HEALTH CARE PROVIDER
BLOOD PRESSURE
REFRESHER COURSE
Material in this course was derived from the Blood Pressure Measurement Mini Course (NCBPmini). The NCBPmini course was developed by the former Heart Disease and Stroke Prevention Branch of North Carolina’s Division of Public Health with support from multiple partners, and is based on an in-depth Blood Pressure Measurement Course developed by the Heart Disease and Stroke Prevention Branch at the Virginia Department of Health.
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LEARNING OBJECTIVES:

This course is intended to update health care providers on current concepts in hypertension detection, evaluation and treatment. It also provides information on accurately and reliably measuring blood pressures, properly maintaining and calibrating blood pressure equipment and lifestyle changes that can be made to reduce high blood pressure.

Upon completion of this course, participants will be able to:

1. Distinguish between normal, prehypertension and hypertension.
2. Describe the different types of blood pressure manometers.
3. Understand and describe the proper use and maintenance of blood pressure equipment.
4. Understand the correct blood pressure measurement technique according to current evidence-based guidelines.
5. Define and describe the phases of Korotkoff sounds and their use in blood pressure measurement.
6. Define auscultatory gap and maximum inflation level (MIL).
7. Determine systolic and diastolic criteria for measuring blood pressure.
8. Describe the physiological variations in blood pressure.
9. Understand current recommendations for follow-up based on initial blood pressure readings.
10. List the lifestyle modifications that can help to prevent and/or reduce high blood pressure.
CHAPTER 1: INTRODUCTION

Blood pressure (BP) is the force of blood pushing against the walls of the arteries that carry blood from the heart to other parts of the body. Blood pressure normally rises and falls throughout the day based on the kind of activity in which an individual is engaged. High blood pressure, also known as hypertension, is a disease that occurs when blood pressure stays above normal for a long time. As a result, the walls of arteries get stretched beyond their healthy limit, and damage occurs, creating a variety of other health problems.

Blood pressure is measured in millimeters of mercury (mmHg) using two numbers. The first number, called systolic blood pressure, measures the pressure in blood vessels when the heart beats. The second number, called diastolic blood pressure, measures the pressure in blood vessels when the heart rests between beats.

The chart below reflects blood pressure categories defined by The Seventh Report of the Joint National Committee (JNC) on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure.¹

<table>
<thead>
<tr>
<th>Blood Pressure Category</th>
<th>Systolic BP (mmHg)</th>
<th>Diastolic BP (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt;120</td>
<td>&lt;80</td>
</tr>
<tr>
<td>Prehypertension</td>
<td>120-139</td>
<td>80-89</td>
</tr>
<tr>
<td>Stage I Hypertension</td>
<td>140-159</td>
<td>90-99</td>
</tr>
<tr>
<td>Stage II Hypertension</td>
<td>≥160</td>
<td>≥100</td>
</tr>
</tbody>
</table>

Please stay abreast of updates from organizations that disseminate national guidelines regarding blood pressure categories. There have been concerns about the JNC 8 guidelines released in 2014. Furthermore, new studies such as the SPRINT trial are also challenging the current blood pressure guidelines.

**Isolated systolic hypertension** occurs when the systolic blood pressure is elevated ≥ 140mmHg but the diastolic remains <90 mmHg. This reading is more commonly seen in the elderly. Until recently, it was thought that the bottom number (diastolic BP) was the more important of the two numbers since this was the pressure when the heart was at rest. However, recent research has determined that the systolic pressure is actually more important (especially in persons age 50 or older) because it is a better predictor of future complications.

High blood pressure is the 12th leading cause of death in the United States. In North Carolina in 2013, high blood pressure was the primary cause of 855 deaths (about one
percent of all deaths) and a contributing cause to 23,808 heart disease and stroke
deaths. These statistics mean high blood pressure causes or contributes to at least 30
percent of all deaths in North Carolina each year. Almost one out of every three adults
in the United States (31 percent or 76 million people) has been diagnosed with high
blood pressure. In addition, up to one out of five adults with high blood pressure may be
unaware of their condition. 2

About 2.7 million North Carolina adults (36 percent) have been diagnosed with high
blood pressure by a health care professional. Assuming that national rates also apply to
North Carolina, up to an additional 560,000 North Carolinians may have high blood
pressure but are unaware of their condition. The North Carolina Medicaid program
spent $189 million on 166,700 beneficiaries with high blood pressure in 2011. That’s
about $1,100 per beneficiary with high blood pressure. 2

Measurement of blood pressure (BP) is one of the most frequently performed medical
tests. Because it seems to be such an easy measurement to make, the accuracy of the
results is seldom questioned. However, numerous studies have shown that 60-100
percent of blood pressure measurements are performed inaccurately, and hypertension
is likely to be over, or under, diagnosed 3.

Underestimating true blood pressure by five mmHg would mislabel more than 20 million
Americans with prehypertension when true hypertension is present. It has been
predicted that the consequences of an untreated five mmHg of excessive systolic blood
pressure would be a 25 percent increase over current levels of fatal strokes and fatal
myocardial infarctions for these individuals. Conversely, overestimating true blood
pressure by five mmHg would lead to inappropriate treatment with antihypertension
medications in almost 30 million Americans, with attendant exposure to adverse drug
effects, the psychological effects of misdiagnosis and unnecessary cost. 4

Controlling hypertension is the single most effective clinical service for reducing
mortality. 5 It is therefore important to practice accurate blood pressure measurement
techniques, while being aware of the proper use and maintenance of the blood pressure
equipment.
CHAPTER 2: TYPES OF BLOOD PRESSURE MEASURING DEVICES

There are many different devices available for measuring blood pressure (BP). Below is a discussion about the different devices and how to measure BP using mercury devices, aneroid devices and electronic devices.

