

chapter **3**

# Assessment of Vital Signs



## LEARNING OBJECTIVES

*After reviewing this chapter, the learner will be able to:*

- 1 Discuss the importance of taking a patient's vital signs.
- 2 Describe the five methods of taking a patient's temperature.
- 3 Discuss the proper technique to take a patient's pulse.
- 4 Apply the correct technique to take a blood pressure.
- 5 State the stages of blood pressure.
- 6 Define the orthostatic changes in blood pressure.

## KEYWORDS

Amplitude of pulse	Pulse deficit
Bradycardia	Sinus arrhythmia
Dyspnea	Tachycardia
Eupnea	Temporal temperature
Orthopnea	Tympanic temperature

## Introduction

The healthcare provider is assessing the patient from the beginning of their first encounter until the end of the physical examination. The healthcare provider observes the patient's physical appearance, manner of dress, hygiene, and posture. The healthcare provider notes if the mental condition of the patient is appropriate to the patient situation. The healthcare provider starts the physical examination by taking the vital signs of the patient. It is important to have baseline vital signs to compare with the current vital signs. The proper procedure for checking the temperature followed by pulse, respirations, and blood pressure will be discussed.

## Temperature

The average temperature taken by an oral thermometer is 98.6°F (37°C). The patient's temperature in the early morning is lower than average and is higher than average in the late afternoon or evening. The rectal temperature is higher than the oral temperature by about 1°F. The axillary temperature is usually lower than the oral and rectal temperature by about 1°F and can take up to 10 minutes to register. The tympanic and temporal temperature is higher than the average oral temperature by about 1°F. A patient's temperature can range from 96.7°F (35.9°C) to 100°F (37.8°C) depending on the method used to take the temperature and time of day the healthcare provider takes the temperature of the patient. The temperature will also fluctuate with exercise, pregnancy, menstrual cycle, emotional stress, age, gender, and the patient's state of physical health.

It is important for the healthcare provider to remember that it is his/her responsibility to check to ensure that all equipment is working properly. If the task of checking vital signs is delegated to other personnel, it is important to

ensure that they have been properly trained in the correct procedures to take vital signs.

## Oral Temperature Technique

The average range of the patient's temperature taken by the oral method is 96.4°F-99.1°F (36.8°C-37.3°C). The patient needs to be alert and capable of holding the thermometer in a closed mouth. The healthcare provider should wait 30 minutes if the patient has had a hot or cold beverage to drink or has recently smoked a cigarette. The healthcare provider should place the oral probe under the patient's tongue in the sublingual pocket. This area under the tongue has a good blood supply. This method cannot be used for a patient who is in an unconscious state or is incapable of holding the thermometer in their mouth due to oral trauma or oral surgery. It is not recommended to take an oral temperature on a child under the age of 7 years.

## Axillary Temperature Technique

The average range of a patient's temperature taken by the axillary method is 95.9°F-98.6°F (35.5°C-37°C). The axillary method measures surface skin temperature and is the least reliable method, but is commonly used in infants and young children.

## Rectal Temperature Technique

The average range of the patient's temperature taken by the rectal method is 97.1°F-100.4°F (36.2°C-38.0°C). This method has been commonly used in the past and reflects the core temperature of the body. However, it is now considered an invasive procedure and is not recommended for infants and small children or for those patients with diarrhea, rectal surgery, lesions of the rectal area, and for the immunocompromised patient. The healthcare provider should don gloves and apply a water-soluble lubricant to the rectal probe. The healthcare provider should insert the rectal probe no deeper than 1 inch into the adult rectum.

## Tympanic Temperature Technique

The average range of the patient's temperature taken by the tympanic method is 95.7°F-100.0°F (35.4°C-37.8°C). The tympanic membrane probe is inserted about 0.5 cm into the ear canal and the temperature of the tympanic membrane is measured. If performed properly, it is an effective and quick method

to take the patient's temperature. This method can be used with a patient who is unconscious or in an acute emergency situation. This temperature is not affected by smoking or oral intake, but should not be used with the patient with ear pain or an ear infection.

## Temporal Temperature Technique

The average range of the patient's temperature taken by the temporal method is 98.7°F-100.5°F (37.1°C-38.1°C). This method is a quick and easy way to take the patient's temperature and it measures the heat from the temporal artery. It is suggested that the patient does not have any facial lotion on the forehead and that the thermometer is not swiped too quickly across the forehead. The infrared lens of the thermometer must be kept clean of the skin's oil. This technique can be used with patients in most circumstances and should not be used if there is trauma to the forehead or face.

