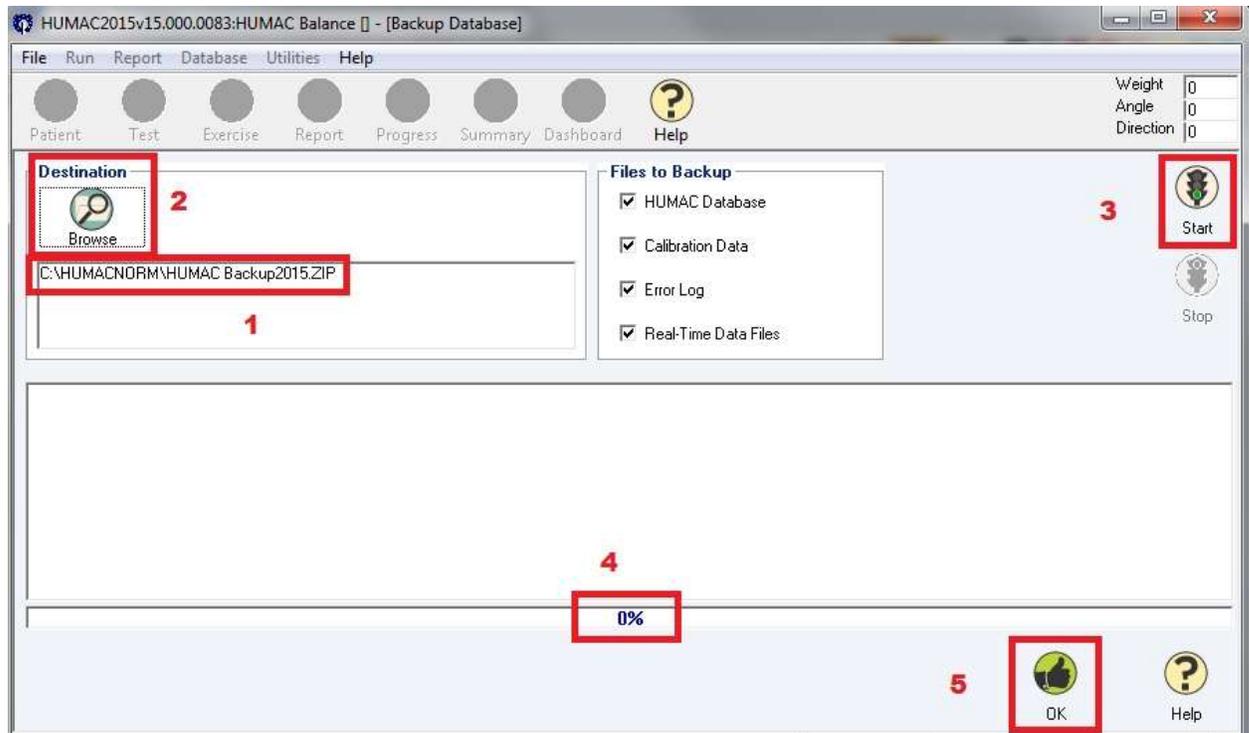
Note: The default name of the backup file for the HUMAC NORM software will be “**HUMAC backup2015.zip.**”

1. Backup procedure

Before your very first backup of the database for MOST, create the following folder structure on the computer’s C drive: C:\HUMACNORM\. This will be the main back up folder for HUMAC data. Follow this back up procedure at the end of each week.

Note: the C:\HUMACNORM folder is also where the weekly dated subfolders are located and where the participant report Word documents will be saved. See screenshot below for an example of what C:\HUMACNORM should look like, including the subfolder structure.





To begin the backup procedure, from the main HUMAC screen, navigate to File>Database>Backup and you will see the screen above.

1. Check the file path indicated by the red #1 in the screenshot and verify that it says C:\HUMACNORM\HUMAC Backup2015.zip.
2. If #1 shows a different file path, then click the Browse button (#2 above) to open a new window to select the C:\HUMACNORM folder.
3. Press the Start button (#3) to begin the back-up process. Depending on the size of the database, it may take a moment before anything appears to happen.
4. When the Status Bar (#4) reaches 100% and a “Back up complete” message appears, the backup is finished.
5. To exit the Backup Database window, click the OK button (#5). You will need to exit the Backup Database window before you can close the HUMAC software.

Do not rename or move the “HUMAC backup2015.zip” file from C:\HUMACNORM. You will be creating a new back up zip file that replaces the old file every week.

2. Secure data transfers to UCSF

At the end of the day where any sessions have been recorded the operator will need to check that the computer is left switched on (but log off or “lock” the screen) and verify that files have synchronized to the UCSF ftp server that day. This is done by clicking on an icon in the bottom right of the screen. See section 4 of the MOST Secure Data Transfer Operations Manual for more details.

Appendix 4 CSMi Service Request Procedure



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CSMi Service Request Procedure

As part of our continuous improvement initiative, CSMi has recently implemented a new support ticketing system. Submitting a service request is a simple process that ensures your issue is resolved quickly and correctly. Each request is given a tracking number and all communication for that request stored in one location and accessible at any time.