1. Mercury-Gravity Manometer
The mercury manometers have changed little over the last 50 years, but modern versions are less likely to spill mercury if dropped. The use of mercury devices is widely regarded as the gold standard for BP measurement, but due to various concerns about the safety of mercury, they are being used with less frequency. With these devices, the weight of the mercury liquid column is balanced against the pressure exerted by the patient’s brachial artery and BP cuff. Mercury, although a metal, is liquid at standard temperatures and is especially dense which makes it useful for this purpose. The BP is determined by inflating a BP cuff to a point beyond where the brachial artery is occluded, and then the BP cuff pressure is slowly deflated, and the systolic BP and diastolic BP measurements are recorded by listing to the Korotkoff sounds which are discussed later in this course.

Mercury manometers are calibrated when manufactured, and recalibration is unnecessary which makes them useful for checking the accuracy of other BP measuring devices such as aneroid devices. If the Mercury gets dirty, the equipment may need to be cleaned or repaired by a medical supply company licensed to service mercury-containing equipment (of note, mercury is a hazardous substance and should only be handled and disposed of by those knowledgeable in handling mercury).

2. Aneroid Devices
“Aneroid” means devoid of liquid. These devices have a gauge that detects pressures that are indicated on a dial. They are commonly used today and the technique of measuring BP is essentially the same as with the mercury devices (use a cuff to occlude the brachial artery, slowly deflate and listen for Korotkoff sounds).

Aneroid devices need to be checked for accuracy on a regular basis as the gauge and needle system can become inaccurate relatively quickly compared to the other devices. They need to be checked for accuracy approximately every three to six months and can be checked against accurately working mercury devices as described in Appendix A: Checking an aneroid manometer for accuracy. (Please note: instructions on when to check for accuracy vary by manufacturer; thus you should refer to a user manual specific to your equipment.) Most laboratory equipment repair companies can check aneroid devices for accuracy as well. They may even be able to repair a faulty
instrument. The positioning of the dial at the zero mark of an aneroid manometer under no pressure does not indicate that the instrument is accurate; routine calibration is necessary.

3. Automated Electronic Devices
Many organizations use electronic BP cuffs that record BP measurements based upon detecting “oscillations” (pulsations) in the brachial artery. The oscillations begin approximately at the systolic pressure and continue below the diastolic. The maximal oscillation corresponds to the mean arterial pressure and the systolic and diastolic measurements are then estimated indirectly according to derived algorithms.

Electronic devices can be accurate and reliable, although like other BP measuring devices, they need to be checked for accuracy as recommended by the various manufacturers’ instruction manuals. Most of the time this involves sending devices back to the company that provided or services BP cuffs, as one cannot test for accuracy against mercury manometers in the same way aneroid devices can.

The www.dableducational.org website provides information regarding how well hundreds of BP devices have been validated and in what populations. This is a great resource to check regarding BP device quality. It lists if the devices are acceptable via criteria set by the British Hypertension Society, the International Protocol of the European Society for Hypertension, and the American Association of Medical Instrumentation.
CHAPTER 3: PATIENT PREPARATION AND POSITIONING

It is important to keep in mind the following points regarding patient preparation and positioning prior to taking blood pressure readings.

1. Effort should be made to help the patient relax for at least five minutes before measuring blood pressure. Care should be taken to eliminate external factors, such as a noisy environment. Patient should be reassured that results of the blood pressure (BP) measurement will be confidential.

2. The patient should not smoke, drink caffeinated beverages or exercise for 30 minutes prior to the measurement. Patient should also empty his/her bladder, as a full bladder can increase blood pressure slightly.

3. The patient should be seated in a relaxed, comfortable position with back well supported, feet flat on the floor and legs uncrossed. If the feet do not reach the floor, use a book or similar object on which to rest the feet. If the patient is slouched, both the systolic and diastolic pressures will be inaccurately high. (For example, sitting on an examining table with no support for the back can cause the diastolic BP to read as much as 6.5 mmHg higher.)

4. Cuff should be placed on bare skin. If one is going to roll up a sleeve to place the BP cuff, it must be rolled up as high as possible, and it must be possible to place two fingers under the sleeve with no difficulty.

5. The arm should be slightly flexed, the palm of the hand facing up, with the entire forearm supported on a smooth, flat surface. The brachial artery must be at heart level. Desk-high tables will position the arm at heart level. If an individual is exceptionally tall or short, adjustments should be made to position the arm properly. If the brachial artery is above the level of the heart, both the systolic and diastolic blood pressures will be inaccurately low. If the brachial artery is below the level of the heart, the opposite will be true.

6. The patient should not talk and should stay still while blood pressure is being measured.
CHAPTER 4: CUFF SIZE, INFLATION SYSTEM AND APPLICATION

The inflation system of a blood pressure device such as mercury or aneroid manometer consists of the cuff, inflatable bladder inside the cuff, pressure bulb, pressure control valve (thumb valve) and all the tubing of the manometer.

The bladder is the critical part that determines the proper size cuff to use. It is therefore important to understand how to use the long measurement of the bladder (the length) and the shorter measurement (the width) of the bladder to ensure that you are using the right sized cuff. Make sure the bladder of the cuff can encircle at least 80 percent of the upper arm circumference in adults and 100 percent in children. The width of the bladder must encircle at least 40 percent of the arm circumference (picture below from http://www.aafp.org/afp/2006/0501/p1558.html).

