

## HEEL-TO-KNEE LENGTH

### 1 Background and Rationale

The purpose of the heel-to-knee (knee height) measure is to be able to get an estimate of standing height for those people whose total height has diminished due to spinal curvature. Unlike stature, knee height changes little with increasing age yet is highly correlated with stature. Sex and age specific formulas have been developed which compute standing height from knee height.

### 2 Definitions

2.1 Knee height The distance from the sole of the foot to the anterior surface of the thigh with the ankle and knee each flexed to a 90 degree angle.

### 2.2 Equipment/Supplies

! Heel-to-knee caliper calibrated in centimeters

### 3 Methods

Knee height is measured with a sliding caliper on the left leg of each participant just before the ECG measurements, after the participant is supine on the examination table.

O Heel to knee length measurement is taken using the following procedure:

- ! Participant wears the CHS sweat suit, but no shoes.
- ! Push the sweat pants up above the knee.
- ! With the ankle and knee in 90 degrees of flexion, place one blade of a sliding, broad-blade caliper under the left heel; place the other blade over the anterior surface of the left thigh above the femoral condyles and about 2 inches proximal to the patella.
- ! Hold the shaft of the caliper parallel to the tibial shaft and apply pressure to compress the tissue.
- ! Record the measurement on the form to the nearest 0.1 cm.

## BIOELECTRIC IMPEDANCE MEASUREMENT

## Background and Rationale

Several studies have suggested a relationship between body composition, in particular obesity, and cardiovascular diseases. While other anthropometric variables can be used to assess relative overweight, bioelectric impedance is used to directly measure body composition by measuring the resistance and reactance to a tiny electrical current which is introduced into the body. **No sensation is felt by the participant.** Values for resistance and reactance can then be used to calculate percent body fat, lean body mass and percent body water (this will be done in the computer).

Estimation of body composition by measurement of bioelectric impedance is based on the principle that lean tissue and body fat differ considerably in electrical properties. Lean tissue, because of its greater content of water and electrolytes, is a good electrical conductor, whereas fat is relatively anhydrous and impedes an electrical current. Since lean tissue contains most of the water and electrolytes in the body, the more lean tissue a person has, the less will be the electrical resistance.

## Definitions

- O Bioelectric Impedance Bioelectric impedance (Z), measured in ohms, is the square root of the sum of the squares of resistance (R) and reactance ( $X_c$ ), or

$$Z^2 = R^2 + X_c^2$$

It is frequency-dependent.

- O Resistance Bioelectric resistance is the pure opposition of a biological conductor to the flow of an alternating electric current.
- O Reactance Reactance is the resistive effect due to capacitance produced by tissue interfaces and cell membranes. Capacitance, or the storage of electric charge by a condenser, causes the current to lag behind the voltage, creating a phase shift. This shift is quantified geometrically as the angular transformation of the ratio of reactance ( $X_c$ ) to resistance (R), or the phase angle ( $\Phi$ ). Phase angle and reactance are a function of cell membrane capacitance and represent the intracellular mass.

### Equipment/Supplies

- ! Danninger Medical "TVI-10 Body Composition Analyzer" (includes participant leads)
- ! ECG electrodes
- ! 9-volt batteries
- ! Scissors
- ! Cardboard (about 20" by 8)

## Methods

Bioelectric Impedance is measured in the ECG station, while the participant is supine on the examination table, wearing the CHS examination suit.

