MEASURING AND RECORDING BLOOD PRESSURE

Abstract

Measuring and recording blood pressures is more difficult than measuring and recording the body temperature, pulse, and respirations. It is easier to make mistakes when measuring the blood pressure than when measuring the other vital signs. Certified Nursing Assistants must learn the proper way to measure blood pressure. If blood pressure is not measured correctly, an inaccurate blood pressure reading may be obtained that might be higher or lower than the true reading. Inaccurate measurements recorded in the patient's chart may negatively impact the patient's care. With practice and a conscientious effort, the patient's blood pressure can be accurately measured and recorded.

Learning Goals:

1. Identify a basic definition of blood pressure.
2. Identify the factors or components that work together to create blood pressure.
3. Describe how to measure and record a patient's blood pressure.
4. Identify the signs and symptoms of hypertension and hypotension.

Introduction

The blood pressure, body temperature, pulse, and respirations, are bodily vital signs. These measurements are used to quickly, easily, and reliably assess a patient's basic state of health. They are also used to detect the presence of illness or injury, to monitor the progress of a disease or medical condition, or to see if a patient is responding favorably to a medication or a treatment. The blood pressure, specifically, can give valuable information about the condition of a patient's heart, the condition of a patient's blood vessels, and signal potential problems with the circulating blood volume.

Anatomy and Physiology of the Circulatory System

Blood pressure may be defined as a measurement of the amount of force that is being exerted against the walls of the blood vessels. To understand blood pressure, a person must understand the circulatory system. The circulatory system is comprised of the heart, the blood vessels, and the blood volume. The circulatory system and its components make up a closed system. Each of these parts of the circulatory system is essential for maintaining a normal blood pressure.

The Heart

The heart is a muscular pump that is divided into four chambers. It beats rhythmically, with an equal amount of time between each beat. For the average adult, the normal heart rate is approximately 72 beats a minute, and the normal range is 60-100 beats a minute. There are two phases to a heartbeat. The first phase is *diastole*. In this first phase, the chambers of the heart fill with blood. The second phase is

systole. In this second phase, the chambers of the heart forcefully contract and pump a volume of oxygenated blood out to the body through the blood vessels. The oxygenated blood is delivered to the tissues and organs, and it is then unoxygenated blood is returned to the heart

The Blood Vessels

The *arteries* and the *capillaries* carry oxygenated blood from the heart to the organs and tissues. After the oxygen has been released to them, the *veins* carry unoxygenated blood and metabolic waste products byproducts - mostly carbon dioxide - back from the body to the lungs. The carbon dioxide is eliminated from the blood when a person exhales, and then oxygen is delivered to the blood when a person inhales. The oxygenated blood is delivered to the heart and the cycle starts again.

It is important to know that the arteries and capillaries are strong and have muscular tone, as do the veins but to a lesser degree. When the heart pumps a wave of blood out to the circulation, the blood vessels expand to accommodate the increased volume. Because they have muscular tone or tension, they also contract down in response and that moves the blood along and out through the body. Systole, the second phase of a heartbeat, is strong enough to send a volume of blood out through the arteries but systole is not strong enough to send that volume of blood from the heart, out to the body and back to the heart. The muscular tone of the blood vessels must be maintained or blood pressure would fall below the normal limit.

The Blood Volume

The blood volume for an average adult is approximately five liters: five liters is approximately 1.3 gallons. Blood volume slightly more in men than it is in women. As explained above, blood carries oxygen to the body and carbon dioxide from the body to the lungs.

The purpose of the circulatory system is to circulate blood through the body, and the following are the basic steps of this process.

- Oxygen combines with blood that is circulating through the blood vessels of the lungs - the pulmonary circulation. The oxygen is delivered to the pulmonary circulation when a person inhales.
- The oxygenated blood in the lungs is delivered to heart.
- The heart pumps the oxygenated blood out to the organs and tissues and then back through the blood vessels consisting of the arteries, the capillaries and the veins.
- Oxygen is delivered to the body, and then carbon dioxide moves from the tissues and organs into the blood.
- The unoxygenated blood that is carrying carbon dioxide is circulated back to the lungs.
- Carbon dioxide is eliminated when unoxygenated blood reaches the lungs and a person exhales. Oxygen is inhaled and the process starts over.