[Diagram of Blood Pressure Cuff]

If the bladder inside the cuff is too small for the patient’s arm, the reading obtained will be falsely high. If the bladder inside the cuff is too large for the patient’s arm, the reading will be falsely low. The center of the bladder should rest just above the brachial artery. If the bladder is not centered over the artery, the blood pressure (BP) reading will be erroneously high. For routine adult screening activities, four different cuff/bladder sizes are required. See table below:

[Insert Table]

https://www.google.com/search?q=blood+pressure+cuff&biw=1745&bih=837&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjGk6m6io7MAhXB8CYKHZobCz8Q_AU1BygC#tbs =sur:fmc&tbm=isch&q=blood+pressure+bladder&imgurl=FZGENh9j7FtjnM%3A
<table>
<thead>
<tr>
<th>Name of cuff</th>
<th>Arm Size (circumference)</th>
<th>Bladder Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Adult</td>
<td>9 – 10 inches</td>
<td>5 inches wide X 9 inches long</td>
</tr>
<tr>
<td>Adult</td>
<td>10 – 13 inches</td>
<td>6 inches wide X 12 inches long</td>
</tr>
<tr>
<td>Large Adult</td>
<td>13 – 17 inches</td>
<td>6 inches wide X 14 inches long</td>
</tr>
<tr>
<td>Thigh</td>
<td>17 – 20 inches</td>
<td>6 inches wide X 16.5 inches long</td>
</tr>
</tbody>
</table>

There are two additional checks to do to make sure you have the right technique.

1. The lower edge of the cuff should be at least one inch (2 ½ cm) above the bend in the elbow (antecubital fossa). Palpate the location of the brachial pulse at the antecubital fossa and center the inflatable bladder directly above the brachial artery. Wrap the cuff smoothly and snugly around the arm.

2. Test for proper cuff application by placing both thumbs under the applied cuff and tug gently; the cuff should not move. If the cuff is too loose, the blood pressure will be incorrectly high.

Note: Sometimes, when a large cuff is required, the lower edge of the larger cuff extends below the bend in the elbow. In this situation, it may be more accurate to apply the appropriate size cuff to the lower arm (the top edge of the cuff should be placed just below the elbow), and use the radial pulse to determine both the maximum inflation level and the actual pressure reading. Be sure that the radial pulse is at the same level as the heart. Using the bell side of the stethoscope may be necessary in order to hear the fainter sounds produced by the radial artery.
CHAPTER 5: DETERMINING THE START POINT USING MAXIMUM INFLATION LEVEL

When using aneroid or mercury devices, it is recommended to first determine the maximum inflation level (MIL) in order to have a good sense of the systolic blood pressure, and to not get confused with patients who may have an auscultatory gap (description in Chapter 6).

Maximum inflation level refers to the maximum level to which the pressure in the cuff needs to be elevated before measuring blood pressure using the Auscultatory-Palpatory (AP) Method. When measuring blood pressure using aneroid and mercury devices, perform the steps below to determine the MIL.

1. After applying the cuff, locate the radial pulse. Then palpate the radial pulse while steadily inflating the cuff and watching the mercury column or aneroid gauge. Note the point on the mercury column (or aneroid gauge) at which the pulse disappears.

2. Rapidly deflate the cuff.

3. The point at which the radial pulse disappeared is approximately the same as the client’s systolic blood pressure (BP). Remember this number.

4. This step also alerts the screener to irregularities of the heart rate that could affect interpretation of blood pressure readings.
Follow the steps below to start taking blood pressure readings.

1. After the estimate of systolic pressure is completed (via following the MIL steps in Chapter 5), wait 15 to 30 seconds before measuring the pressure with the stethoscope. This will allow time for the blood to return to the forearm. This wait must occur between every consecutive measurement of blood pressure.

2. Before inflating the cuff, always use both hands to squeeze the inflatable bladder to release all air and ensure that the pressure level (the mercury column or the gauge in an aneroid manometer) is at zero.

3. After the 15 to 30 second wait, palpate the brachial pulse and place the stethoscope head directly over the brachial pulse just below, but not touching, the cuff or tubing. Unless absolutely necessary (i.e., in using a large adult or thigh size cuff), never place the stethoscope under the cuff. The stethoscope should be applied firmly, but with light pressure. Heavy pressure will distort the artery and may cause sounds to be heard below the true diastolic pressure.

4. When using the diaphragm side of the stethoscope, there should be no air between the skin and the stethoscope. When using the bell side of the stethoscope, be certain that all edges of the bell are in contact with the skin.

5. With the stethoscope in place, close the thumb valve, and by rapidly and steadily squeezing the pressure bulb, inflate the cuff 20-30 mmHg above the point where the pulse disappeared in the MIL steps.

6. Then open the valve smoothly and slightly to begin cuff deflation. Maintain a constant deflation rate of two-three mmHg per second. If the cuff is deflated too quickly, it results in inaccurate, usually low, readings. If using a mercury manometer, never allow the mercury to stop during deflation, and once the mercury begins to fall, never pump the pressure higher without completely deflating the cuff, waiting 15 seconds and starting over. Both these situations cause venous congestion and result in erroneously high readings.

7. Continue to listen until about 10 mm below where the last sound was heard. If the sounds reappear and disappear again, this second disappearance of sound should be recorded as the diastolic blood pressure since auscultatory gaps can be found at the diastolic level of blood pressure also. Remove the stethoscope, and deflate the
cuff completely by opening the thumb valve all the way and squeezing the rubber bladder.

8. Record the blood pressure: Systolic blood pressure (BP) is the point at which the first of two or more continuous sounds are heard, and Diastolic BP is recorded at the disappearance of sound (also called the onset of silence), not at the last sound. For example, if the last sound is heard at "90," then the diastolic blood pressure is recorded as "88."

9. Record the blood pressure: Read to the nearest even number. If the reading falls between two numbers, read the number above.

