BLOOD PRESSURE, RADIAL PULSE, RESPIRATORY RATE, AND TEMPERATURE

TABLE OF CONTENTS

BLOOD PRESSURE, RADIAL PULSE, RESPIRATORY RATE, AND TEMPERATURE

1. Background and rationale

Blood pressure measurements will be recorded to document blood pressure, and radial pulse will be counted to document heart rate. Also, the standing blood pressure measurement will be used for the long distance corridor walk exam. In addition, individuals with extremely high levels of blood pressure will be excluded from quadriceps strength and endurance testing and referred for medical care according to the protocol for referrals. Participants with very low or very high heart rates will be excluded from the long distance corridor (2-minute and 400 meter) walk.

In addition, the participant's body temperature will be measured using a digital oral thermometer, and their respiratory rate will be recorded.

2. Equipment and supplies

- conventional mercury sphygmomanometer.
- blood pressure cuffs (small, regular, large and thigh cuffs).
- stethoscope: standard stethoscope and ear pieces with bell, tubing to be maximum of 14 inches long.
- double-headed stethoscope (for training only)
- tape measure
- eyebrow pencil
- chair with back support
- digital stop-watch
- Diatek Model 600 thermometer
- probe covers for thermometer

2.1 Maintenance of blood pressure equipment

With Each Use:

1) Check the sphygmomanometer for correct zero. Place the instrument flat on the table and disconnect the inflation system. With eyes level with the zero line, assure the top of the meniscus is on the zero line.

2) Check the shape of the meniscus--it should be a smooth, well-defined curve.

Monthly:

1) Check that the mercury rises easily in the tubing and that the mercury column does not bounce noticeably when the valve is closed.

2) Check for cracks in the glass tube.

3) Check the cap at the top of the calibrated glass tube to make sure it is securely in place.

4) Check for spilled mercury in the manometer case.

5) Check the cuffs, pressure bulb, and manometer and stethoscope tubing for cracks or tears.

6) Check the pressure control valve for sticks or leaks.

7) Check the stethoscope diaphragm for cracks.

8) Make sure when you close the manometer case that:

- the manometer tubing is connected and the thumb valve is closed
- the manometer case is stored on its right side so that the mercury will flow back into the reservoir.

9) Never attempt to repair the equipment yourself. Send the instrument for repair if any of the above checks reveal a problem.

10) Check the sphygmomanometer for air leaks. Roll the cuff around a plastic bottle or tin can and secure in place. Close the valve on the Air-Flo system and inflate the instrument until the mercury rises to 240 mm Hg. Close the valve. The mercury column should remain stable. If the column continues to fall, there is an air leak and the system should be re-inflated until the column rises to 200 mmHg. Pinch the

tubing at various locations to localize the area of the leak, then replace the leaking tubing, cuff, or valve.

General:
With time, the mercury will become dirty and an oxide layer will be deposited on the inside of the glass tube. Do not attempt to clean the glass column with a pipe cleaner, as hazardous levels of mercury aerosol will be produced. Have your QC supervisor send the instrument to your local supplier for repair.

Since mercury is a hazardous, toxic substance, all maintenance and proper disposal procedures must be performed carefully (consult your local institution for guidelines). Do not perform any maintenance procedures that will expose mercury to air. A manometer specialist with expertise in handling toxic substances should be contacted to add or withdraw mercury from the instrument.

Check the blood pressure cuffs on a monthly basis to assure all sizes of cuffs are available. Document the monthly checks of the sphygmomanometer on your Quality Assurance (QA) Equipment Log Form.

Inspect the tape used to measure arm circumference for damage or wear twice a year and record these checks on the QA Equipment Log Form.

2.2 Stop watch

See Long Distance Corridor Walk chapter (2I, pages 1-2) for instructions on using the stopwatch.

2.3 Thermometer

2.3.1 Self tests:

1. Initial power up display – a special display test is performed each time a new set of batteries is installed. Upon inserting batteries, all display segments are sequentially turned on for 0.4 seconds. The complete test requires 25 seconds and happens only when the batteries are changed.

Instructions:
- Install a new set of batteries
- Immediately upon inserting the last battery, the display test will start
- Observe all display segments as they are sequentially lighted and then extinguished. Every segment must be visible.