Definitions	
<b>Hypothermia</b>	Temperature below average range.
<b>Hyperthermia</b>	Temperature above average range.
<b>Bradycardia</b>	Heart rate less than 60 beats per minute.
<b>Tachycardia</b>	Heart rate greater than 100 beats per minute.
<b>Sinus arrhythmia</b>	Heart rhythm increases with inspiration and decreases with expiration, and is common in children and young adults.
<b>Pulse deficit</b>	Difference between a peripheral pulse and apical pulse.
<b>Eupnea</b>	Within normal range of breathing
<b>Tachypnea</b>	Breathing more frequently than normal (more than 20 breaths per minute in the adult).
<b>Bradypnea</b>	Breathing less frequently than normal (less than 12 breaths per minute in the adult).
<b>Dyspnea</b>	Difficulty with breathing.
<b>Orthopnea</b>	Difficulty with breathing in the supine position, prompting the need to sit up to breathe.

## Pulse

The pulses are generated when the left ventricle pumps blood into the aorta and generates a pressure wave. The pulse can be felt over a peripheral artery and also at the apical impulse at the fifth intercostal space, at the midclavicular line on the left side (apex of the heart).

**TABLE 3-1** Normal Pulse Rate Levels

Stage	Age Range	Pulse Rate, Beats per Minute
Newborn	Birth to 3 mo	100-150
Infant	3-6 mo	90-120
	6-12 mo	80-120
Toddler	1-3 y	70-150
Preschooler	3-6 y	70-130
School-aged child	6-12 y	65-125
Adolescent and adult	Over 12 y	60-100
Conditioned athlete	Over 12 y	40-60

The heart rate is defined as the number of pulsations (beats) counted within 1 minute. The healthcare provider assesses the pulse for rate, rhythm, amplitude, and elasticity of the pulse. The average heart rate is 60-100 beats per minute in an adult. The average heart rate varies with age, gender, exercise, pain, medications, stress, and disease state. A well-conditioned athlete can have a heart rate between 40 and 60 beats per minute (see Table 3-1). The rhythm of the pulse can be regular or irregular. A regular pulse is evenly spaced between beats and the irregular pulse is unevenly spaced between beats. The amplitude of the pulse is defined as the ease with which the pulse can be obliterated (see Table 3-2). The elasticity of the pulse is the resilience of the artery. A pulse deficit is the difference between an apical pulse and a peripheral pulse.

## Technique

The healthcare provider takes the radial pulse using the pads of the fingers at the lateral aspect of the anterior wrist. If the pulse is regular in rhythm, the

**TABLE 3-2** Amplitude of Pulse

Amplitude of Pulse	
0	Nonpalable pulse or no pulse
1+	Weak, thready pulse and easily obliterated
2+	Normal pulse, felt with a moderate amount of pressure
3+	Bounding, easily felt and difficult to obliterate

healthcare provider can take the pulse for 30 seconds and multiply by two. If the pulse is irregular, the healthcare provider should take the radial pulse for one full minute. The apical pulse should be taken for one full minute, listening for changes in rate, rhythm, and heart sounds. The other places where the healthcare provider can palpate the pulses are not commonly counted but assessed for pulse amplitude and compared bilaterally.

These areas are:

### Head and Neck

**Temporal artery:** In the temple area, anterior to the natural hairline by the top of the ear.

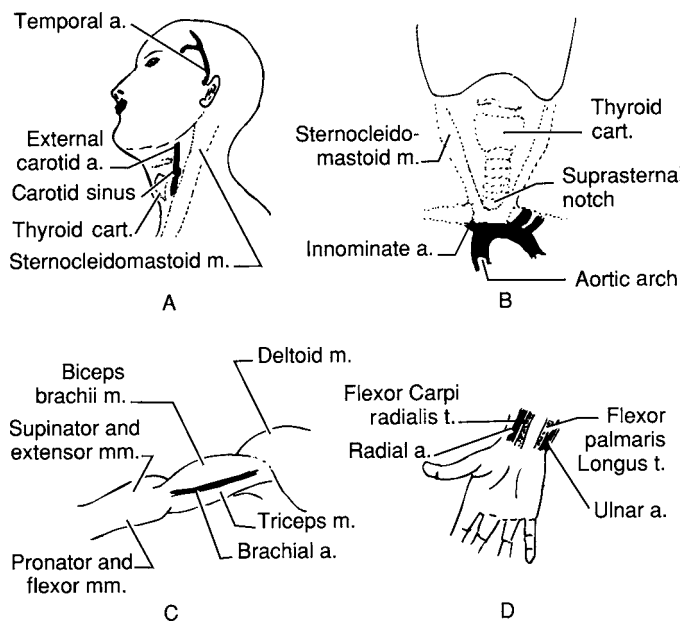
**Carotid artery:** In the space between the sternomastoid muscle and the trachea.