Auscultatory Gap:

In certain persons, as the pressure in the cuff is lowered, the first Korotkoff sounds (details in Chapter 8) fade or disappear completely and reappear at a level well above the diastolic pressure. Although the Korotkoff sounds disappear, the pulse can still be felt during the silent period. This auscultatory gap usually occurs at the end of Phase 1 and the beginning of Phase 2 or between Phase 1 and Phase 3 (no sound is heard in Phase 2).

If you measure a blood pressure without first performing an estimate of systolic blood pressure (using the MIL method), your choice of the level to which the cuff pressure is inflated is arbitrary and, in fact, may result in failure to inflate the cuff above the pressure range of the auscultatory gap. Thus you will record the systolic blood pressure at the beginning of the second group of sounds.

For example, if a person’s true blood pressure is 210/90 with an auscultatory gap between 180 and 144 and the pressure in the cuff is raised to only 160, the systolic blood pressure would be recorded at the incorrectly low level of 144.

Measuring blood pressure (BP) in one or both arms: Leading authorities in the field of hypertension recommend that blood pressure be measured in both arms (unless contraindicated by mastectomy, dialysis shunt, rash, wounds, etc.) at each screening or clinical visit. This is necessary because several medical conditions can produce a low BP reading in one arm while the client is actually hypertensive. Usually BP differs slightly in the two arms; however, any significant difference (more than 10 mmHg) should be evaluated by a qualified health care provider.

Recent European Guidelines (the NICE guidelines - www.nice.org.uk/guidance/cg127/chapter/1-recommendations) recommend measuring both arms. If the systolic blood pressure in one arm is greater than the other by more
than 20 mmHg, then repeat the measurements in each arm. If after the second set of readings one arm is still more than 20 mmHg greater than the other, then the arm with the higher levels will be the arm to use for blood pressure measurements.
Korotkoff sounds are the series of sounds heard through a stethoscope placed over an artery as the blood begins flowing back through the vessel that had been closed off by a blood pressure cuff. These sounds, by which blood pressure is determined, were first described in 1905 by a Russian physiologist, Dr. Korotkoff.

The sounds are divided into five phases:

Phase 1: The first appearance of clear, tapping sounds that gradually become louder.

Phase 2: The sounds change to a murmur and have a swishing sound.

Phase 3: The sounds have a loud, knocking quality, but are not quite as clear as those in Phase 1.

Phase 4: The sounds suddenly are muffled and again have a faint, swishing quality.

Phase 5: All sounds disappear (often referred to as the onset of silence).

For more details on Korotkoff sounds visit https://vimeo.com/8068713.

Issues:

“Absent” Fifth Phase: There are times when sounds can be heard all the way to zero (see Appendix B for details and instructions on how to record the blood pressure (BP) in this situation).

See Appendix C for procedures to enhance the loudness of Korotkoff sounds.
CHAPTER 8: USING A STETHOSCOPE FOR BLOOD PRESSURE MEASUREMENT

When using a stethoscope to measure blood pressure (BP), the stethoscope should be applied directly over the brachial pulse—never under the cuff or touching the rubber tubing as this can cause false sounds. Place the bell or diaphragm over the brachial artery with the entire surface/rim in contact with the skin, while applying light pressure. Heavy pressure can distort the artery and produce sounds below the true diastolic BP. There should be no air between the skin and the stethoscope. In using stethoscopes with bent ear tips, be certain that the ear tips point forward.
CHAPTER 9: TAKING BLOOD PRESSURE USING ELECTRONIC DEVICES

For electronic devices positioning and patient preparation is the same as described in Chapter 3, but maximum inflation level (MIL) determination is not required as the electronic devices determine the mean arterial pressure and then estimate the systolic and diastolic pressures via proprietary algorithms.

Follow the steps below to take blood pressure readings:

1. Hit the “Start” button (see instruction manual).

2. Record reading of blood pressure.

3. Repeat steps if determining an average blood pressure (BP). Consult the manometer’s instruction manual regarding how long to wait in between measurements; many devices allow the user to program in the time intervals, the number of recordings and whether the individual BPs or the average of the readings is displayed.
There are two main explanations for obtaining blood pressure readings that do not reflect a patient’s true resting blood pressure (BP):

1. Physiological variations in blood pressure
2. Errors in the measurement process – equipment, screener and patient

**Physiological variations in blood pressure**

Physiological variations can cause temporary or ongoing elevations in blood pressure. These elevations may be mistaken for high blood pressure, and lead to an error in diagnosis. Blood pressure fluctuates greatly throughout the day and night, mostly in relation to activity, but also may fluctuate due to experiencing anxiety or stress, eating, having a full bladder, being in a hot or cold environment, experiencing pain, using nicotine, drinking caffeinated beverages and taking certain over-the-counter or prescription medications.

Below is a table demonstrating changes in blood pressure during common activities:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Systolic</th>
<th>Diastolic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attending a meeting</td>
<td>+20.2</td>
<td>+15.0</td>
</tr>
<tr>
<td>Working</td>
<td>+16.0</td>
<td>+13.0</td>
</tr>
<tr>
<td>Commuting</td>
<td>+14.0</td>
<td>+9.2</td>
</tr>
<tr>
<td>Walking</td>
<td>+12.0</td>
<td>+5.5</td>
</tr>
<tr>
<td>Dressing</td>
<td>+11.5</td>
<td>+9.7</td>
</tr>
<tr>
<td>Doing Chores</td>
<td>+10.7</td>
<td>+6.7</td>
</tr>
<tr>
<td>Talking on the telephone</td>
<td>+9.5</td>
<td>+7.2</td>
</tr>
<tr>
<td>Eating</td>
<td>+8.8</td>
<td>+9.6</td>
</tr>
<tr>
<td>Talking</td>
<td>+6.7</td>
<td>+6.7</td>
</tr>
<tr>
<td>Doing desk work</td>
<td>+5.9</td>
<td>+5.3</td>
</tr>
<tr>
<td>Reading</td>
<td>+1.9</td>
<td>+2.2</td>
</tr>
<tr>
<td>Doing business (at home)</td>
<td>+1.6</td>
<td>+3.2</td>
</tr>
<tr>
<td>Watching television</td>
<td>+0.3</td>
<td>+1.1</td>
</tr>
<tr>
<td>Sleeping</td>
<td>-10.0</td>
<td>-7.6</td>
</tr>
</tbody>
</table>

