

## **3.8.4 Arterial Pulse Wave**

### **Sonographer Manual**

#### **Ultrasound Reading Center, New England Medical Center**

##### **1.0 Overview of the Arterial Pulse Wave Protocol**

The MESA sonographers will acquire the arterial pulse wave data and the Ultrasound Reading Center will supervise the acquisition and compile it. Analyses will follow. The arterial pulse wave data will be acquired with the Hypertension Diagnostics, Inc. PulseWave CR-2000 device. PulseWave CR-2000 devices were sent to each of the six MESA field centers the week of May 1, 2000. The MESA computers that will be connected to this device were delivered to the field centers the week of May 8, 2000. HDI has provided null modem cables and specific directions on how to connect the pulse wave device to the computer.

The PulseWave CR-2000 obtains blood pressure measurements and arterial pulse waveforms with an oscillometric blood pressure module, and an arterial pulse pressure sensor. The blood pressure measurements are taken from the upper left arm and the pulse pressure sensor is positioned on the right wrist.

The arterial pulse wave data is initially and temporarily stored on the PulseWave CR-2000. A maximum of 30 records can be stored in the device. Subsequent records are deleted: first in, first out. At the end of each working day, the new MESA data is uploaded to the MESA computer. Each Thursday data is transmitted to the Ultrasound Reading Center where it will be processed.

##### **1.1 Introduction to the Arterial Pulse Wave Protocol**

###### **Training and Certification**

[removed for LAD purposes] from HDI presented a lecture and provided a brief opportunity for hands-on practice on April 28, 2000 as part of the central MESA Ultrasound Reading Center Sonographer Training. Arterial pulse wave technician training includes reading the MESA Arterial Pulse Wave MOP (this document), viewing the HDI/PulseWave-CR2000 video, reading the HDI/PulseWave CR-2000 manual and performing 10 pulse wave procedures. Training is complete, and the technician will be certified, upon the URC's review of the data from the 10 procedures.

As part of the initial training at the start of MESA, each sonographer will repeat the entire arterial pulse wave procedure 3 times on the same subject, performing the 3 procedures within a 15-30 minute period with no smoking or food/ medication intake by subject

between procedures. Print the three “Cardiovascular Profile” reports from the instrument on the standardized forms that HDI has provided for these tests. Annotate the reports with the acronym “MESA”, and the Technician’s MESA ID. Fax the reports with a cover sheet to [removed for LAD purposes].

HDI will provide feedback and comments to improve data quality.

To be certified to perform the pulse wave procedure in MESA, technicians must complete the following:

- View the HDI PulseWave cardiovascular profiling device video.
- Read the HDI PulseWave manual
- Read the MESA Arterial Pulse Wave MOP
- Perform 10 pulse wave procedures and successfully transmit the procedure data to the URC for a quality review.

The sonographer will be responsible for operating the device and collecting the arterial pulse waveform data from each MESA participant. At some field centers, the data manager will be responsible for uploading data to the PC, archiving it and transmitting it to the URC.

## **1.2 Exclusions**

- Participants with a diagnosis of heart failure, arrhythmia, or cardiac valve abnormality (aortic stenosis or mitral regurgitation)
- Participant unwilling or unable to have wrist stabilizer on his right wrist
- If the movement at the monitoring location of the sensor of the participant’s wrist cannot be controlled
- Participants who have skin or vascular lesions at the sites where the sensor, wrist stabilizer or restraint straps must be positioned.
- Participants with capillary fragility or excessive tendency to bruise
- Participants who are non-ambulatory.
- Participants who weigh less than 50 or more than 500 pounds.

## **1.3 Positioning: Participant, Blood Pressure Cuff, Wrist Stabilizer, and Acoustic Sensor**

The participant is supine during the arterial pulse wave exam and encouraged to relax, uncross legs, not talk, breathe normally, not move, and not fall asleep. Use only the blood pressure cuffs supplied with the PulseWave CR-2000. Using other cuffs may result in

inaccurate measurements.