By understanding that the circulatory system is a closed system, it is easier to see how its components work together to produce blood pressure. Without a strong, functioning heart, the blood would not move through the circulation. Without healthy, functioning blood vessels, the initial wave of pressure that is created by systole would

not be strong enough or last long enough for the blood to reach the extremities, the deep organs, and tissues and return to the heart. Without a normal blood volume, the closed system would not have enough fluid to generate normal blood pressure.

In order to maintain blood pressure there must be: 1) A normal, functioning heart, 2) Normal, healthy blood vessels, and 3) A normal volume of blood. These points cannot be stressed enough. If a patient's blood pressure is abnormally high or abnormally low, there is a problem with one of these three.

In the beginning of this section, blood pressure was defined as the measurement of the amount of force that is being exerted against the walls of the blood vessels. This force or pressure varies. It rises when the heart pushes out a volume of blood, and then it goes back down to a steady state that represents the pressure inside the blood vessels between each heartbeat.

Blood pressure is defined as the measurement of the force pressure exerted against the walls of the blood vessels but as mentioned above, blood pressure rises sharply during each heartbeat and there is a steady state of pressure in the blood vessels between each heartbeat.

The first of those two pressures, the pressure in the blood vessels as the heart is contracting, is called the *systolic pressure*. The second pressure, the steady state pressure in the blood vessels between heartbeats, is called the *diastolic pressure.*
When measuring a patient's blood pressure, the clinician is checking the systolic and diastolic pressures. A patient's blood pressure is the

measurement of both pressures. It is incorrect to report only the systolic pressure. The diastolic pressure reflects the constant pressure in the circulatory system, and it provides key information about how well the body is being supplied with blood. A clinician must record both the systolic and the diastolic pressures when measuring a patient's blood pressure.

Measuring and Recording Blood Pressure

Measuring and recording blood pressures is more difficult than measuring and recording the body temperature, pulse, and respirations. It is easier to make mistakes when measuring the blood pressure than when measuring the other vital signs. A healthcare worker must learn the proper way to measure blood pressure. If blood pressure is not measured correctly, the clinician will obtain an inaccurate blood pressure reading that might be higher or lower than the true reading. This inaccurate measurement is then recorded in the patient's chart, which may negatively impact the patient's care. With practice and a conscientious effort, a clinician can learn to accurately measure and record a patient's blood pressure.

In order to measure a blood pressure, a clinician will need a stethoscope and a blood pressure monitor. The systolic blood pressure can be measured without a stethoscope by a method called palpation, which is not discussed here.

The technical term for a blood pressure monitor is *sphygmomanometer* but they are more commonly called *blood pressure cuffs.* They can use mercury or they can be mechanical. The mechanical ones are also called *aneroid cuffs*. Digital blood pressure cuffs are also commonly

used. These simply require that the blood pressure monitor be attached to the person, then the machine measures blood pressure.

The mercury and the mechanical sphygmomanometers have an inflatable cuff. With a mercury blood pressure apparatus, the cuff is attached with a rubber tube to a vertical glass tube that is filled with mercury and has gradations imprinted on it. An aneroid sphygmomanometer also has a rubber tube that is attached to the cuff, but this tube is attached to a gauge with a moveable needle, much like the face of a clock.

The blood pressure can also be checked in the wrist using a regular sphygmomanometer or a blood pressure cuff designed for that purpose. This is done to measure the pressure in the radial artery, the same blood vessel used to check pulse rate. Measuring blood pressure in the wrist may be necessary if a properly-sized cuff is not available or for some other reason. However, measuring the blood pressure at the wrist using a sphygmomanometer or one of these special cuffs will usually result in a reading that is higher than if the pressure was measured in the upper arm. Also, the wrist blood pressure cuffs are very sensitive and must be used correctly or the readings will be inaccurate.