- O Remove stockings or socks from the right foot.
- O Attach two self-sticking ECG electrodes to the right hand and two to the right foot as follows:
  - O Hand electrodes
    - ! Red electrode (source electrode) placed just above the knuckles of the right hand (below the phalangeal-metacarpal joint, in the middle of the dorsal side of the hand).
    - ! Black electrode (detector electrode) placed on an imaginary line from the protruding bone of the wrist (the posterior side of the right wrist midline).
  - O Foot electrodes
    - ! Red electrode (source electrode) placed just above the toes of the right foot (below the transverse (metatarsal) arch on the superior side of the right foot).
    - ! Black electrode (detector electrode) placed on an imaginary line between the protruding ankle bone (ventrally across the medial ankle bone of the right ankle with the foot semi-flexed).
- O Cut electrodes in half.
- O Attach the red and black leads to the TVI-10 and to the electrodes.
- O Make sure the participant is relaxed.
- O Make sure that arms and legs are spread slightly and not touching any part of the body.
  - ! When a participant is obese so that thighs are touching each other, place the cardboard between the thighs.
- O To switch the Body Composition Analyzer on
  - ! Press "ENTER" and "7" simultaneously, switch the instrument on; continue holding these two keys until the following message appears

"IMPEDANCE METER MODE ENABLED  
<Press any key>"

! Release the keys.

! Press any key. A tone will sound and measurements will begin.

O Record the resistance and the reactance onto the form.

O Turn the instrument off.

## 7 **Equipment Calibration**

Each morning the Quality Control Officer or a proxy performs the following "Check Calibration Procedure"

O Attach the red and black leads to the TVI-10.

O Attach the red and black hand-leads to the test point marked "HAND CALIB. POINT".

O Attach the red and black foot-leads to the test point marked "FOOT CALIB.POINT".

O To turn on the machine:

! Press "ENTER" and "7" simultaneously, switch the instrument on; continue holding these two keys until the following message appears:

"IMPEDANCE METER MODE ENABLED  
<Press any key>"

! Release the keys.

O Press any key. A tone will sound and testing will begin.  
Test results should read

Resistance =  $511.0 \pm 5.1$

Reactance = 0.0

O When these values are not obtained, the Quality Control Officer calls the Danninger Medical Company for assistance. Enter all calibration procedures and results into a log book.

## **RESTING 12-LEAD ELECTROCARDIOGRAM**

## 8 **Background and Purpose**

The baseline ECG is one measure used to define the incidence of CHD in the elderly. Measurements made from the baseline ECG can also be used to investigate the relationship of ECG findings to the development of CHD and stroke. Follow-up ECGs will be used to trace the evolution of ECG findings.

All 12 lead ECGs will be sent for computer analysis by phone modem to the ECG Reading Center, EPICORE, in Edmonton.

## 9 Definitions and Alerts

- 9.1 ECG wave measurements and classification will follow the measurement and classification guidelines specified in the Minnesota Code Manual of Electrocardiographic Findings, Ronald J. Prineas, Richard S. Crow and Henry Blackburn, John Wright - PSG Inc, 1982. These ECG wave measurements and classification data are produced at the ECG Reading Center in Edmonton. In addition, clinical diagnostic ECG interpretation data are produced by MAC/PC cardiograph at the time of ECG acquisition and printed on the hard copy produced.
- 9.1.1 Any ECG classified as "Abnormal ECG" by the MAC/PC cardiograph requires further review by the technician: The program quite frequently classifies ECGs as abnormal in situations which do not require any special acute medical attention. Such conditions include reference to an old myocardial infarction and ventricular conduction defects, abnormal P or QRS axis, non-specific ST-T abnormalities, etc. Whenever the overall classification is "abnormal ECG" (the last printed diagnostic statement), the technician must verify whether any of the preceding statements include any serious arrhythmias or reference to myocardial injury or ischemia due to possible recent myocardial infarction.
- 9.1.2 The following statements qualify as **ALERTS**:
- Heart rate less than 50 or over 100
  - Atrial Fibrillation
  - Atrial Flutter
  - Wolf-Parkinson White (WPW) or Ventricular Pre-Excitation
  - Idioventricular Rhythm
  - Ventricular Tachycardia
  - Complete Heart Block
  - Acute Pericarditis
  - Any statement including reference to **INJURY** or **ISCHEMIA**.

These statements will be described in detail with illustrations during the training sessions and in the ECG training manual.