To obtain pulse pressure data it is necessary to place the subject's wrist in the wrist stabilizer. Have the subject hold out his right arm, point his thumb upward and extend his fingers. Wrap the wide strap around the subject's forearm and the narrow strap around his fingers.

The sensor is positioned on the area of maximum radial artery pulsation. The maximum pulsation is typically adjacent to thumb in the location between the distal, lateral bony prominence of the right radius bone (styloid process) and tendons medial to the same. Adjusting the hold-down pressure optimizes the pressure waveform.

Note that the pulse pressure waveform sweep will not start until after the first set of blood pressure measurements have been taken.

#### **1.4 Anatomical Site of Interest**

The sensor is placed on the area of maximum radial artery pulsation. Palpate the area at the base of the subject's thumb where the pulse can be felt at against the underlying bone. Mark the location with a water soluble felt tip pen. Typically this spot is about two centimeters from the base of the thumb (towards the elbow).

Once the area of maximum pulsation has been marked, the Sensor Holding and Positioning device is placed on the right wrist. The device is strapped to the wrist such that the rubber feet are parallel to the radial artery and the sensor is directly over the marked area of maximum pulsation. Position the sensor on the skin by turning the knob. After it is touching the skin the sensor will require one to three additional turns to begin the display of the pressure waveform.

#### **1.5 Arterial Pulse Wave Equipment**

The following equipment is necessary for the Arterial Pulse Wave protocol.

<b>Item</b>	<b>Note</b>
HDI PulseWave CR-2000 Research CardioVascular Profiling Instrument	The device has a touch sensitive screen, keep air vents clear to dissipate heat.
Arterial Pulse Pressure Sensor	Piezoelectric transducer within a metal canister. Positioned on radial artery to obtain pressure waveform.
Sensor Holding and Positioning Device	Holds and positions transducer, is adjustable in three dimensions
Wrist Stabilizer	Rigid plastic material to position and immobilize participant's wrist, held on with Velcro straps.

Blood Pressure Cuffs Green – small Blue – regular Red – large	Use the regular (Blue) cuff for all but extreme MESA participants.
Cords/Cables packaged with the HDI instrument	Power cord – main power cord  Arterial Pulse Pressure Sensor – connects pulse pressure sensor to device  Blood pressure cuff hose – connects blood pressure hose to the rear panel of the device  Printer power cord – power is provided to printer through the device  Parallel printer data cable – connects the printer to the device
Computer	Upload data to computer by the end of each day. Transmit data by e-mail via a computer connected to the internet.
Printer – a printer has been provided by HDI to print “Research CardioVascular Profile” reports	<b>These reports will not be printed for MESA participants.</b> However, the capability to print is valuable both for training and troubleshooting.

## 1.6 Initial Signal Adjustment

**Note:** Items in this document that refer to CR-2000 menu options and commands that are indicated in bold and are enclosed in “< ... >” marks. For example, <**START**>.

The pulse pressure waveform sweep will not start until after the first set of blood pressure measurements have been taken.

When the wrist stabilizer and pulse sensor is in position, confirm that the blood pressure cuff is properly positioned on the subject’s left arm. The sensor and the blood pressure cuff should be at about the same level as the subject’s heart.

Encourage the subject to relax, breathe normally, not to cross legs, not to talk, and to remain awake. Tell the subject that repeated blood pressure measurements will be taken.

The technician can then repeat the blood pressure measurement by selecting <**START**> CUFF, which will give the subject time to relax and a chance to get accustomed to the blood pressure cuff inflation. Alternatively the technician can select <**START RECORD**> which causes a repeat blood pressure followed by the recording of the pulse pressure waveform for 30 seconds.

## 1.7 Signal Optimization

When the subject has the wrist stabilizer, sensor and blood pressure cuff in position and is supine, comfortable, relaxed and breathing normally, the operator observes the waveform sweeping across the display screen. The sensor hold-down pressure can be increased by slowly, turning it down. After each adjustment wait three complete signal sweeps for the signal stabilize.