### Arm

**Brachial:** About 0.5 inch above the antecubital fossa of the elbow, medial side.

**Radial:** Medial to the radius bone on dorsal side of the hand turned upward, proximal to the thumb.

**Ulnar:** Medial on the wrist with the palm turned upward (see Figure 3-1).



**FIGURE 3-1** • Sites of palpable arteries.

(Reproduced with permission from LeBlond RF, DeGowin RL, Brown DD: *DeGowin's Diagnostic Examination*, 9<sup>th</sup> edition. New York, NY: McGraw-Hill; 2008. Figure 4-2.)

## Leg

**Femoral:** Under the inguinal ligament in the groin area.

**Popliteal:** Deep in the soft area of the posterior knee.

**Posterior tibial:** Below the medial malleolus in the groove between the medial malleolus and the Achilles tendon.

**Dorsalis pedis:** Dorsum of the foot; below, proximal to and parallel to the great toe.

## Heart

**Apical:** Between the fourth and fifth intercostal space, left side, midclavicular line in an adult.

## Respirations

After the healthcare provider counts the pulse for 30 seconds, he/she will then count the patient's respirations for the next 30 seconds. The healthcare provider keeps his/her fingers on the patient's wrist so that the patient will be unaware of counting the respirations, and hence the respirations will not be altered. Respirations should normally be between 12 and 20 breaths per minute in the adult patient. The respiratory rate in an infant is faster than that in the adult, and is usually between 25 and 55 breaths per minute. The respiratory rate in a child can be from 14 to 40 breaths per minute depending on the child's age. The respiratory rate can change with exercise, anxiety, fever, and disease. The respiratory rate is counted by observing the rise and fall of the chest (see Table 3-3). One respiratory breath is equivalent to one inspiration

**TABLE 3-3** Normal Respiratory Rate Levels

Stage	Age Range	Respiratory Rate, Breaths per Minute
Newborn	Birth to 3 mo	35-55
Infant	3-6 mo	30-45
	6-12 mo	25-40
Toddler	1-3 y	20-30
Preschooler	3-6 y	20-25
School-aged child	6-12 y	14-22
Adolescent and adult	Over 12 y	12-20

(rise) and one expiration (fall) of the chest. The healthcare provider records the rate, rhythm, and depth of the patient's respirations. The patient's respirations should be relaxed, unlabored, without noise, and with equal and bilateral chest expansion.

## Blood Pressure

It is important for the healthcare provider to assess the patient's blood pressure to evaluate the patient's cardiac output, blood volume, and elasticity of the arteries. The healthcare provider evaluates the systolic and diastolic blood pressure. The systolic blood pressure represents the left ventricle during contraction (systole) and the diastolic blood pressure represents the elastic recoil of the arteries or the resting state of the ventricles. A pulse pressure is the difference between the systolic blood pressure and the diastolic blood pressure, and represents the stroke volume: The amount of blood ejected from the heart with each beat. The pulse pressure increases with age due to the loss of elasticity (compliance) of the aorta. The patient's blood pressure can vary with: age, gender, race, ethnicity, obesity, anxiety, exercise, pain, fever, nicotine, caffeine intake, and medications. The blood pressure can also change with a patient's position. In the supine position, the blood pressure is the lowest because of decreased resistance; and it is the highest when the patient is standing, due to gravity. The blood pressure will vary during the day as the patient's activities change (see Table 3-4).