2. Calibration check – Each time the thermometer is turned on, an internal check for proper calibration is made at 100.5° F during the display test. A malfunction error will be indicated if the thermometer calibration is in error by more than 0.2° F.

Calibration plug procedure:

- Disconnect the probe and remove it from the thermometer.
- Set the normal / monitor switch to the monitor position.
- Insert the calibration plug into the receptacle on the thermometer.
- Following the display test, the display should indicate the temperature stated on the calibration plug. CAUTION: Do not check calibration in the normal mode since an erroneous reading may occur.

3. Startup display test and calibration check

- Set the normal / monitor switch to the monitor position.
- Insert a calibration plug into the thermometer.
- Observe the startup display test and check that all segments except the timer are lighted.
- Following the display test, the unit should indicate the temperature stated on the calibration plug.
- Note also that the horn sounds for a brief period as a test.

4. Microprocessor self check – Each time the thermometer is turned on, an internal check for proper microprocessor operation, including a test of the entire program, is made during the display test. A malfunction error will be indicated if any faults are located.

5. Error Indicators

When any of the following errors occur, a tone will sound twice for .1 seconds and the appropriate error indicator will be flashing on and off (.5 seconds). Except for probe position error, no temperature will be displayed while in the error mode and the unit will shut off in 5 minutes.

The horn will repeat the double beep every 10 seconds if the error is not rectified.

Types of errors are listed below:

- Broken probe – This error is intended to indicate that the probe will not function correctly and should be replaced.

- Low batteries – the purpose of the low battery indication is to preclude an improper reading, and to notify the user to change batteries.

- Probe position error – This occurs whenever there is a rapid drop in temperature. This can be the result of excessive probe movement or poor tissue contact. No audible tone will sound for this error indication. However, a visual indicator will activate. The temperature display is unaffected by this indicator except that it will not update until temperature rises.

- Malfunction – The malfunction error indicator activates after the self check whenever the thermometer will not function correctly (does not include probe and battery malfunctions).

2.3.2 Cleaning and sterilization

The Model 600 unit and probes should periodically be cleaned by wiping it with an alcohol soaked cloth or pad, warm water, or non-staining disinfectant.

Do not autoclave or immerse the Model 600 unit.

Under conditions where an alcohol wipe or germicidal wipe are inadequate, the unit may be sterilized in Ethylene Oxide (ETO). This is to be done at no more than 100° F and 85% humidity. This procedure is to be used only when absolutely necessary. It is imperative that the batteries be removed from the unit before ETO sterilization.

2.3.3 Battery replacement

Remove the battery access screw by turning it counter clockwise with a Phillips screwdriver. Slide the battery access cover away from the battery access label to expose the batteries. Install three new AA alkaline batteries paying special attention to the + and – marks in the battery compartment. (Note: use of any other alkaline type batteries could impact accuracy). Slide the cover back into place and install the screw, turning it clockwise.

As soon as the batteries are installed, a special display test is activated which sequentially lights then extinguishes each display segment. The entire test lasts about 25 seconds. NOTE: if the horn is activated by installing new batteries allow the display test to finish, then activate the pulse timer to reset the horn.

3. Safety issues and exclusions

None.

4. Participant and exam room preparation

Caffeine (from coffee, tea, or soda), eating, heavy physical activity, smoking and alcohol should be proscribed for 30 minutes prior to recording the blood pressure.

4.1 Arm circumference

Refer to the Health ABC Data from Prior Visits form to see which arm was used at the baseline visit. If possible, use the same arm that was used at the baseline visit (usually the right arm). If the participant's right arm is injured or missing, or if the participant has had a mastectomy on the right side, use the left arm for the arm circumference and blood pressure measurement. Measure the participant's arm to determine the appropriate cuff size before allowing the participant to rest.

Use the following procedures to measure the participant's arm and determine the appropriate cuff size:

- Proper measurement requires that the participant's arm is bare to the shoulder. The participant will be wearing a gown or loose-fitting top provided by the clinic.

- Request the participant to stand, bend the elbow, and put the forearm straight across the chest. The upper arm should be at a 90 degree angle to the lower arm.

- Measure arm length from the bony prominence of the shoulder girdle (acromion) to the tip of the elbow using a tape measure.