The Relative Signal Strength is displayed as an aid to assist in signal optimization. The higher the Relative Signal Strength, the better the arterial waveform data will be. It has been suggested by HDI that the signal strength be at least 12. More likely ranges for signal strength is from 30 to 50. If an adjustment does not improve or decreases the signal strength, return the sensor to the previous position.

## 1.8 Data Collection

### Measurement Summary

Turn on the HDI device  
Wait for it to start-up. This takes a few minutes

The display screen is touch sensitive. To select an option or a data record, touch the screen on the appropriate place to initiate action.

After start-up, agree to licensing agreement by selecting **<AGREE>**. If you don't agree the machine won't work so you no choice.

### The Main Menu

The Main Menu screen has four options

1. **<Perform Cardiovascular Profile>**
2. **<Review Stored Records>**
3. **<Measure Blood Pressure>**
4. **<Update Instrument Settings>**

Verify that the correct date and time are displayed in the upper right hand corner of the display. If the date or time is not correct. Select **<Update Instrument Settings>** to correct the date and time.

To begin the process for a new participant select **<Perform Cardiovascular Profile>**.

A demographics entry screen with a list of fields that must be entered now appears. The information is entered using the alphabetical touch-screen keyboard displayed in the bottom half of the screen. The letters and numbers that are available for entry into each field are highlighted. After completing the entry for one field, move to the next by selecting **<Next Selection>**. When all the information has been entered and checked,

proceed by selecting <Next Screen>.

Field	Enter	Note
Research Subject ID:	Participant's MESA ID followed by a space and the sonographer's MESA Technician ID	Example: [removed for LAD purposes]
First Name	Sonographer's Initials	
Middle Name	Leave blank	
Last Name	Leave blank	
Gender	M for Male or F for Female	
Birth date	Format is DD MMM YYYY	Example: 15 Dec 1963
Weight	Pounds	
Height	Inches	

When all the necessary fields have been completed select <Next Screen>. The next screen includes a pulse pressure display window, blood pressure and pulse rate measurements and four buttons.

1. <Start Cuff>
2. <Start Record>
3. <Report>
4. <Main Menu>

Select <Start Cuff> to initiate a blood pressure measurement and the display of the arterial pulse signal. Adjust the sensor to optimize the relative signal strength. When the signal strength is optimized and the signal appears to be clean and stable select <Start Record>. Another blood pressure measurement will be made and then the acquisition of the arterial pulse wave form will begin.

When the acquisition is finished, select <Report>. <Report> will cause the data to be save to the device and start the cardiac output and elasticity calculations. Selecting <Main Menu> at this point will cause the loss of data.

The report screen displays the Research Subjects Cardiovascular Profile. Included in the display are the blood pressure, pulse pressure, pulse rate, and cardiac output and elasticity calculations. The buttons on the report screen are

1. <Transmit Results>
2. <Repeat Profile>
3. <Print Report>
4. <Main Menu>

If the computer is ready to accept the data, select <**Transmit Results**>. If not then either get the computer ready by starting up HyperTerminal and selecting Transfer → Capture Text or select <**Main Menu**> to start a new participant.

## **1.9 Transferring Data from the HDI/Pulse Wave CR-2000 to a Computer**

### **Computer Directory Structure**

It will be necessary for each field center to keep the computer to which the arterial pulse wave data is uploaded well organized. The sonographer or field center data manager will create the following directory structure on the MESA Ultrasound PC.

C:\ArterialPulseWave\Test

Will contain data from non-MESA test cases

C:\ArterialPulseWave\MESAPilot

Will contain data from MESA Pilot cases

C:\ArterialPulseWave\MESANewData

Will contain the current week's MESA participant data

C:\ArterialPulseWave\MESAArchive

Will contain all previous weeks' MESA participant data

The data files will be transferred from the HDI device to the Ultrasound computer at the end of every working day. The HDI device stores a maximum of 30 records. The first record saved is the first record that is deleted. Records cannot be deleted from the HDI device.