To initiate a service request, visit our website (www.csmisolutions.com) and click on the orange **REQUEST SERVICE** button in the top right corner.

You will be taken to the main CSMi Support page. **Note:** *If this is your first time logging a service request, you need to register with a user name and password. This is done by clicking the **SIGNUP** link. If you have already registered, click **LOGIN** link.*

Now that you have logged in, you can:

- Submit a new service ticket by clicking the **NEW SUPPORT TICKET** link.
- View/Update an existing by clicking the **CHECK TICKET STATUS** link.

When creating a new ticket, please provide specific, detailed information about your issue. You can also attach files using the **ATTACH A FILE** link at the bottom of the response area.

After a support ticket has been issued or updated, you will receive an email confirmation verifying your request along with your support ticket number.

You can review an existing ticket with either of the following methods:

- Click the hyperlink in the response e-mail (<https://csmisolutions.freshdesk.com/helpdesk...>)
- Login directly to the ticket system.

You can respond to an existing ticket with either of the following methods:

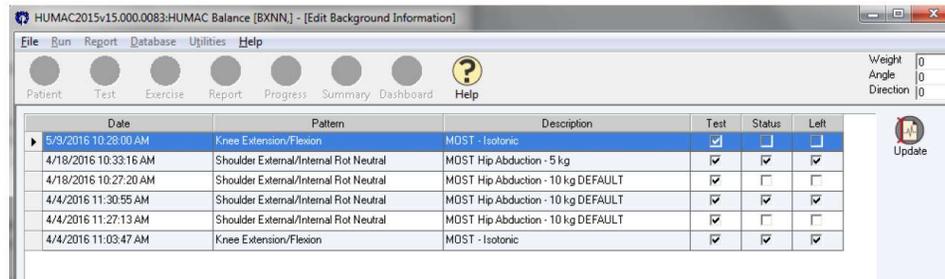
- Open the ticket in the system, scroll to the bottom of the page and click the **REPLY** link.
- Reply directly to the e-mail and your response will automatically be added to the ticket.

Appendix 5 Modifying Data in HUMAC Database for Quad Power/Hip Strength Exam

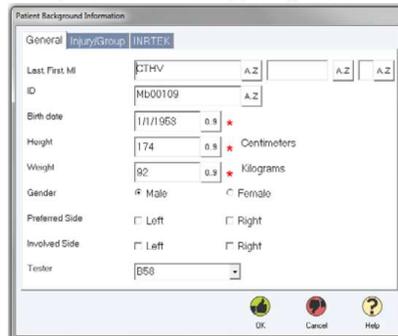
Modifying Data in HUMAC Database for Quad Power/Hip Strength Exam

For the quadriceps power and hip strength exam, the participant characteristics and scores are saved in the HUMAC software. In cases where the clinic must access an existing record to modify participant characteristics such as gender, height, or weight, the following procedure should be used.

1. Start the HUMAC software and click on the Patient icon in the upper right of the software
2. Find the respective participant record by either scrolling through the participant list, or using the acrostic in the Search box.
3. When the correct participant record is found, click the record in the listing to highlight it, then click the OK icon in lower right corner. You will return to the main screen.
4. Go to the Database menu at the top, and then select Edit Background. You should then see a screen like below.



5. **Important Note:** Participant characteristics like height and weight are stored independently with each hip or knee exam, so you must modify these characteristics in every exam that needs correction.
6. In the list of exams, select the first exam you want to modify, click to highlight, and then click the Update icon in the upper right corner. You will see a screen like below.



Last updated: 11/10/2016

7. Make the desired changes, making sure to enter new values using the appropriate units displayed on the screen. Click the OK icon to close the window.
8. Repeat this procedure for as many exams as you want to modify for this participant.
9. When you have finished with this participant, from the screen shown in step 4, click the OK icon to close this participant record.
10. After correcting an exam record, create new quad power and/or hip strength reports for each corrected exam. **Note:** creating knee reports after the actual exam is finished works differently than when the report is created during the actual exam. If you are creating new reports after the exam is finished, the knee report template will only display results for one knee, but not the other. So, knee exams that you have corrected, create a separate report for each knee using the two report template files. To differentiate the knees, you may leave in the “(left then right)” or “(right then left)” in the file names.
 - a. If the corrected values appear in the report, then the change was successfully saved.
 - b. If the incorrect values still appear, then the changes were not saved, or the wrong exam was modified. Double-check what you did and correct.
11. After checking the report, save the new report in the appropriate weekly sub-folder (i.e. the weekly folder for the actual exam date you just modified) and add the suffix “update” in the file name (for example, MOST Knee Power Report (left then right) MX00000_update.docx).
 - a. The new report files should transfer automatically because they are brand new files.
 - b. Leave the original reports as they are in the subfolder.
12. If you have additional participant records to modify, go back to step 2 and repeat this procedure for each participant.

Last updated: 11/10/2016