

## 3.5.2 Seated Blood Pressure

### I. BACKGROUND AND PURPOSE

Blood pressure (BP) level is a major risk factor for coronary heart disease, congestive heart failure, and stroke. Heart rate reflects autonomic nervous system function and cardiovascular fitness. The measured BP level is subject to biological and observer variability. The purpose of a specific measurement protocol, or training and certifications of technicians, and of ongoing quality control is to minimize variability due to known exogenous factors and to reduce imprecision and biases in measurement.

The main advantages of the Dinamap<sup>®</sup> automated device are accuracy comparable to manual mercury sphygmomanometry, with reduced potential for observer biases and less demand on research assistants in terms of training and effort in data collection. The available data that describes the accuracy of the Dinamap<sup>®</sup> and other oscillometric BP devices are reviewed in Appendix A.

### II. MATERIALS AND EQUIPMENT

- Dinamap<sup>®</sup> automated blood pressure device (Dinamap Monitor Pro 100<sup>®</sup>, which includes printer paper, power cable, and power converter.)
- Blood pressure cuffs in a variety of sizes (Dura-cuf Adult Assortment Pack<sup>®</sup> [#2699]).
- Measuring tape (for arm circumference).
- Watch or stop watch (to time five-minute rest and resting heart rate).
- Hand calculator (to average 2<sup>nd</sup> and 3<sup>rd</sup> BP readings).
- Copy of Critikon<sup>®</sup> chart for choosing correct BP cuff size (see Table 2).
- Information sheet on interpretation of BP from JNC VI (see Table 1).
- Resting Heart Rate/Blood Pressure Form.

### III. DEFINITIONS

1. Sphygmomanometry: Measurement of blood pressure.
2. Oscillometric device: Method for measuring blood pressure that relies on the oscillation or fluctuation in arterial pressure generated by the cardiac cycle and transmitted to an inflated blood pressure cuff overlying an artery. This method differs from the auscultatory method, which relies on audible changes over an artery during deflation of an inflated cuff.

### IV. CLASSIFICATION OF THE PARTICIPANT'S BLOOD PRESSURE WITHIN THE JNC VI CATEGORIES AND CRITERIA FOR ALERTS AND REFERRALS

The 1993 Report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure (JNC VI) defines categories of blood pressure and recommends follow-up according to the following criteria:

**Table 1. Classification of BP in Adults Aged 18 Years or Older\*.**

BP Category	SBP (mm Hg)		DPB (mm Hg)	Action
Optimal	<120	and	<80	Recheck in 2 years
Normal	<130	and	<85	Recheck in 2 years
High-normal	130–139	or	85–89	Recheck in 1 year
Hypertension**				
Stage 1	140–159	or	90–99	Refer within 2 months
Stage 2	160–179	or	100–109	Refer within 1 month
Stage 3	≥180	or	≥110	Refer within 1 week or immediately

\* When recommendation for follow-up of DBP and SBP are different, the shorter recommended time for recheck and referral should take precedence. This classification applies only to participants not taking antihypertensive drugs.

\*\* Diagnosis of hypertension must be based on two or more readings taken at each of two or more visits following an initial screening.

SBP= systolic blood pressure. DBP= diastolic blood pressure.

1. Alert levels requiring immediate referral (send participant directly to a physician or hospital) for MESA participants are:
  - Diastolic BP >120 mm Hg
  - Systolic BP >210 mm Hg
2. Alert levels requiring urgent referral (within one week) are:
  - Diastolic BP 110–119 mm Hg
  - Systolic BP 180–209 mm Hg
3. BP >140/90 mm Hg requires follow-up within two months time, and, therefore, we recommend physician notification for systolic or diastolic BP above these levels.
4. JNC VI states that blood pressure classifications and referral recommendations are based on the average of two or more readings on two or more occasions. In MESA we intend to use the average of the 2<sup>nd</sup> and 3<sup>rd</sup> blood pressure readings (see below) in order to reduce the impact of reactivity (higher first reading) on the estimate of the value of the underlying blood pressure. Thus, in deciding whether a participant meets criteria for an alert level, the average of the 2<sup>nd</sup> and 3<sup>rd</sup> readings should be used. This will require on-the-spot arithmetical manipulation of the systolic and diastolic values. A hand calculator may be useful. The data forms will include fields for these averaged values and for any actions taken.

## V. METHODS

### 1. Preparation

- 1.1 *Record the date of the procedure and the Dinamap<sup>®</sup> number on the Seated Blood Pressure Form during the five-minute rest period.*
- 1.2 Before the BP measurement procedure, explain to the participant what to expect and how long the procedure will take. The following script is suggested:

**“This part of the exam involves taking your resting blood pressure. It will take about 10 minutes. We would like you to sit with both feet on the floor and your arm supported on the table. We will have you sit quietly for five minutes. Then we will take your blood pressure three times, one minute apart, using an automated device. We will give you your blood pressure readings and some material to help you interpret them at the end.”**

- 1.3 Make sure the room temperature is between 70° and 76° Fahrenheit.