With the mercury and the aneroid sphygmomanometer, another rubber tube is attached to the cuff and at the end of that tube is a rubber bulb, and the rubber bulb is used to inflate the cuff. Once a clinician has a stethoscope and a sphygmomanometer he or she is ready to begin. The following points should be followed to insure an accurate blood pressure.

1. The patient should be lying down or sitting. If the blood pressure is taken when the patient is standing, the measurement will be too low. Remember, the pressure at a particular point in a closed system is being measured. When someone is standing, it is more difficult for the heart and the blood vessels maintain a blood pressure because they are working against gravity, so to get an accurate blood pressure the patient must be lying down or sitting.

2. Either arm may be used to measure blood pressure but do *not* measure the blood pressure in an arm in which there is an intravenous needle, a hemodialysis shunt, or any other type of vascular access device. Do not take the blood pressure in an arm that has been injured. A woman who has had a breast removed should have her blood pressure taken in the arm opposite the side of the surgery.

3. Make sure the arm is level with the heart. This is very important. If the arm is above the level of the heart, the blood pressure reading will be falsely low. If the arm is below the level of the heart, the blood pressure reading will be falsely high.

4. Have the patient move his or her clothing up the arm, towards the shoulder, until there is room for the blood pressure cuff. Do not take someone's blood pressure with the cuff placed over a shirt, sweater, *etc.*
5. The patient should be relaxed and ideally. The patient should be in the sitting or lying position for at least two minutes before the blood pressure is checked.

6. The cuff should be the proper size. A cuff that is too big will result in a reading that is falsely low, and a cuff that is too small will result in a reading that is falsely high. The cuffs have demarcations on them that will help to determine which size to use. For the majority of patients, there is a standard-sized cuff that will be appropriate. There should be several different sizes of cuffs available so that people who are very thin or who are obese can be accommodated.

7. Try to measure the blood pressure in a place where there is a minimum of background noise.

To measure the blood pressure, have the patient hold his or her arm out straight with the palm of the hand facing upward. Wrap the cuff around the patient's arm securely. It should be placed so that the edge of the cuff is one inch above the bend of the elbow. Next, find the *brachial artery*. This is the blood vessel that will be used to determine the blood pressure. The brachial artery is located on the arm on the left side of the fold of the elbow, towards the center of the patient's body. Use the fingers, not the thumb, to palpate the area until a pulse is felt. When the pulse is found, put the stethoscope over that spot.

Next, close the valve that is attached to the rubber bulb and begin squeezing. The column of mercury will rise in the tube or the needle of the aneroid sphygmomanometer will move. Keep inflating the cuff until the mercury level or the needle on the aneroid gauge is at 160. This is a good starting point to begin. When the level of 160 has been reached, the brachial artery will be completely occluded, and the

person taking the blood pressure should not hear anything through the stethoscope.

Slowly open the valve. The mercury column or the needle will start to drop. Remember to open the valve slowly. If the air is let out of the cuff too quickly, the blood pressure will not be correctly measured. The person taking the blood pressure needs to closely watch the mercury or the needle on the gauge. The proper amount of time to deflate the cuff is 2 mmHg a second. If the cuff is deflated too quickly, the systolic blood pressure will be read as too low and the diastolic pressure will be read as too high.

After a few seconds, the pulse sound will be heard through the stethoscope and the person taking the blood pressure will be able to *see* the column of mercury or the needle on the aneroid sphygmomanometer move back and forth at the same time as they are dropping. Each movement of the mercury column or the aneroid needle represents a heartbeat. That point at which the movement is seen is the *systolic blood pressure*.

In a few more seconds, there will be a point at which the person taking the blood pressure will no longer hear the pulse or see the mercury column or the needle moving back and forth; that point is the *diastolic blood pressure.* The cuff should be allowed to deflate completely, and then removed to complete the measurement.

If it is noticed from the patient's chart that the systolic pressure when last measured was over 160, the cuff should be inflated a bit higher. Also, if the cuff is inflated to 160 but the patient's pulse is immediately

heard, the cuff should be deflated; and the person taking the blood pressure should wait a few minutes and then inflate the cuff a bit higher.