There are several options for transferring the pulse wave data from the PulseWave CR-2000 to the computer. It can be sent as one file per participant or it can be sent as a cumulative data that contains the data for multiple participants.

### **One Participant per File**

The MESA arterial pulse wave file naming convention is

**[removed for LAD purposes]**

Repeat pulse wave data can be indicated with the addition of a “\_2”, “\_3” and so on added to the end of the file name.

### **Multiple Files per Participant**

The HDI data to computer transmission procedure can be worked into the protocol

routine. Following this procedure will improve efficiency by eliminating the need to transmit the HDI data to the computer at the end of the day. The computer must be set up in the morning, left on and for the sake of efficiency HyperTerminal kept open.

Capture all data onto computer into one data file each day.  
At start of day start up

CR 2000 Hyperterminal  
From top menu select **Transfer → Capture Text**  
Browse to appropriate folder  
Name file according to the following format

MPW9YYMMDD.txt

where,

M stands for MESA Pulse Wave

9 is the field center number

YY is the year

MM is the month

DD is the day

For example arterial waveform data collected at the University of Minnesota on July 23, 2000 would be captured into a file named, “MPW6000723.txt”

The computer is now ready to accept data transmitted to it from the HDI CR 2000 device. Run the procedure on the participant. After <**Report**> select the <**Transmit Results**> button. Data will be displayed on the HyperTerminal window as it streams into the computer.

### **1.10 Data Transmission to the Ultrasound Reading Center**

Data will be transmitted to the Ultrasound Reading Center on a weekly basis. The field center Data Manager will be responsible for copying the data from the MESA Ultrasound computer and transmitting it. The data should be transmitted each Thursday. Call or e-mail the Ultrasound Reading Center if for any reason data cannot or will not be sent on a particular Thursday.

Transfer individual files as e-mail attachments to Laurie Funk (lrcfunk@iw1.net).

Data should be sent as e-mail attachments with the body of the e-mail message containing the following information: field center, number of arterial pulse wave files and the names of the pulse wave files. The Subject should be MESA PW Data – *Center Number Center Name*.

During the actual MESA exam cycle sonographers will e-mail the URC data files on Thursday of each week. Copies of all the data files are to be kept at the field center.

Before transmitting data to the URC copy the data files from the directory C:\PulseWave\MESANewData to a floppy disk.

Move all files raw data files and the archive file that are in the directory C:\PulseWave\MESANewData to C:\ArterialPulseWave\MESAArchive.

Bring floppy to MESA 1 computer.  
Copy the files to a temporary space such as C:\Temp

Send the files as an attachment to [lrcfunk@iw1.net](mailto:lrcfunk@iw1.net) along with the following information

- Field Center Number
- Field Center Number
- Number of pulse wave data files in archive
- List of participant ID's whose data is being transmitted

If the sonographers or data manager prefer, data can be sent to the URC as WinZip file archives instead of individual files. Archive files should be named according to the following naming convention

MPWXYMMDD.zip  
where,

MPW stands for MESA Pulse Wave  
X = field center number  
YY = last two digits of the year  
MM = month with preceding zeros: January = 01, Feb = 02, ..... Dec = 12  
DD = day of the month with preceding zeros

### **1.11 Data Quality**

The quality of the waveform is determined by the consistent presence of characteristic features:

- Steep rise from diastole to a distinctive systolic peak
- Prominent dicrotic notch
- Smooth and gradual decline of the diastolic decay curve

### **1.12 MESA Alert Sonographer Response to High Blood Pressure**

**The sonographer is to report blood pressure alerts to the clinic coordinator immediately without indicating a concern to the participant.**

Alert levels requiring immediate referral for MESA patients are:

Immediate: Systolic > 200 mmHg or Diastolic > 120 mmHg

Alert levels requiring referral within one week are:

Urgent: Systolic > 180 mmHg or Diastolic > 110 mmHg