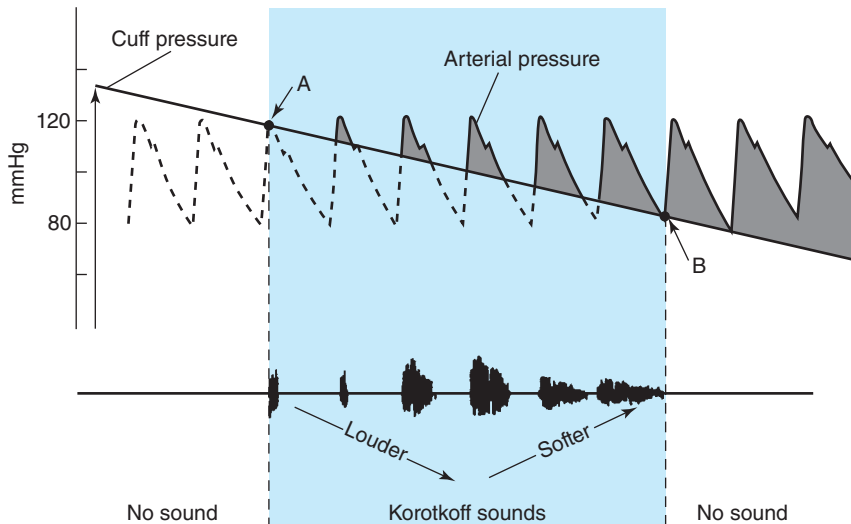
**TABLE 3-4** Blood Pressure Stages

Blood Pressure Stages		
Normal	120 mm Hg or less/ 80 mm Hg or less	Check yearly.
Hypotension	Less than 90 mm Hg/less than 60 mm Hg	Treat underlying condition.
Prehypertension	120-139/80-90 mm Hg	Check in 6 mo.
Stage 1 hypertension	140-159/90-99 mm Hg	Check within 2 mo.
Stage 2 hypertension	Greater than 160/ 100 mm Hg	Recheck in 1 wk or if greater than 180/100 mm Hg, treat immediately.



## Technique

The healthcare provider measures the patient's blood pressure using a stethoscope and a sphygmomanometer. The patient is seated comfortably with their back supported, both feet on the floor, or in the supine or semi-Fowler position, and should be at rest for 5 minutes before taking the blood pressure. The arm should be supported at heart level to ensure an accurate reading. The patient's clothing on the arm should be removed. It is important to check that all equipment is in working order and has been calibrated. The healthcare provider needs to ensure use of a proper-sized blood pressure cuff according to the patient's arm and thigh sizes, available for infants, children, small adults, adults, and large adults. A cuff that is of incorrect size will result in a false reading. In the adult, 75% of the cuff should encircle the patient's arm, whereas in the child 100% of the cuff should encircle the arm. The patient's arm should be at the same level as the patient's heart. The healthcare provider palpates the brachial artery and places the cuff about 1 inch above the brachial artery. Most blood pressure cuffs have an arrow to line up the brachial artery with the blood pressure cuff. Encircle the cuff snugly around the patient's arm and place two fingers of your nondominant hand over the radial artery. Tighten the screw valve of the bulb and then inflate the cuff using the bulb with the dominant hand continuing to inflate the cuff about 30 mm Hg after which the radial pulse can no longer be palpated. This technique will estimate the systolic blood pressure and prevent missing an auscultatory gap; that is, no Korotkoff sounds (see Figure 3-2). The Korotkoff sounds are the arterial sounds heard through the stethoscope when taking a patient's blood pressure. Place the stethoscope (the bell or diaphragm are equally applicable) over the brachial artery, tighten the screw valve of the bulb, and inflate the cuff to the predetermined point (ie, 30 mm Hg above the loss of the radial pulse). Release the screw valve and deflate the cuff slowly, listening for the first sound (systolic blood pressure) and then continuing to listen until the last sound (diastolic blood pressure) is heard. After the last sound is heard, continue to deflate the cuff slowly for another 20 mm Hg and then, with the absence of sounds, deflate the cuff completely. The first and last sounds are recorded as the blood pressure (see Figure 3-2). The healthcare provider should wait a few minutes before attempting to take the blood pressure in the same arm to avoid venous congestion. A baseline blood pressure is recorded, however; hypertension is diagnosed after two to three abnormal readings. If the blood pressure is above 180/100 mm Hg, the patient should be referred immediately for treatment.



**FIGURE 3-2** • Blood pressure measurement by auscultation. Point A indicates systolic blood pressure and point B indicates diastolic blood pressure.

(Reproduced with permission from Mohrman DE, Heller LJ: *Cardiovascular Physiology*, 7<sup>th</sup> edition. New York, NY: McGraw-Hill; 2011. Figure 6-9.)

## Thigh Blood Pressure

Occasionally, the healthcare provider may need to take a patient's blood pressure using the upper leg to compare the arm pressure with the leg pressure. The leg pressure is normally higher than the arm pressure. Place the patient in the prone position and wrap a large blood pressure cuff around the lower third of the thigh. Place the stethoscope over the popliteal artery and take the patient's blood pressure using the same method employed for arm blood pressure. The leg reading is normally 10-40 mm Hg higher than that in the arm. An abnormal reading would reveal a lower leg blood pressure than the arm blood pressure.

### ALERT

#### Orthostatic Changes in Blood Pressure

Perform postural blood pressure to check for changes, if the healthcare provider suspects dehydration or if the patient complains of dizziness.

- Have the patient lie supine quietly for 2-3 minutes.
- Take the blood pressure and pulse in the supine position.
- Assist the patient to the sitting position and take the blood pressure and pulse again.