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**Errors in the measurement process**

Errors in the measurement process may involve the equipment, the person taking the blood pressure (screener) or the patient who is having their BP taken.
Equipment errors:

• Use of the wrong size BP cuff can lead to measurement error. The most common mistake is using a cuff that is too small, which will result in an overestimation of the BP.

• Mercury manometers will not produce accurate readings if the mercury is dirty or bouncing excessively on deflation, or if the mercury column is above or below zero when the system is deflated.

• Aneroid manometers can become inaccurate and must be checked for accuracy on a regular basis (every 3-6 months) against a mercury manometer. (Please note: The fact that the needle on the aneroid is at zero when the system is deflated is not a guarantee that the instrument is functioning properly.)

• A hole in the manometer bladder or tubing can lead to a measurement error.

• Automatic-electronic devices available for home or office use appear easy to use and in general are reliable. However, some of these instruments may lose their accuracy over time and require recalibration which usually is done by sending them back to the company that sells and/or services them.

Finger BP devices are not recommended for use, but some wrist devices have been validated. Benefits of wrist units include: They can be used without removing clothing, they are small and easily transportable, and they can be used in larger patients since wrist circumference varies less with body weight than upper arm circumference. The disadvantage of wrist devices is that accuracy is dependent on precise patient positioning -- having the arm at heart level during the measurement (see manufacturer’s instructions for the device). The position of the lower arm can greatly influence the measurement from a wrist device, whereas it has no such effect with upper arm devices. Visit dableducational.org for more information regarding wrist devices.
Blood pressure screener errors include:

- Hearing impairment
- Poor eyesight (making it difficult to distinguish between the millimeters lines on the gauge)
- Arthritis or other orthopedic problems of the hands, wrist or lower arm that make it difficult to “pump up” the manometer rapidly.
- Inattention or carelessness
- Hearing fatigue (after two hours of continuous BP screening, the screener should take a 15 minute break to allow hearing acuity to return to normal).
- Subconscious biases such as:
  - Terminal digit preference -- defaulting to certain numbers such as zeros or fives instead of the actual number
  - Cut point bias-- unconscious tendency to under-read the blood pressure so as to avoid having to tell the client his/her BP is elevated
  - Previous reading bias and
  - Assumptions that someone is hypertensive or not
- Poor technique when measuring the BP, such as failure to adjust for the auscultatory gap, can also lead to inaccurate readings when using mercury or aneroid devices

The position of the client and the conditions under which the blood pressure is measured can also influence the accuracy of readings.

See Appendix D for a list of common causes for errors in blood pressure measurements.
CHAPTER 11: DETERMINATION AND CONFIRMATION OF BLOOD PRESSURE CATEGORY

Hypertension cannot be diagnosed from only one set of readings at a screening. Several measurements taken during a number of health care provider office visits are necessary to diagnose hypertension, and only health care providers can confirm the diagnosis. Also, a person’s blood pressure varies from time to time depending on recent activity. It is lowest while asleep, rises following a meal or exercise and will vary at least slightly each time it is taken. Because of these normal fluctuations, consider following the instructions below:

• Take two readings one to two minutes apart, and average the readings (preferred).

• Measure blood pressure in both arms at initial evaluation. Use the arm with the higher reading for measurements thereafter.

• Confirm the diagnosis of hypertension at a subsequent visit one to four weeks after the first visit.
CHAPTER 12: TARGET BLOOD PRESSURE LEVELS AND OTHER RECOMMENDATIONS

In those who have been diagnosed with hypertension the goals of treatment vary.

According to the JNC 7 guidelines:

Target blood pressure (BP) for persons who do not have diabetes, chronic kidney disease, coronary heart disease (CAD) or heart failure, or who are not at high risk of developing CAD is:

- Systolic BP <140 mmHg and
- Diastolic BP <90 mmHg.

Target BP for people with diabetes, chronic kidney disease, those with established coronary artery disease (CAD) or those at high risk for CAD is:

- Systolic BP <130 mmHg and
- Diastolic BP <80 mmHg.

Please watch for updates from organizations that disseminate national guidelines regarding blood pressure categories. There have been concerns about the JNC 8 guidelines released in 2014. Furthermore, new studies such as the SPRINT trial are also challenging the current blood pressure guidelines.

For people with high blood pressure, it is very important to do the following:

- Have blood pressure checked frequently. This is the only way to know if the treatment is working.
- Take medication exactly as prescribed by their health care provider.
- Understand that taking medications as prescribed does not necessarily mean that BP is under control.
- Report all side effects to their health care provider as soon as possible, but continue to take the medication unless the health care provider changes or discontinues its use. Some BP medications, if suddenly discontinued, can cause dangerous reactions such as rebound hypertension -- a condition in which the BP becomes very high very quickly. This reaction can lead to a stroke or angina (angina is chest pain due to spasms or constriction of the coronary arteries).
- Follow lifestyle behavior changes (See Appendix E) to lower blood pressure and improve overall health status.
CLICK HERE TO WATCH A SHORT VIDEO DEMONSTRATING THE PROPER TECHNIQUE FOR MEASURING BLOOD PRESSURE.