### 2. Cuff Size Selection

- 2.1 Use the proper cuff size to avoid under- or over-estimation of the correct blood pressure. Selection of the proper sized cuff is based on the guideline that the length of the inflatable bladder in the cuff should be at least 40% of the arm circumference. Measurement of the bladder length in the Critikon<sup>®</sup> cuffs confirms that the chart in Table 3 conforms to this guideline. A copy of this chart should be available during the BP measurement procedure for easy reference. *Selection of cuff size should be based on the Critikon<sup>®</sup> chart in Table 2, and only Critikon<sup>®</sup> cuffs should be used.* If the participant’s arm size falls in a range in which there is overlap of two Critikon<sup>®</sup> cuff sizes, use the *larger* cuff.
- 2.2 Measure the right arm circumference as follows:
  - Ask the participant to bare the upper arm.
  - Instruct the participant to sit or stand holding forearm horizontal, i.e., parallel to the floor.
  - Measure arm length from the acromion (bony extremity of the shoulder girdle) to the olecranon (tip of the elbow) using a metric tape.
  - Mark the midpoint on the dorsal (back) surface of the arm.
  - Ask participant to relax arm along side of the body.
  - Draw the measuring tape snugly around the arm at the midpoint mark, keeping the tape horizontal. Tape should not indent the skin.

Record the arm circumference in cm in Field 1 on the Seated Blood Pressure Form.

- Use the criteria in Table 2, below, to determine cuff size. Check the cuff size used in Field 2 on the Blood Pressure Form by filling in the appropriate circle.

**Table 2. Cuff Size Indicated by Measured Arm Circumference**

Arm Circumference*	Cuff Name**	Bladder Length (cm)
12-19	Child	8
17-25	Small Adult	10
23-33	Adult	13
31-40	Large Adult	17
38-50	Thigh	

\* These circumferences are printed on the corresponding cuff for verification.

\*\* Critikon Dura-cuf® nomenclature, also printed on the cuff.

### 3. Setting up the Dinamap® BP Machine

- 3.1 Load the printer paper by opening the flap on the side of the device. There is a diagram showing how to thread the paper on the inside of the door. There is a gray plastic wheel to the left of the roller. Just to the right of the gray wheel is a *gray plastic lever*. Gently flip this lever up. This releases the roller so that you can use the gray plastic wheel to turn the roller to thread the paper. Flip the gray lever down when finished.
- 3.2 To turn on the Dinamap® device, push the "Off/On" button on the front control panel (lower left).
- 3.3 After five seconds an initial message will appear on the LCD screen. It will consist of a WARNING and the instruction, "PUSH A FRONT PANEL KEY TO START."
- 3.4 In the main menu select PRINT using the gray toggle knob. In the next menu, select AUTO and then push the toggle knob. This will program the device to print the blood pressure measurements.
- 3.5 Do not touch the monitor again until you have completed steps 4–6, below, and you are ready to proceed with blood pressure measurement.

### 4. Positioning the Participant

- 4.1 The workstation should be free of excessive noise or distractions.
- 4.2 The participant should be seated and relaxed in a comfortable chair, to ensure that:

- He or she is sitting up (not slouched).
- Both feet are on the floor (legs/ankles not crossed).
- Right forearm is supported resting on the table.

4.3 The participant should not talk, eat, or drink during the procedure.

4.4 Ideally, the Dinamap output will not be visible to the participant during the measurement, as this may cause anxiety.

## 5. Application of the Blood Pressure Cuff

5.1 Place the appropriate cuff around the upper right arm so that the mid-height of the cuff is at heart level. Palpate the patient's brachial artery and place cuff so that the artery is aligned with the cuff arrow marked "artery."

5.2 Place the lower edge of the cuff, with its tubing connections, two centimeters above the natural crease across the inner aspect of the elbow.

5.3 Wrap the cuff snugly around the arm, with the palm of the participant's hand turned upward.

5.4 Secure the wrapped cuff firmly by applying pressure to the locking fabric fastener over the area where it is applied to the cuff.

5.5 Do not wrap the cuff too tightly around the arm. You should be able to insert the first joint of two fingers under the cuff. The cuff should be snug but not tight.

5.6 Be sure all air is squeezed out of the cuff before each inflation.

## 6. Rest Period

6.1 The participant should rest for five minutes (timed using a watch or stop watch) prior to the heart rate and blood pressure measurement.

6.2 When the five-minute rest period is over, but before the first blood pressure measurement is started, *record the time of day in Field 4 on the Seated Blood Pressure Form* (examples: 04:25 P [p.m.] or 11:38 A [a.m.]).

6.3 *Record the room temperature in Field 7 on the Seated Blood Pressure Form.*

## 7. Blood Pressure Measurement

- 7.1 To begin the blood pressure procedure, access the Main Menu on the Dinamap<sup>®</sup> by pushing the “Start/Stop” button at the lower right of the monitor. (Please note that the gray knob located at the upper right of the monitor allows you to change selections in the monitor screen, in a manner similar to a computer mouse or pointing device. Rotate the knob in order to move from one item to another in the monitor screen, and push it to select the desired option.)

Use the knob to select the SET BP option from the menu and then press the knob (equivalent to clicking a mouse) to implement the selection. The next menu appears automatically.