By convention, blood pressure is recorded using units called millimeters of mercury. This is often recorded using the abbreviation mmHg (mm stands for millimeters, and Hg is the chemical symbol for mercury). The blood pressure should be recorded immediately after the measurement is complete and make a notation that indicates whether the patient was lying or sitting at the time. By tradition, the blood pressure is recorded with the systolic pressure first, a forward slash, and then the diastolic pressure; for example, 126/68.

Blood pressure and pulse may be measured when the patient is lying down, sitting, and then when standing. These measurements are also done with timed intervals between the readings. This procedure is called checking *postural vital signs*, and it is often used to determine whether a patient is dehydrated or is bleeding. Checking postural vital signs will not be discussed.

Normal Blood Pressure

The parameters of "normal" blood pressure are somewhat arbitrary and flexible but in this module, a normal blood pressure will be defined as *a systolic pressure less 120 mmHg and/or a diastolic pressure less than 80 mmHg.* This definition is merely a starting point because it is not possible to provide a single number or a range that is considered normal for everyone. There are simply too many variations in blood pressure among the general population for this to be practical and accurate. The blood pressure of many women, a small population of

elderly people, thin people, and people who are very athletic is typically at the lower end of the normal range.

The blood pressure of children and infants is lower than the blood pressure of adults. The blood pressure of people who are obese, people of certain ethnic groups such as African-Americans, and most elderly people is likely to be at the higher end of the normal range. Blood pressure, like temperature and pulse, varies depending on the time of day. It is typically higher during the day and lower during the evening hours and the early morning.

Most authorities agree that instead of looking for a blood pressure that can be defined as normal, it is more useful to think of what blood pressure means and what effects a high or low blood pressure can have on health. If blood pressure is considered that way, then a normal blood pressure is a pressure that can be safely maintained over the course of a person's life. An abnormal blood pressure is a pressure that is potentially harmful to a person because it can cause adverse health effects.

A blood pressure that is abnormally high is typically indicative of a chronic condition that has existed for many years, although there are some acute conditions that cause sudden, dangerous elevations of blood pressure. A blood pressure that is abnormally low is typically caused by an acute medical problem. In either situation, there can be serious consequences if the blood pressure is not stabilized.

With children and adolescents, normal blood pressure differs based on age. The following chart provides a normal measurement for the age groups.

Blood Pressure: Normal Ranges for Infants, Children and Adolescents

Newborn: 65/50
2 months: 85/50
4 months: 90/50
6 months 90/55
1 year: 100/55
2 years: 102/58
4 years: 104/65
6 years 107/69
10 years: 115/74
12 years: 119/76
16 years: 120/80

Blood Pressure Measurement Errors

If the patient's blood pressure is too high or too low but the patient has no complaints and he or she appears comfortable then it is likely that an error has been made in the technique. In this case, the person obtaining a blood pressure measurement should make sure that that the patient has been resting comfortably for at least five minutes, and then perform the following checks.

- Was the cuff the correct size? If the cuff was too small, the blood pressure will be too high, and if the cuff was too large the blood pressure will be too low.

- Was the cuff deflated too quickly?
- Check to see if the patient's arm was placed at the level of the heart.
- Was the stethoscope placed over an article of clothing, *i.e.*, a shirt or sweater sleeve?

The patient should be asked if he or she was feeling anxious or stressed. The patient may have been upset but it may not have been obvious. Also, the patient should be asked whether he or she recently exercised, consumed a cup of coffee, or took a medication that may have elevated the blood pressure. If someone's blood pressure is too high or too low and there was no error in technique, and no other reason for the abnormal reading, there should be a five-minute waiting period and the blood pressure rechecked. If the reading is still abnormal, it must be assumed that the blood pressure is too high or too low and a registered nurse or immediate supervisor should be notified.

Hypertension and Hypotension

When a patient's blood pressure is outside the normal range, there may be a condition that caused it to be too high or too low. Some of the more common ones are listed here.