## 9.2 Equipment

- ! Two Marquette Electronics Inc. MAC/PC Personal Cardiographs
- ! Two sets electrode adapters (banana plug to electrode clip)
- ! Two Dal Squares
- ! Recorder paper
- ! Adult disposable electrodes
- ! Exam table
- ! Mattress pad
- ! Tables/carts for ECG recorder
- ! Isopropyl alcohol
- ! Gauze squares
- ! Felt pens
- ! Hypoallergenic tape

## 10 **Methods**

A standard 12-lead resting supine electrocardiogram is recorded for each participant at the Surveillance Clinic Visit. A 12-lead resting ECG is obtained consisting of 10 seconds of data from leads I, II, and V1-V6, sampled simultaneously. (Leads III, AVR, AVL and AVF are calculated from leads I and II.)

### 10.1 Electrode Position Measuring and Marking

To assure comparability of data, the following uniform procedure for electrode placement and skin preparation must be followed:

- O Instruct the participant to lie down on the recording bed with shoulders straight and arms relaxed at the sides. Open the gown to mark electrode positions.
- O If the participant is female, keep the gown draped over her chest as much as possible.
- O Ask the participant to avoid movements which may cause errors in marking the electrode locations, but encourage participant to converse with the technician.
- O Mark the ten electrode positions with a felt tip pen on the supine participant.
- O Wipe the general area of each electrode position with a sterile alcohol prep to remove skin oil and perspiration.
- O Electrode positioning in women:
  - ! Determine electrode positions in women with large, pendulous breasts in relation to the anatomic points described below.

! Electrodes may be placed on top of the breast in the correct position.

## O Electrode Placement

! Electrode V2 Use right hand to locate the sternal angle and second left rib between the index and middle fingers. Count down to the fourth rib and identify the fourth intercostal space below it. Locate V2 in the fourth intercostal space immediately to the left of the sternal border.

! Electrode V1 Locate electrode V1 in the fourth intercostal space at the right sternal border. This should be at the same level as V2 and immediately to the right of the sternum.

! Electrode V6 Locate the V6 electrode in the mid-axilla using the following procedure.

- To locate the E Point: Identify the fifth rib and fifth intercostal space below V2 and follow the fifth intercostal space to its intersection with the midclavicular line. Project this intersection point horizontally to the midsternal line and mark the E point on the lower sternum.
- Move the participant's left elbow away from his/her body.
- Start in the left axilla and move down to make a mid-axillary mark approximately horizontal to the E point.
- Place the Dal-Square firmly against the chest on a horizontal plane from the E point to the mid-axillary point. (Figure 1)
- Ensure the Dal-Square is parallel. The mid-axillary point may need to be moved up or down to ensure this.
- When breast tissue is over the V6 area, mark the V6 location on the breast. Do not attempt to move the breast in order to mark V6 on the chest wall.

! Electrode V4 Locate the V4 electrode using the following procedure.

- Keep the Dal-Square in place on the participant's chest.
- Record the distance between the E point and point '0' on the Dal-Square on the paper form or into the computer data base.
- Record the distance from point '0' to the V6 mark on the form or into the computer data base.

- Calculate the difference between the two recorded numbers, subtracting the smaller number from the larger.
  - Locate the value from above calculation on the Dal-Square starting at point '0' and moving toward the E point. Follow the projection of the angled line on the Dal-Square to the chest surface with the pencil and place the V4 mark.
- ! Electrode V3 Use a flexible, graduated straight edge to mark a point midway between the locations of V2 and V4.
- ! Electrode V5 Mark the location of electrode V5 midway between the locations of V4 and V6. These points should be linear.
- ! Limb Leads
- Locate electrode LL on the inside left ankle.
  - Locate electrode RL on the inside right ankle.
  - Locate electrode LA on the inside left wrist.
  - Locate electrode RA on the inside right wrist.