See Appendix F for a quick reference guide.
1. The aneroid manometer is the preferred or gold standard for measuring blood pressure?
   a) True
   b) False

2. To accurately measure blood pressure (BP), the manometer/gauge should be positioned at the eye level of ___________.
   a) patient
   b) screener
   c) attendant

3. The positioning of the dial at the zero mark of an aneroid manometer under no pressure means the instrument is accurate.
   a) True
   b) False

4. Using tobacco and consuming coffee within 30 minutes of taking a BP is unlikely to influence the readings.
   a) True
   b) False

5. The bladder of the cuff (length-wise) should encircle at least what percentage of an adult’s arm?
   a) 75%
   b) 40%
   c) 60%
   d) 80%

6. If the bladder inside the cuff is too small for a patient’s arm, then the reading obtained will be___________ the actual reading.
   a) Equal to
   b) Lower than
   c) Higher than
7. The lower edge of the BP cuff should be at least _______ above the bend in the elbow (antecubital fossa).
   a) 2 inches
   b) 1 inch
   c) 1.5 inches

8. Systolic BP is the point at which the first of two or more continuous sounds are heard.
   a) True
   b) False

9. The Korotkoff phase used to determine diastolic BP is
   a) The phase when all sounds disappear.
   b) The phase when all sounds become muffled.
   c) The last sound heard through the stethoscope.

10. Automated electronic blood pressure devices need not be checked for accuracy in order to be used reliably.
    a) True
    b) False

11. Blood pressure should be taken in both arms initially, and then in subsequent visits the arm with the ______ reading should be used.
    a) Higher
    b) Lower

12. A blood pressure reading of 127/72 would fall under which category according to the JNC 7?
    a) Normal
    b) Prehypertension
    c) Stage I hypertension
    d) Stage II hypertension

13. The target BP for a person with diabetes, according to the JNC 7 is _______.
    a) less than 130/80 mmHg
    b) less than 135/85 mmHg
    c) less than 140/90 mmHg
14. Reducing sodium intake in the diet to less than 2.4 g leads to an average reduction of _____ mmHg in the systolic blood pressure.
   a) 2-4
   b) 4-8
   c) 2-8
   d) 2-10

15. While taking a blood pressure, the first sound heard through the stethoscope is at 150 mmHg, and sounds are heard from 150 until the last sound is heard at 78. What is the patient’s blood pressure?
   a) 150/78 mmHg
   b) 148/76 mmHg
   c) 150/76 mmHg
   d) 148/78 mmHg

16. Common causes of error in blood pressure measurement include ______
   a) dirty mercury.
   b) cuff applied over clothing.
   c) leaks in the pressure bulb or tubing.
   d) arm above or below the level of the heart.
   e) all of the above

17. It is acceptable to talk to the patient while measuring blood pressure.
   a) True
   b) False

18. Maximum inflation level refers to ______________
   a) the maximum level to which a manometer can be inflated.
   b) the maximum systolic blood pressure of an individual.
   c) the maximum level, as determined by palpating the radial pulse to which pressure in the cuff needs to be raised to accurately assess systolic blood pressure.

19. When using the auscultatory-palpatory technique of blood pressure measurement, the pressure in the cuff should be raised __________.
   a) 20-30 mmHg higher than the point where the pulse disappeared
   b) 30 mmHg higher than the point where the pulse disappeared
   c) 20 mmHg higher than the point where the pulse disappeared
20. Automated electronic devices measure ________ and then derive systolic and diastolic blood pressure through an algorithm.

a) mean arterial pressure  
b) mean systolic pressure  
c) mean diastolic pressure

CLICK HERE FOR TEST/EXAM KEY.
REFERENCES:

APPENDIX A: CHECKING AN ANEROID MANOMETER FOR ACCURACY

Equipment needed:

• Aneroid manometer gauge to be tested
• Mercury manometer
• Three 12-inch pieces of non-latex tubing with a Y-connector

Technique:

• Remove coiled tubing from mercury manometer. Connect one end of the “Y” tubing to mercury manometer.
• Connect the other end of the “Y” tubing to the aneroid manometer gauge.
• Connect the third side of the “Y” tubing to the aneroid pressure bulb.
• Hold the aneroid gauge at the same level as the mercury manometer (for accurate viewing).
• Inflate the mercury gauge to four test levels (60, 120, 180 and 240 mmHg).
• Compare aneroid reading to reading on mercury manometer at each level, and compute average deviation.
• If not accurate within plus or minus 4 mmHg at any one test level or as an average deviation, then discontinue use and replace or repair faulty gauge.

Additional checks:

• Bladder: Should be intact without leaks.
• Tubing: Should have no leaks.
• Valve: Should not stick or leak.
• Cuff: Should fasten securely. Center of bladder should be marked.
APPENDIX B: ABSENT FIFTH PHASE

In some persons, sounds are heard down to zero, resulting in an absent fifth phase. This condition can occur in a number of instances – in persons with aortic regurgitation or a hyperkinetic cardiovascular system, after vigorous exercise, in severe anemia, in thyrotoxicosis and as a normal occurrence in children.

If an absent fifth phase occurs, the diastolic blood pressure is recorded when the loud sounds of the third phase become muffled (beginning of Phase 4) and at zero. Example: 160/72/0

If an absent fifth phase is encountered, the measurement technique should be checked to insure that faulty technique is not responsible. Either improper cuff size (too wide or too narrow) or heavy pressure on the stethoscope can also cause sounds to be heard to zero.
APPENDIX C: PROCEDURES TO ENHANCE THE LOUDNESS OF KOROTKOFF SOUNDS

The intensity and loudness of the Korotkoff sounds depend on the difference between the pressure of the blood in the vessels of the forearm and the pressure of the blood entering the forearm from under the cuff. If a large amount of blood is trapped in the forearm when blood pressure is being measured, this condition increases the pressure in the forearm and thus decreases the intensity and loudness of the Korotkoff sounds.