- Mark the midpoint on the dorsal (back) surface of the arm.

- Ask the participant to relax their arm along the side of the body.

- Draw the tape measure horizontally around the arm at the midpoint mark, but do not indent the skin.

- Use the measurement to determine the correct cuff size.

Do not use the markings on the blood pressure cuff for reference. Instead, use the following criteria for determining the appropriate cuff size for the participant:

Arm Circumference (cm / in.)	Cuff's Bladder Size (cm)*
16.0 - 22.5 cm (6.4 - 9.0 in)	small cuff (9.0 cm)
22.6 - 30.0 cm (9.1 - 12.0 in)	regular cuff (12.0 cm)
30.1 - 37.5 cm (12.1 - 15.0 in)	large cuff (15.0 cm)
37.6 - 43.7 cm (15.1 - 17.5 in)	thigh cuff (17.5 cm)

Keep the above chart of arm circumference measurements and corresponding cuff sizes readily available for easy reference.

5. Detailed measurement procedures

In measuring the participant's blood pressure, the participant should rest for approximately five minutes with their feet flat on the floor and legs and ankles uncrossed. The maximum inflation level should be determined and two blood pressure readings obtained.

5.1 Application of the cuff

- Ensure that the participant is seated comfortably in a chair with back supported and both feet are flat on the floor.
- Make sure that the participant's arm is resting on the table at a 90 degree angle with the palm facing up.
- Palpate the brachial artery.
- Mark the brachial artery with an eyebrow pencil.
- Place the appropriate-sized cuff around the upper right arm, approximately at heart level, with the participant's palm facing upward (the participant may rest their forearm and elbow on a table or arm of the chair). Place the lower edge of the cuff with its tubing connections about one inch above the natural crease across the inner aspect of the elbow.

- Wrap the cuff snugly about the arm, with the inflatable inner bladder centered over the area of the brachial artery. The brachial artery is usually found at the crease of the arm, slightly toward the body. Secure the wrapped cuff firmly by applying pressure to the locking fabric fastener over the area that it overlaps the cuff. You should be able to insert two fingers under the cuff.

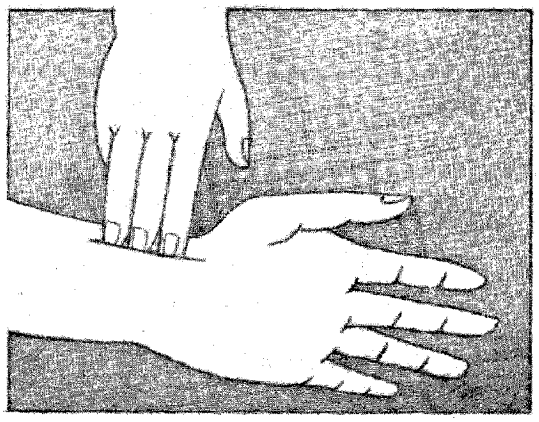
- If it is not feasible to measure blood pressure using the right arm, the left arm may be used. The change in arm and the reason for the change should be noted on the comments section of the form.

5.2 Rest period

Ask the participant to sit with both feet flat on the floor and to rest without talking for five minutes before measuring their blood pressure. Instruct the participant on the correct posture with the back supported and both feet flat on the floor. The work station should be free of excessive noise and the participant should not be interviewed nor asked to read anything at this time. Record the radial pulse and respiratory rate (see section 5.3 below) and then the two blood pressure measurements. After the seated blood pressure measurements are recorded, the participant should be instructed to quietly stand for one minute before the standing blood pressure is measured.

5.3 Radial pulse and respiratory rate measurement

BE SURE TO WAIT UNTIL THE PARTICIPANT HAS BEEN RESTING FOR 5 MINUTES.



Have the participant turn their palm upward (see figure above). Palpate the radial pulse with your index and middle fingers. Use the stopwatch to count the pulse for 30 seconds and record the number of beats in 30 seconds as Measurement 1 on the Weight, Radial Pulse, Respiratory Rate, and Temperature form; Count the pulse for 30 seconds

again, and record the number of beats as Measurement 2. Set the stop-watch again and continue to hold the patient's wrist, but focus on their breathing. The respiratory rate is determined by the number of inspirations (inward breaths) taken. Count the number of inspirations in 30 seconds and record this number on the Weight, Radial Pulse, Respiratory Rate, and Temperature form. After completing the radial pulse and respiratory rate measurements, multiply the number of beats recorded in 30 seconds by two (both Measurement 1 and Measurement 2) and average the beats per minute. Record this number on the Weight, Radial Pulse, Respiratory Rate, and Temperature Form, and on the Long Distance Corridor Walk Eligibility Assessment Form. For information about the stopwatch, please see section 2.1 of the Long Distance Corridor Walk chapter.