## 10.2 Skin Preparation and Electrode Application

- O Briskly rub each chest and limb location with alcohol and gauze.
  - O Let alcohol dry completely before proceeding, as alcohol may dissolve silver chloride.
  - O Disposable Electrodes
- ! Ask the participant to lie down on the bed.
- ! Place a small amount of electrode paste on each location.
- NOTE: Additional amounts may be needed for participants with increased amounts of chest hair. However, excessive amounts increase the possibility of contact between two adjacent sites.
- ! When placing each electrode, massage it in a small circular motion to maximize the pre-gel contact with the skin but avoid overlap of gel from one electrode to the next.
- ! Center the four limb electrodes on the inside of the wrist or ankle with the tab for the clip pointing toward the head.



NOTE: If participant has an amputated limb, the electrode may be placed further up on the limb, but the electrodes on both limbs must be at the same point on the limb.

- ! Center the six chest electrodes on the chest markings (with the tabs pointing down when using disposable electrodes). Do not allow the electrodes to overlap or touch each other.
- ! Clip the appropriate leadwire to each electrode. Make sure the leads are tight.
- ! Do not pull or jerk tangled wires. To untangle wires, disconnect lead wires from electrodes.
- ! Double check to make sure all leads are correctly located and attached.
- ! Ask the participant to relax, breathe normally and to remain still (without talking) while the tracing is recorded.
- ! Reassure participant that the procedure will not hurt.
- O Disposable electrodes Disposable electrodes are packaged ten per card. Use alligator clips to connect the "banana" plug from the MAC/PC leadwire to the disposable electrode.

### 10.3 **Recording the 12-LEAD ECG**

- O Ensure that the correct Field Center site number is set up in the cart setup menu. This is especially important when a new or recently serviced cart is used since the default settings for all carts is site #1.

Before recording any ECGs for the day:

- O Ensure the MAC/PC has been fully charged as described in the Operators Guide.
- O Each ECG is stored in memory until it is deleted.
  - ! From Main Menu press "PAT" (F1) key.
  - ! Enter the Participant's I.D., first name, last name.
  - ! Press the "STOP" symbol to bypass other participant information and return to the main menu.
  - ! To start taking the 12-lead ECG, tell the participant to relax and keep still, then press the RECORD ECG key (see page 3-10 of the Operator's Guide).

- ! The machine will display message "Acquiring Data" and the left side of the display will show a count.
- ! When there are technical problems the display will show which lead is involved and will keep counting until it gets 10 seconds of good data.
  - Check electrode contacts and leadwires, then check the display again.
  - When the display counts past 75, push the STOP key and remove the electrodes (discard disposable electrodes).
  - Prepare the electrode sites as discussed in Section 10.2 Skin Preparation and Electrode Application, and follow the protocol to relocate the electrodes.
  - Press "Record ECG".
  - The computer will prompt: "Enter a new participant or press record".
  - Press "Record ECG" to start the ECG.
- ! The computer will print the ECG after it has acquired 10 seconds of good data.

#### 10.4 Local Records

- O File the original ECG record at the Field Center. Multiple copies, when required, can be generated from the machine's memory before the ECG is deleted.
- O Verify participant identification information.

When errors are found, take corrective action as described under section 11.4 below.

#### 10.5 ECG Form

Specific pieces of information from the ECG reading are to be recorded onto the ECG paper form.

- O Question 1 - Chest square readings

Record the following measurements as instructed in Section 10.1 above (electrode position measuring and marking):

! 0-E Measurement: Record the distance between the E point and point '0' on the Dal-Square.

! 0-V6 Measurement: Record the distance between point '0' to the V6 mark.

O Question 2 - Results of ECG

! Check 'Done' if the ECG has been completed successfully.

! Check 'Incomplete' if the ECG was initiated but not completed successfully.

! Check 'Not Done' if the ECG was not done or attempted for any reason.

O Question 3 - Reason ECG incomplete or not done.