There are three procedures that can be employed to reduce the amount of blood trapped in the forearm (venous congestion) and thereby increase the intensity and loudness of the Korotkoff sounds. Choose one of the three techniques below.

1. Rapidly inflate the pressure cuff.

2. Raise the arm and forearm for several seconds to drain venous blood. Inflate the cuff to the MIL while the arm is elevated. Lower the arm and begin deflation while listening to the sounds through the stethoscope.

3. Instruct the patient to open and close his fist 8-10 times after the pressure cuff is inflated above the systolic level, but before deflation is begun.
## APPENDIX D: COMMON CAUSES FOR ERRORS AND CORRECTIONS FOR BLOOD PRESSURE MEASUREMENT

### Equipment Error

<table>
<thead>
<tr>
<th>Cause</th>
<th>Effect</th>
<th>Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of mercury</td>
<td>Reading too low</td>
<td>Add mercury.</td>
</tr>
<tr>
<td>Too much mercury</td>
<td>Reading too high</td>
<td>Have extra mercury removed or have system cleaned</td>
</tr>
<tr>
<td>Clogged diaphragm</td>
<td>Mercury will not rise easily or will bounce</td>
<td>Replace diaphragm</td>
</tr>
<tr>
<td>Dirty mercury or dirty tube</td>
<td>Mercury meniscus is irregular and reading is impaired</td>
<td>Have mercury and tube cleaned</td>
</tr>
<tr>
<td>Bladder too narrow/small</td>
<td>High reading</td>
<td>Use proper cuff size. The circumference and diameter of the arm determines the size of the bladder</td>
</tr>
<tr>
<td>Bladder too wide/large</td>
<td>Low reading</td>
<td></td>
</tr>
<tr>
<td>Leak in the bladder or tubing</td>
<td>Mercury or aneroid needle continues to fall when valve is closed</td>
<td>Replace bladder or tubing.</td>
</tr>
<tr>
<td>Bladder not centered over artery</td>
<td>High reading</td>
<td>Use proper technique.</td>
</tr>
<tr>
<td>Cuff not applied snugly</td>
<td>High reading</td>
<td>Reapply cuff</td>
</tr>
<tr>
<td>Cuff applied over clothing</td>
<td>Incorrect reading</td>
<td>Use proper technique.</td>
</tr>
<tr>
<td>Pressure bulb has air leaks</td>
<td>Mercury or aneroid needle continues to fall when valve is closed</td>
<td>Replace bulb</td>
</tr>
<tr>
<td>Control valve “sticks”</td>
<td>Unable to control deflation rate resulting in incorrect reading</td>
<td>Replace valve</td>
</tr>
<tr>
<td>Control valve dirty, worn or has broken parts</td>
<td>Mercury or aneroid needle continues to fall when valve is closed</td>
<td>Have valve cleaned or repair broken parts</td>
</tr>
<tr>
<td><strong>Cause</strong></td>
<td><strong>Effect</strong></td>
<td><strong>Correction</strong></td>
</tr>
<tr>
<td>------------------------------------------</td>
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<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ear tips not forward.</td>
<td>Unable to hear blood pressure (BP) sounds clearly</td>
<td>Use proper technique</td>
</tr>
<tr>
<td>Stethoscope placed under cuff or touching tubing</td>
<td>False sounds are heard that may be mistaken for the BP sounds.</td>
<td>Use proper technique</td>
</tr>
<tr>
<td>Stethoscope applied with heavy pressure</td>
<td>Sounds may be heard below the true diastolic resulting in an incorrect reading</td>
<td>Use proper technique</td>
</tr>
<tr>
<td>Patient slouched</td>
<td>High reading</td>
<td>Have client sit up straight</td>
</tr>
<tr>
<td>Brachial pulse below heart level</td>
<td>High reading</td>
<td>Brachial pulse at heart level</td>
</tr>
<tr>
<td>Arm not fully supported on stable surface</td>
<td>High reading</td>
<td>Place arm on desk, table, etc.</td>
</tr>
<tr>
<td>Brachial pulse above heart level</td>
<td>Low reading</td>
<td>Place brachial pulse at heart level</td>
</tr>
<tr>
<td>Clothing around arm too tight</td>
<td>Incorrect reading</td>
<td>Remove clothing on arm</td>
</tr>
<tr>
<td>Leaning on arm</td>
<td>High reading</td>
<td>Have patient sit back in chair with no weight on arm</td>
</tr>
<tr>
<td>Inflation rate slow or inconsistent</td>
<td>Incorrect reading - may cause auscultatory gap</td>
<td>Maintain rapid and constant inflation rate</td>
</tr>
<tr>
<td>Cuff inflated too high</td>
<td>Painful to client and may cause incorrect (high) reading</td>
<td>Determine MIL</td>
</tr>
<tr>
<td>Deflation rate too slow</td>
<td>High diastolic reading and may cause auscultatory gap</td>
<td>Deflate at 2-3 mmHg per second</td>
</tr>
<tr>
<td>Deflation rate too fast</td>
<td>Low reading</td>
<td>Deflate at 2-3 mmHg per second</td>
</tr>
<tr>
<td>Cuff re-inflated after deflation has begun</td>
<td>Incorrect reading</td>
<td>Deflate cuff completely. Wait 15-30 seconds before re-inflating</td>
</tr>
<tr>
<td>Observer bias, digit preference, cut-point bias, previous reading bias or fatigue</td>
<td>Incorrect readings</td>
<td>Be aware of and on guard against these problems</td>
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</tbody>
</table>
APPENDIX E: LIFESTYLE CHANGES TO PREVENT AND MANAGE HYPERTENSION

1. Lose weight if overweight or obese:

Thin people are less likely to have high blood pressure (BP) than those who are overweight. Increased weight is a risk factor for cardiovascular disease, thus increasing the chance of having heart attacks or strokes. Maintaining a normal body weight (body mass index 18.5–24.9 kg/m²) could result in an average systolic blood pressure reduction of 5 – 20 mmHg/10 kg.