- Assist the patient to the standing position and take the blood pressure and pulse for the third time.
- Record the findings.

An orthostatic change of systolic blood pressure greater than 20 mm Hg and a pulse increase of greater than 20 beats per minute is abnormal and can occur with increasing age, hypovolemia, and various medications.

## Electronic Equipment

In many settings, the healthcare provider may use electronic equipment to take the patient's temperature, pulse, or blood pressure. It is important to remember that the equipment needs to be checked frequently to ensure that it is in good working order. The accuracy of the equipment is dependent on using the correct blood pressure cuff according to the size of the patient's arm or thigh. The equipment needs to be calibrated according to the manufacturer's instructions. If the healthcare provider obtains an abnormal reading, then the patient's blood pressure should be rechecked by the manual method. Electronic equipment should not be used if the patient is having tremors, seizures, or has an irregular heart rate.

## REVIEW QUESTIONS

1. The term **prehypertension** is defined as a blood pressure between which of the following ranges?
  - A. 90/60-110/60 mm Hg
  - B. 120/80-139/90 mm Hg
  - C. 150/90-160/100 mm Hg
  - D. 160/100-180/100 mm Hg
2. A patient's temperature can vary with which of the following factors? *Select all that apply.*
  - A. Stress
  - B. Age
  - C. Time of day
  - D. Gender
  - E. Eye color

3. **The healthcare provider is preparing to take the patient's blood pressure and understands that the patient should initially:**
  - A. rest quietly for 5 minutes.
  - B. drink 4 oz of water.
  - C. elevate the legs.
  - D. lie in the prone position.
  
4. **The healthcare provider takes the adult patient's respiratory rate and counts 26 breaths in 1 minute. The healthcare provider would document this as:**
  - A. bradypnea.
  - B. eupnea.
  - C. tachypnea.
  - D. dyspnea.
  
5. **The healthcare provider takes the patient's blood pressure when the patient is lying, sitting, and then standing, and obtains a difference of 30 mm Hg from the lying position to standing position. The healthcare provider recognizes that this could be caused by:**
  - A. hypervolemia.
  - B. asthma.
  - C. decreased blood volume.
  - D. ethnicity.
  
6. **The arterial sounds the healthcare provider hears through the stethoscope when taking a patient's blood pressure are called?**
  - A. Normal sounds
  - B. Korotkoff sounds
  - C. Pulse sounds
  - D. Carotid sounds
  
7. **Which of the following is the least reliable method for taking a patient's temperature?**
  - A. Temporal
  - B. Tympanic
  - C. Oral
  - D. Axillary
  
8. **The amplitude of the normal pulse is:**
  - A. 1+
  - B. 2+
  - C. 3+
  - D. 4+

9. **The patient should not be aware of the healthcare provider taking the respiratory rate to avoid:**
- A. increased anxiety of the patient.
  - B. altering the rate of respirations.
  - C. changing the pulse rate.
  - D. bilateral chest expansion.
10. **The healthcare provider takes the pulse of a 5-year-old child and notes that the rhythm increases with inspiration and decreases with expiration. The healthcare provider documents this as:**
- A. bradycardia.
  - B. tachycardia.
  - C. pulse deficit.
  - D. sinus arrhythmia.

## ANSWERS

1. B. Prehypertension is defined as a blood pressure in the range of 120-139/80-90 mm Hg.
2. A, B, C, D. Affects the patient's core body temperature.
3. A. The patient should initially rest for 5 minutes before the healthcare provider takes the blood pressure.
4. C. Respirations greater than 20 breaths per minute in the adult are defined as tachypnea. Bradypnea is respirations less than 12 breaths per minute and eupnea is between 12 and 20 breaths per minute. Dyspnea is when the patient is having difficulty breathing.
5. C. Decreased blood volume or hypovolemia can cause a change in the blood pressure when the patient changes position from lying to sitting or standing.
6. B. Korotkoff sounds are the arterial sounds the healthcare provider hears through the stethoscope when taking a patient's blood pressure.
7. D. The axillary method is the least reliable method to take the patient's temperature. The other methods are more reliable if done correctly.
8. B. 2+ is the normal amplitude of the pulse. The abnormal pulse ranges are: 0 is no pulse; 1+ is a weak, thready pulse; and 3+ is a bounding pulse.
9. B. The healthcare provider should count the patient's respiratory rate without the patient's awareness to avoid altering the rate of respirations.
10. D. Sinus arrhythmia. Bradycardia is a pulse less than 60 beats per minute, tachycardia is a pulse greater than 100 beats per minute, and a pulse deficit is the difference between the radial and peripheral pulse.