! Record the reason for an incomplete ECG or if not done:

- 1 - software malfunction
- 2 - hardware malfunction or lack of supplies
- 3 - insufficient time available or room not available
- 4 - examinee refused or uncooperative
- 5 - examinee medically excluded by staff for safety
- 6 - examinee unable to physically cooperate
- 7 - other, specify (please record reason)

O Information from ECG record

The following data from the ECG computer-generated report should be recorded on the ECG form:

! Heart rate in beats per minute

! An indication in the text portion of the computer printout that any of the following conditions are present. (Check 'Yes' if present, check 'No' if not present):

- atrial fibrillation
- atrial flutter
- Wolf-Parkinson White (WPW) or ventricular pre-excitation
- idioventricular rhythm
- ventricular tachycardia
- complete heart block
- acute pericarditis
- any reference to 'injury' or 'ischemia'

NOTE: Do not interpret the ECG tracing yourself. Use ONLY the information in the text section of the computer printout.

NOTE: The presence of an infarct does not constitute an alert.

O Question 6 - Performance-based measures: Is the participant able to do the following?

Five performance-based functions have been identified for assessment during the ECG procedure. For each of the following measures, record if the function was performed unaided by the participant by checking 'Yes'. "Able" is defined as doing the action independently without help from another person. The participant is allowed to use an assisting device (e.g., cane) if needed. The technician may not in any way support the participant; he/she may, however, "contact spot" for safety. To contact spot means to remain close to the participant, keep hands out to "catch" the participant if necessary, and be there if the participant is unable to transfer independently. The participant may rest his/her hand on the technician for balance, but may not use the technician for support (i.e., no weight put on technician).

- ! Remove shoes - The ability to remove shoes is assessed here, regardless of the type of shoe worn. If the participant elects to keep shoes on during the ECG procedures, ask him/her to demonstrate the ability to take shoes off and put back on.
- ! Transfer off chair - The participant is able to sit down and get up from a chair independently. If the participant does not sit on a chair during the ECG procedures, ask the participant to demonstrate this for you.
- ! Get onto table - The participant is able to move him/herself onto the table independently for the ECG.
- ! Get off table - the participant is able to get down off the table after the ECG is completed.
- ! Put on shoes - The participant is able to put his/her shoes back on unaided after removing them. (See 'remove shoes' above).

For all of the above measurements, the data entry screen will show a code for "don't know/not assessed" (although it is not on the form). If for any reason the ECG is not done, please ask the participant to demonstrate the performance-based measurements listed here. If these are refused, indicate on the form that these were not assessed; the data entry technician can then code in the appropriate code when keying the data.

## 11 Transmission to Edmonton

The MAC/PC can hold a maximum of 11 to 15 ECGs in its memory. When the memory is full new ECGs cannot be stored until previous ones are deleted. To ensure a margin of error in the event of transmission problems, the ECGs must be transmitted to Edmonton on a daily basis.

The two receiving units in Edmonton are always in the receiving mode. In the event that both lines are busy and you get a "no transmission" message, try again in 15-30 minutes. If there are continuing problems, phone Loralee Kuryvial at (403) 492-6295 or 492-6433.

### 11.1 Data Transmission

- O Program the phone number for the Edmonton receiving port [(403) 492-6032 or 492-6045] in the setup menu of the electrocardiograph. See Operators Guide for details.
- O Make sure the phone line is connected by moving the jack from your regular phone to the port in the back of the MAC/PC and listening for the dial tone.

### 11.2 Print Directory

- O From the main menu press the F1 key under the word "INFO" to show the system functions.
- O Press F1 - STORAGE to display the storage functions.
- O Press F2 - DIRECTORY to print the directory.
- O Press F2 - DIRECTORY again to get a second copy.
- O Mail one copy of directory to:

Patty Montague  
EPICORE  
Heritage Medical Research Building - Room 213  
University of Alberta  
Edmonton, Alberta  
Canada T6G 2S2

### 11.3 To complete transmission

- O Display the MAIN MENU  
Press F1 - INFO to display system functions.
- O Press F1 - STORAGE to display storage functions.
- O Press F5 - MORE to show the additional storage functions.
- O Press F1 - TRANSMIT to show the transmission display.
- O Press F1 - PHONE. (The Edmonton number should not need to be re-entered).
- O Press ENTER.