- Hypertension - Abnormally high
- Blood loss - Abnormally low
- Infection - Abnormally low because the blood vessels have dilated in response to the infection
- Myocardial infarction - Abnormally low

- Drug overdose - Abnormally high as with cocaine, or abnormally low, as with narcotics
- Adverse drug reaction - Abnormally high or low
- Dehydration - Abnormally low

A normal blood pressure for one person would be considered abnormally high or low for someone else. For example, a young, slender, athletic woman may have a blood pressure of 98/48 mmHg. This reading is on the lower end of the normal range but it is still normal for someone of her age, gender, and life style. However, a reading of 98/48 mmHg may indicate that something is wrong if the patient normally has a blood pressure of 139/78 mm Hg *and* that patient is 78 years old, obese, or sedentary. The opposite may also be true; if someone normally has a blood pressure of 98/48 mm Hg and now has a pressure of 139/78 mm Hg that may be cause for concern. In either situation, these changes should require attention.

If the patient's blood pressure is unusually high or low when compared what it has been before, a registered nurse or immediate supervisor should be notified immediately. The most common cause of an elevated blood pressure is hypertension. There are many causes of hypotension but it usually simple to determine why the blood pressure is low.

Hypertension

Hypertension is defined as a systolic blood pressure greater than 140 mmHg or a diastolic blood pressure greater than 90 mmHg. Hypertension is very common. Approximately 75 million Americans

have hypertension, and it is a major contributing risk factor for the development of coronary artery disease, kidney disease and stroke.

In approximately 95% of all cases hypertension there is no identifiable cause. These cases are called primary hypertension, and they are most likely due to a genetic predisposition to the disease. There are some endocrine, renal, and vascular problems that can cause hypertension, but these are relatively rare.

Hypertension affects men more than women until the age of 45; after that point, both genders are equally affected. In the United States, there is a higher incidence of hypertension in African Americans than in any other ethnic group.

A diagnosis of hypertension is usually made by chance when someone has his or her blood pressure checked during a routine physical exam. This is not surprising as blood pressure can be elevated for years without producing any signs or symptoms. Once an initial reading of over 140 mmHg or over 90 mmHg has been made, it is recommended that these readings be confirmed to be sure that the elevations noted were not an isolated incident.

Confirmation should be done by checking the blood pressure on three or more separate occasions, each occasion separated by at least several days. During these visits, great care should be taken to ensure that the readings are accurate, such as making sure that patient has rested for at least five minutes, the right size blood pressure cuff is used, *etc.* Three readings should be obtained, each reading separated by at least five minutes. The average of the three is used as the true

value and if the average is greater than 140 mmHg or 90 mmHg, the patient has hypertension.

Once the diagnosis of primary hypertension has been made, the patient will be checked for damage to the blood vessels, eyes, heart, and kidneys, as these are organs and structures that are typically affected by the long-term elevation of blood pressure. The higher the blood pressure and the longer it has been elevated, the greater the risk is for complications.

Treatment of hypertension begins with lifestyle changes. The patient will be advised to eat a low-salt, low-fat diet, engage in aerobic exercise, limit alcohol intake, lose weight, and stop smoking. If these lifestyle changes are not successful or the patient cannot comply with them, antihypertensive medications are the next step.

There are situations in which a patient's blood pressure is elevated and the patient is symptomatic. *Hypertensive emergencies* occur when the patient's systolic blood pressure is greater than 180 mmHg or diastolic pressure is greater than 120 mmHg and the patient has clear evidence of organ damage such as blurred vision, chest pain, or confusion. Obviously, these situations should be brought to the immediate attention of a physician. If the Certified Nursing Assistant obtains a patient's systolic blood pressure and finds it is greater than 180 mmHg or the diastolic blood pressure is greater than 120 mmHg, this is an *emergency* and should be reported immediately to a registered nurse or immediate supervisor. Also, the patient should be asked if he or she is experiencing any dizziness, headaches, blurred vision, or chest pain.