2. Adopt the Mediterranean Eating Pattern:

Greater adherence to a Mediterranean eating pattern has been shown to be associated with substantial reductions in total mortality, cancer and cardiovascular disease mortality. 7,8

The Mediterranean eating pattern has been described by the following characteristics:

• Eating primarily plant-based foods, such as fruits and vegetables, whole grains, legumes and nuts.
• Replacing butter with healthy fats, such as olive oil.
• Using herbs and spices instead of salt to flavor foods.
• Limiting red meat to no more than a few times a month.
• Eating fish and poultry at least twice a week.
• Drinking red wine in moderation (optional).

3. Reduce Sodium Intake:

It is recommended that adults under age 51 consume no more than 2,300 mg of sodium a day. For specific groups such as all persons age 51 and older, and/or those with hypertension, diabetes or chronic kidney disease and all blacks (including children), the recommendation is no more than 1,500 mg per day to prevent/control hypertension. The 1,500 mg recommendation applies to about half of the U.S. population. It is estimated that the average intake of sodium for all Americans age 2 and older is approximately 3,400 mg per day.

Reducing dietary sodium intake to <100 mmol per day (2.4 g sodium or 6 g sodium chloride) could result in an average systolic blood pressure reduction of 2-8 mmHg.
4. **Increase Aerobic Physical Activity:**

Regular aerobic physical activity (e.g., brisk walking) at least 30 minutes per day, most days of the week, could result in an average systolic blood pressure reduction of 4-9 mmHg.

5. **Limit Alcohol:**

The 2015-2020 *Dietary Guidelines for Americans* recommend that if alcohol is consumed, it should be in moderation—up to one drink per day for women and up to two drinks per day for men—and only by adults of legal drinking age. However, the *Guidelines do not* recommend that individuals who do not drink alcohol start drinking for any reason.

6. **Stop Smoking**
Consider placing the information near all areas of your facility where blood pressures (BPs) are taken to help staff remember the main points regarding accurate measurement technique.

<table>
<thead>
<tr>
<th>Summary of Blood Pressure Measurement Technique</th>
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<tbody>
<tr>
<td><strong>1. Patient position</strong></td>
</tr>
<tr>
<td>a. Seated with feet flat on floor, legs uncrossed.</td>
</tr>
<tr>
<td>b. Leaning against back of chair, not on the arm.</td>
</tr>
<tr>
<td>c. Entire arm fully supported on table with brachial artery at heart level.</td>
</tr>
<tr>
<td>d. Upper arm should be bare-do not apply cuff over clothing or even partially over clothing.</td>
</tr>
<tr>
<td><strong>2. Cuff size</strong></td>
</tr>
<tr>
<td>Most modern cuffs are marked with range lines to denote the need to use a larger or smaller cuff. However, the markings on some cuffs may not be adequate; thus, the screener must ensure that the bladder inside the cuff covers 80-100 percent of the circumference of the arm (100 percent in children) and that the width of the bladder covers 40 percent of the circumference of the arm.</td>
</tr>
<tr>
<td><strong>3. Cuff placement</strong></td>
</tr>
<tr>
<td>a. Apply cuff snugly to bare upper arm.</td>
</tr>
<tr>
<td>b. Place center of bladder directly above brachial artery.</td>
</tr>
<tr>
<td>c. Place bottom edge of cuff about 1 inch above the crease in the elbow.</td>
</tr>
<tr>
<td><strong>4. Palpate (feel) for radial pulse.</strong></td>
</tr>
<tr>
<td><strong>5. Inflate manometer while palpating radial pulse.</strong></td>
</tr>
<tr>
<td>a. Note level on the gauge at which radial pulse disappears.</td>
</tr>
<tr>
<td>b. Release air from cuff rapidly.</td>
</tr>
<tr>
<td><strong>6. Wait 15 seconds and then:</strong></td>
</tr>
<tr>
<td>a. Palpate brachial pulse.</td>
</tr>
<tr>
<td>b. Place ear tips of stethoscope in ears with tips facing forward.</td>
</tr>
<tr>
<td>c. Place stethoscope over brachial artery not touching the cuff.</td>
</tr>
<tr>
<td><strong>7. Measure blood pressure by:</strong></td>
</tr>
<tr>
<td>a. Rapidly inflating cuff to a level 20-30 mmHg above the point where the radial pulse disappeared.</td>
</tr>
<tr>
<td>b. While slowly releasing the air in the cuff, listen for the Korotkoff sounds.</td>
</tr>
<tr>
<td><em>The first of two consecutive sounds is recorded as the systolic pressure. The diastolic is recorded at the level where the sound disappears.</em></td>
</tr>
<tr>
<td><strong>8. When the sound disappears:</strong></td>
</tr>
<tr>
<td>a. Continue to deflate the cuff slowly for another 10 mmHg.</td>
</tr>
<tr>
<td>b. If no further sounds are heard, rapidly release all air in the cuff and record the BP.</td>
</tr>
</tbody>
</table>
OTHER REFERENCES

Measuring Blood Pressure the Right Way (pdf)

Control Your Sodium (pdf)

Blood Pressure Risk Factor Table for Hypertension (pdf)

Blood Pressure Classification (pdf)