- ! Participant data for the first ECG will be displayed.
- ! Press F4 - YES key to select all ECGs for transmission. NOTE: To re-transmit individual ECGs, press F1 - YES key.
- ! The machine will dial the phone and transmit each ECG.
- ! Watch the display during transmission to verify that identification codes are on the Directory List. If a problem occurs, the ECG involved can be identified.
- ! After the last ECG to be transmitted is displayed, a message indicating the number of ECGs that were transmitted vs. the number you selected to transmit is displayed.
  - When differences are noted, identify which ECG(s) were not transmitted using the Directory List.

#### 11.4 Participant Information Edits

- O Display the MAIN MENU.
- O Press F1 - INFO to display system functions.
- O Press F1 - STORAGE to display storage functions.
- O Press F5 - MORE.
- O Press F2 - EDIT.
- O Press F2 - PATIENT DATA.
- O Press ENTER.
- O Press F2 - NO when no changes are to be made for the current ECG; or,
- O Press F1 - YES followed by ENTER to make changes for the currently displayed participant information.
  - ! To erase unwanted characters:
    - Use the BACKSPACE key to delete character(s).
    - Enter the correct character(s).
  - ! To proceed to the next ID field:
    - Press ENTER
    - Make corrections as required.
  - ! To continue to the next participant:
    - Press ENTER
    - Make corrections as required.
- O To save the changes:
  - ! Press the SHIFT and F1 keys together.
  - ! Press F1 - PRINT REPORT
  - ! Press ENTER.
  - ! Print a directory to be sure the corrections have been made.
    - Note: Any corrected ECG moves to the bottom of the directory. This is useful when all ECGs except the corrected one should be deleted from the file.

## 11.5 Deleting Stored ECGs

When the MAC/PC becomes full, new ECGs cannot be stored until some or all of the stored ECGs are deleted. Before deleting the previous day's recordings, the operator must ensure that transmission to Edmonton was complete. The ECG Reading Center sends an E-mail message every morning Monday through Friday before 8 am EST to each Field Center that has transmitted ECG's up to the time of the message. This message lists the ID information for each ECG received by Edmonton from the respective sites. It is important for each Field Center to check the E-mail for messages daily to verify that all ECG's transmitted by the Field Center were received and acknowledged by the ECG Reading Center.

To delete ECG(s)

- O Display the MAIN MENU.
- O Press F1 - INFO to display system functions.
- O Press F1 - STORAGE key to display storage functions.
- O Press F4 - DELETE to display delete options.
  - Note: The following instructions do not delete the ECGs but only flag those cases which are to be deleted.
  - ! To delete the current ECG only:
    - Press F1 - DELETE.
  - ! To save current ECG only:
    - Press F2 - SAVE.
  - ! To save current and all subsequent ECGs:
    - Press F3 - SAVE.
- O The display will then ask whether flagged ECGs should be deleted.
  - ! Press F1 - YES to delete or
  - ! Press F2 - NO to cancel the delete procedure and return to the Storage Functions display.

## 12 **Quality Control**

Each Field Center will re-transmit some ECGs every year to Edmonton as part of external quality control procedures. The Coordinating Center will inform the sites as to the selection of these cases and times for transmission. Quality Control "Participant ID Numbers" will be assigned by the Coordinating Center via the quality control person at each site.

All ECGs stored in the MAC/PC remain there until deleted by the operator. The procedures for modifying Participant ID numbers are outlined in the MAC/PC Operator's Guide and above.

Re-transmit Quality Control ECG(s) using the steps above.