5.4 Determining the Maximal Inflation Level (MIL)

5.4.1 Ausculatory gap

An ausculatory gap is the fading or disappearance of sound after the first Korotkoff sounds are heard. The sound then reappears at a level well above the diastolic pressure. The radial pulse can still be felt during the silent phase and the gap usually occurs between Phase I and II. This phenomenon is seen more frequently in older persons.

This means that in an adult with an ausculatory gap, the real systolic pressure may be missed and read as a much lower BP. For example:

Real systolic is 172 but sounds fade at:
168 and reappear at
152 and disappear at
98.

If the correct procedure (inflating to MIL) for BP measurement is not used, this participant's BP may be read as 152/98 instead of 172/98. The only way to avoid this error is to obtain the MIL before BP measurement.

Determine the pressure to which to inflate the cuff for the measurement of the systolic blood pressure. This assures that the cuff pressure at the start of the reading exceeds the systolic blood pressure and allows you to hear the first Korotkoff sound. The procedures for determining maximal inflation level are as follows:

- Attach the cuff tubing to the conventional mercury sphygmomanometer.

- Palpate the radial pulse (if the radial pulse is difficult to palpate, the brachial pulse may be used).

- Inflate the cuff to 70 mmHg. Then increase by 10 mmHg increments until the radial pulse is no longer felt (palpated systolic).

- Deflate the cuff quickly and completely.

- Inflate the cuff to 30 mmHg above the palpated systolic pressure for all subsequent readings.

- Repeat the MIL if the first attempt was unsatisfactory or you have had to readjust the cuff after measuring the MIL. Wait 30 seconds before making a second attempt if the first is unsatisfactory. If the second attempt is unsatisfactory, terminate the procedure and note the problem on the form.

- If the radial pulse is still felt at a level of 270 mm Hg or higher (which means that the MIL is 30 mm Hg higher) repeat the MIL. If the MIL is still 300 mm Hg, terminate the blood pressure measurements and write in "300/MIL" on the form. On the Report of Findings, indicate the blood pressure as 270 palpated, and refer the participant to see their doctor within the next week.

5.5 Performing the blood pressure measurement

- Place the ear pieces of the stethoscope, with the tips turned forward, into your ears.

- Apply the bell of the stethoscope over the brachial artery with light pressure, ensuring skin contact at all points. Effective use of the bell requires careful palpation of the brachial artery to know exactly where to place the bell. Place the bell just below, but not touching, the cuff or tubing.

- Close the thumb valve and squeeze the bulb, inflating the cuff at a rapid but smooth and continuous rate to the maximal inflation level. *Note:* Your eyes should be level with the mid-range of the manometer scale and focused on the level to which you will raise the pressure.

- Open the thumb valve very slightly and maintain a constant rate of deflation at no more than 2-3 mm per second, allowing the cuff to deflate. Listen throughout the entire range of deflation, from the maximum pressure past the systolic reading (the pressure where the first regular sound is heard) until 10 mmHg below the level of the diastolic reading (i.e., 10 mmHg below the level where you hear the last regular sound).

The systolic value (Phase I) is the pressure at which you hear the first of two or more knocking sounds in appropriate rhythm. The diastolic sound (Phase V) is the pressure at which you hear the last muffled sound.

- Deflate the cuff fully by separating the tubing and remove the stethoscope ear pieces.

- Record the systolic and diastolic values from the first reading in the spaces provided on the form.

- Hold the participant's arm vertically above their head for a full five seconds to relieve blood pooling.

- Have the participant sit quietly for 30 seconds, then repeat the blood pressure measurement and record the systolic and diastolic values from the second blood pressure measurement on the form.

- Have the participant stand quietly for one minute, then obtain one standing blood pressure measurement and record the systolic and diastolic values from this measurement on the Blood Pressure Form and on the Long Distance Corridor Walk Eligibility Assessment Form.