If a person with a history of hypertension is complaining of blurred vision, chest pain, dizziness, or headache, this should be reported immediately to the registered nurse or immediate supervisor, *regardless of what the blood pressure measurement is.*

Hypotension

Most people are aware of the dangers of hypertension but hypotension is also a cause for concern as it can have serious consequences. Hypotension will be defined here as a systolic blood pressure less than 90 mmHg or a diastolic blood pressure less than 60 mmHg.

The body requires a sufficient supply of blood to function properly, and blood pressure delivers that volume of blood throughout the body. Bodily organs and structure will suffer without an adequate supply of blood. The brain, the heart, and the kidneys are especially vulnerable because they are metabolically active and each one has a large number of blood vessels. If the blood pressure is too low, the patient can have a stroke, heart attack, or damage to the kidneys.

There are many causes of hypotension. The most common causes are:

- Dehydration
- Hemorrhage
- Infection
- Myocardial infarction, commonly referred to as a heart attack

Each of these causes of hypotension clearly illustrates how maintenance of a normal blood pressure depends on a strong, functioning heart, an adequate blood volume, and good muscular tone of the blood vessels.

Example #1: Dehydration or Hemorrhage

If someone is dehydrated or he or she is hemorrhaging, the volume of the closed system is compromised. The circulatory system can try and compensate by increasing the pulse rate and by having the heart beat more forcefully, but if the volume in the system is too low these compensatory mechanisms will not work.

Example #2: Infection and Vasodilation

Infection can, at times, be so overwhelming that the blood vessels become dilated. These patients are often dehydrated, as well. This widespread vasodilation happens quite often in a condition called septic shock. As with dehydration and hemorrhage, compensatory mechanisms may not be enough to restore and maintain a normal blood pressure.

Example# 3: Myocardial Infarction

Myocardial infarction causes damage to the heart muscle, causing the heart not to be strong enough to pump out blood to the body.

Unlike someone who has hypertension, the patient who is hypotensive often has dramatic signs and symptoms. These include chest pain, confusion, cool/clammy skin, cyanosis, diaphoresis, difficulty breathing, dizziness, fainting, headache, lethargy, lightheadedness, pallor, palpitations, tachycardia, tachypnea, weakness. The first signs of hypotension are often feelings of dizziness and weakness when the patient moves from a lying or sitting position to standing.

If a person is hypotensive, the first thing to do is to make sure the patient is in a safe position. Hypotension can cause fainting or loss of consciousness, which may lead to a fall. The patient should be placed in a supine position. If that is not possible, the patient should be asked or assisted to sit down. Lying or sitting will help keep the patient safe, and it will also help prevent the blood pressure from dropping lower. Next, the nursing assistant should notify a registered nurse or immediate supervisor and make a quick assessment of the patient. The nursing assistant should check the patient's pulse and respirations and, if there is time, check the patient's temperature. The color of the patient's skin should be evaluated, and the skin checked for cyanosis (bluish or purplish coloration that indicates a lack of oxygen), diaphoresis (sweating), or pallor (pale). The patient's neurological status should be checked, such as evaluating for whether the patient is confused, slow to respond - and the nursing assistant should be sure to ask the patient if he or she is having any symptoms.

Summary

Measuring and recording blood pressure quickly and correctly takes time to learn compared to measuring the other vital signs. The important points of blood pressure measurement have been discussed and examples provided of abnormal conditions that can affect the blood pressure.

Hypertensive emergencies occur when the patient's systolic blood pressure is greater than 180 mmHg or diastolic pressure is greater than 120 mmHg and the patient has clear evidence of organ damage such as blurred vision, chest pain, or confusion. When a nursing assistant sees that patient is having a hypertensive emergency,

immediate action is required by notifying a registered nurse or immediate supervisor. Any dizziness, headaches, blurred vision, or chest pain should be immediately identified, as well.

Measuring and recording blood pressures is more difficult than measuring and recording the other vital signs. It is easier to make mistakes when measuring the blood pressure than when measuring a person's temperature, pulse or respiratory rate. All healthcare workers must learn the proper way to measure blood pressure to avoid an inaccurate reading that is higher or lower than the true blood pressure measure.