Use the knob to select AUTO BP and then press the knob.

- 7.2 Immediately after you select AUTO BP the monitor will start the first blood pressure measurement. However, during this first inflation, select the window that has appeared to the right of AUTO BP and push the knob, so that there is a black number against a clear background in the window. Rotate the knob to select “2.” This will select two minutes as the interval between sequential blood pressure measurements. Push the knob again (colors in window will reverse) to implement the selection. (The device will retain this setting, even after it is turned off, so you will not have to repeat this step again.)
- 7.3 Palpate the radial pulse during inflation. The radial pulse should not be palpable at peak inflation pressure. If the participant's radial pressure remains palpable when the device begins to deflate, the device will complete its deflation procedure and then should automatically reset itself for a higher inflation pressure and repeat the measurement. In the unlikely event that this does not occur, manually reset the inflation pressure:
- 7.31 Rotate the knob until the window to the right of TGT PRESSURE is highlighted, push the knob and rotate it again until it reaches 210, and push it again to select. Repeat the blood pressure measurement.
- 7.32 It is not necessary to repeat or prolong the five-minute rest period, if this happens, but explain the change in the procedure to the participant (e.g., “I think we need to use a higher inflation pressure—I'm just going to reset the machine”).
- 7.33 If a higher maximal inflation pressure is needed, reset this parameter at 260 mm Hg, and, if necessary, at 300 mm Hg.

Check carefully to be sure that the cuff is properly positioned on the participant's arm with the arrow at the brachial artery.

- 7.4 When the radial pulse is obliterated at maximal inflation, the first blood pressure measurement will be obtained. The device will automatically obtain the 2<sup>nd</sup> and 3<sup>rd</sup> measurements, at two-minute intervals.
  - 7.5 *Record the three sequential blood pressure readings in Fields 4, 5, and 6 on the Seated Blood Pressure Form.*
  - 7.6 After the 3<sup>rd</sup> measurement is obtained, return to the main menu and select TREND and then PRINT ALL. When printout is obtained and verified, proceed to TREND and then CLEAR. When the monitor requests confirmation, select YES. Paste or staple the printout in the ad-hoc page.
  - 7.7 In order to keep the machine from continuing with further automatic blood pressure measurements go to the main menu, select SET BP and then MANUAL. There is no need to turn off the machine if another participant is ready. If for any reason the machine automatically starts an unnecessary inflation, push the "Start/Stop" button at the lower right hand corner of the monitor and then select MANUAL, as explained above. Remove the blood pressure cuff from the participant's arm and thank the participant for his/her time.
8. BP Measurement Instructions for Participants With Short, Thick Arms
- 8.1 Occasionally there will be a participant whose upper arm is too thick and short for the thigh cuff or on whom the thigh cuff pops open on inflation. The alternative procedure in this case is to obtain the resting blood pressure in the right *forearm*.
  - 8.2 Measure the forearm circumference at the midpoint between the olecranon and the ulnar styloid (wrist bone on pinkie side). Select the proper size cuff based on the forearm measurement. The blood pressure procedure is otherwise the same.
  - 8.3 You must document on the Seated Blood Pressure Form that you have measured the *forearm blood pressure*.
9. Reporting Blood Pressure Results to Participants
- 9.1 The technician may verbally provide the participant with the blood pressure reading (the average of the last two pressures), *if asked*, after the procedure has been completed.

- 9.2 Alternatively, if the blood pressure is normal (<140/90), the technician may say that it is normal, particularly if asked.
- 9.3 If the blood pressure is not normal (>140/90) but not at an alert level (>210 mm Hg), the technician should exercise the standard option of not discussing the interpretation or stating that it does appear to be high (or “somewhat elevated”) but that, again, it will be discussed later.
- 9.4 If an alert level is identified, the technician should calmly notify the clinic coordinator when the procedure has been completed. (If symptoms of severe hypertension are present, the technician should notify the clinic coordinator immediately.)

## **VI. QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES FOR DINAMAP PRO 100®**

1. Once a week each device should be used simultaneously with a paired device to simultaneously measure the blood pressure in each arm of a non-smoker under the age of 50, in whom there is no reason to suspect that the blood pressure in the two arms should differ. Repeat the measurement three times.
2. If the paired blood pressure measurements agree within 4 mm Hg or less, for both systolic and diastolic BP, the devices are considered to be in calibration.
3. Investigate any systematic divergence, even if less than 4 mm Hg (e.g., by switching arms and/or pairing the devices with a third device).
4. If the two devices differ by more than 4 mm Hg, calibration must be done\*. It should be recognized that, if the cuff deflation rate is 2 mm Hg/sec and the heart rate is 60 bpm, divergences of 2–4 mm Hg would be expected, even if the device is in perfect calibration.

\* Calibration will be performed by Critikon. Contact the Critikon sales representative. A loan device will be provided while the study device is being calibrated. In addition, Critikon will perform yearly calibration on all study devices.

## **VII. CERTIFICATION FOR RESTING BLOOD PRESSURE MEASUREMENT IN MESA**

Certification requires five documented, correctly performed blood pressure measurements, following the MESA certification form.