5.6 Criteria for systolic and diastolic blood pressure

To identify correctly systolic (Phase I) and diastolic (Phase V) Korotkoff values, listen carefully via the stethoscope while reading and interpreting the mercury column.

- The systolic value is the pressure level at which you hear the first of two or more knocking sounds in the appropriate rhythm. *Note:* A single sound heard in isolation (i.e., not in rhythmic sequence) before the first of the rhythmic sounds (systolic) does not alter the interpretation of blood pressure).

- The diastolic value can be identified as the pressure level at which you hear the last of these rhythmic sounds (usually muffled).

- Make the mercury column drop at 2 to 3 mmHg per second, from the maximum inflation pressure until 10 mmHg below that of the last regular sound heard. The control of the deflation rate at 2 to 3 mmHg per second is essential for accurate readings and depends on the handling of the bulb and its control valve.

5.7 Guidelines for blood pressure readings

- Record all readings to the nearest even digit, rounding up (i.e., read any value that appears to fall exactly between the markings on the mercury column to the next higher even marking).

- Make readings at the top of the meniscus, or rounded surface of the mercury columns.

- When the pressure is released too quickly from a high level, a vacuum is formed above the mercury and the meniscus is distorted. Allow a few moments for it to reappear before reading the manometer or doing a repeat measurement.

- Repeat the MIL whenever a systolic blood pressure reading is less than 10 mm mercury from the MIL, or if sounds are heard immediately.

- If a measurement was interrupted, use the following guidelines:

  1. Repeat the MIL only if the cuff was removed or more than five minutes has lapsed between the MIL and the first blood pressure reading or between any two blood pressure readings.

  2. Note on the form in the comments section that the measurement was repeated, and indicate why.

- If the blood pressure sounds are not heard during the first measurement, review your technique, check stethoscope position for loose connections or tubing kinks, and maintain a quiet environment. Relocate the brachial pulse and apply the bell headpiece directly over the pulse point. Take care to wait at least 30 seconds between measurements. Use the procedure to enhance the sounds (see below) and measure the blood pressure a second time, placing the stethoscope in the same position. Note the use of the enhancement procedures in the comments section of the form.

5.8 Procedures to enhance the Korotkoff sounds

If you are having difficulty hearing the blood pressure sounds, there are three methods that can be used to increase the intensity and loudness of the sounds.

1. Reduce room noise.

2. Instruct the participant to open and close their fist 8 to 10 times. Inflate the cuff and measure the BP immediately.

3. Have the participant raise their arm and forearm over their head and make a fist several times for at least 60 seconds. Inflate the cuff while the arm is still overhead, but the hand relaxed, to a level 50 mm Hg above the expected systolic level. Then lower the arm rapidly and measure the blood pressure in the usual manner.

5.9 Performing the temperature measurements

Place the carrying strap around your neck with the instrument display facing you. Check that sufficient probe covers remain for a round of temperature taking. Select the Fahrenheit display by setting the °F slide switch to the appropriate position. Select the normal/monitor slide switch to the normal position. Withdraw the probe from the storage channel and observe the 6 second display test ensuring that no display segments are missing. The unit will then display 84.0 °F with the low temperature arrow ON until the probe rises above that temperature.

Load a probe cover onto the probe by holding the probe collar with the thumb and forefinger, being careful not to hold or press the ejection button.

Insert the probe tip gently into the participant's slightly open mouth. Carefully slide the probe under the tongue on either side of the mouth to reach the sublingual artery. Have the participant close their lips around the probe.

Hold the probe during the entire temperature measurement process and keep the probe tip in contact with tissue at all times.

During the temperature taking cycle, a continually increasing temperature should be observed on the display. When the final temperature has been reached, a tone will sound and an "F" will be displayed to the right of the numbers.

After the temperature measurement is complete, eject the probe cover by firmly pressing the ejection button on the probe. Insert into the probe channel to clear the display in preparation for another temperature.

Record the temperature on the Weight, Radial Pulse, Respiratory Rate, and Temperature data collection form on page 7 of the Year 2 Clinic Visit Workbook.

6. Procedures for performing the measurements at home (if applicable)

The same procedures described above may be performed at home.

7. Seated blood pressure alert values/Follow-up/Reporting to participants

- An immediate referral to the participant's primary physician via telephone before the participant leaves the clinic:

  systolic blood pressure ≥210, or
  diastolic blood pressure ≥120

- An urgent referral to the primary care provider (within 1 week):

  systolic blood pressure 180-209
  diastolic blood pressure 110-119

- Report to primary care provider (within 1 month):

  systolic blood pressure 160-179
  diastolic blood pressure 100-109

- Report to primary care provider (confirm within 2 months):

  systolic blood pressure 140-159
  diastolic blood pressure 90-99

- Normal Categories

  High normal:

  systolic blood pressure 130-139
  diastolic blood pressure 85-89

  Normal:

  systolic blood pressure <130
  diastolic blood pressure <85

The seated blood pressure measurement will be given to the participant at the time of the clinic visit. They will receive a printed form with the above referral information and levels, with blanks for recording participant's values. The same information will be included in the final report to participant and participant's physician.

8. Quality assurance

8.1 Training requirements

Clinical experience with blood pressure measurement is required. In addition, training should include:

- Read and study manual
- Attend Health ABC training session on techniques (or observe administration by experienced examiner)
- Practice on volunteers
- Compare measurements with those made by experienced colleagues (Goal: obtain measurements within ± 2 mm Hg of that observed by a trainer listening with a double-headed stethoscope.)
- Discuss problems and questions with local expert or QC officer

8.2 Certification requirements

- Complete training requirements
- Explain and demonstrate daily and monthly checks of sphygmomanometer
- Explain procedure if measurement is interrupted
- Explain procedure to enhance Korotkoff sounds
- Recite alert values
- Conduct exam on two volunteers while being observed by QC officer listening with double-headed stethoscope
- Performs exam according to protocol as demonstrated on completed QC checklist
- Three simultaneous readings of systolic and diastolic measurements recorded by the staff member agree with those of the QC officer within 4 mm Hg, with the average of the three readings within 3 mm Hg.
- Three sequential recordings of radial pulse measurement by the staff member agree with those of the QC officer within 3 beats per 30 second recording and with the average of the three readings within 2 beats.

QC reports: Monthly reports of the distribution of final digits for each technician will be reviewed by the QC Officer. Trends toward digit preference will be discussed with the technician without revealing which digit and retraining/recertification may be required.

8.3 Quality assurance checklist

Blood pressure

- ☐ Explains procedure
- ☐ Measures for cuff size
- ☐ Wraps cuff snugly, centering bladder over brachial artery
- ☐ Five minute rest period before measurements
- ☐ Palpates brachial artery
- ☐ Determines maximal inflation level
- ☐ Inflates rapidly to maximal inflation level
- ☐ Places bell on brachial pulse
- ☐ Deflates cuff 2-3 mm Hg per second
- ☐ First and fifth phase correctly identified (verified with double stethoscope)
- ☐ Standing blood pressure measurement measured after one minute standing rest period
- ☐ Records reading and disconnects tubes
- ☐ Reviews forms for completeness
- ☐ Correctly completes forms
- ☐ Tells participant BP reading and refers as indicated
- ☐ Maintenance log up to date

Radial Pulse

- ☐ Radial pulse palpated correctly
- ☐ First radial pulse correctly measured and recorded (30 seconds)
- ☐ Second radial pulse correctly measured and recorded (30 seconds)
- ☐ Radial pulse averaged correctly on form

Respiratory rate

- ☐ Stop watch set for 30 seconds
- ☐ Number of inspirations correctly counted
- ☐ Respiratory rate entered on form

Temperature

- ☐ Digital thermometer display is 84.0°F before measurement is taken
- ☐ Digital thermometer placed correctly
- ☐ Temperature entered correctly on form

8.4 QC reports

Monthly reports of the distribution of final digits for each technician will be reviewed by the QC Officer. Trends toward digit preference will be discussed with the technician without revealing which digit and retraining/recertification may be required.

Acknowledgments:

Women's Health Initiative Operations Manual. Volume 2, Section 9.2: Blood Pressure. 8/30/95.

WHAS Operations Manual. Section 3.5 Blood Pressure Measurements. 6/18/93.

Diatek Model 600 operating instructions