Vital Sign Measurement Across the Lifespan - 2nd Canadian Edition

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About the Book

The purpose of this textbook is to help learners develop best practices in vital sign measurement. Its intended audience is students in health-related post-secondary programs as well as healthcare providers. Using a multi-media and interactive approach, it will provide opportunities to read about, observe, practice, and test vital sign measurement.

How to Access this Book

Note that this book is **best viewed via the online webbook** on a computer or mobile device so that you can watch the videos and complete the interactive activities. However, it is also available in the following formats:

- **PDF**. You can download this book as a PDF to read on a computer (Digital PDF) or print it out (Print PDF).
- **Mobile**. If you want to read this textbook on your phone or tablet, you can use the EPUB (eReader) or MOBI (Kindle) files.
- **HTML**. An HTML file can be opened in a browser. It has very little style so it doesn't look very nice, but some people might find it useful.

You can access the online webbook and download any of the formats for free here: *Vital Sign Measurement Across the Lifespan – 2nd Canadian Edition*. To download the book in a different format, look for the "Download this book" drop-down menu and select the file type you want.

What to Expect from this Book

This textbook will provide you with the opportunity to read about, observe, practice, and test vital sign measurement. Boxes with helpful tips are provided throughout the chapters:

- **Technique Tips** provide helpful information about measurement techniques, and
- **Points to Consider** highlight key points to consider about vital sign measurements and findings.

A **Chapter Summary** and **Printable Flashcards** highlighting techniques for each vital sign measurement are provided at the end of each chapter. These printable flashcards are all located together in the textbook's conclusion chapter.

You can review the full textbook or advance to sections that you have identified as areas you want to work on. The textbook has a self-directed format and provides an interactive and engaging way for you to learn about and develop competence in the measurement of vital signs while integrating knowledge about anatomy and physiology.

You will learn about various vital signs including **temperature**, **pulse**, **respiration**, **blood pressure**, and **oxygen saturation**. Measurement of vital signs is a foundational, psychomotor skill for healthcare providers and students in post-secondary health-related programs. These measurements provide information about a person's overall state of health and more specifically about their cardiovascular and respiratory status. These measurements can also reveal changes in a client's vital signs over time and changes in their overall state of health. Proficiency in vital sign measurement is essential to client safety, care, and management. Measurements can influence clinical decision-making related to therapeutic interventions.

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://opentextbc.ca/vitalsignmeasurement/?p=331#h5p-1

Level of Organization

- Chapter 1: Introduction
- Chapter 2: Temperature
- Chapter 3: Pulse and Respiration
- Chapter 4: Oxygen Saturation
- Chapter 5: Blood Pressure
- Chapter 6: Knowledge Integration
- Chapter 7: Conclusion

Learning Outcomes

- Define the vital signs used in healthcare
- Integrate knowledge about anatomy and physiology with vital sign measurement
- Evaluate influencing factors related to vital sign measurement
- Synthesize knowledge about various methods and techniques of vital sign measurement across the lifespan
- Integrate knowledge about alternative methods of vital sign measurements
- Assess normal and abnormal vital sign values
- Evaluate significance of vital sign findings
- Generate best interventions based on vital sign findings

Chapter 1: Introduction

General Points to Consider in Vital Sign Measurement

Therapeutic Environment and Informed Consent

It is important to seek informed consent while creating a therapeutic and safe environment during all encounters with clients. You will usually begin by introducing yourself by **name** and **designation** so the client knows who you are. Next, explain what you are going to do and always ask permission to touch before beginning vital sign measurement. For example, an appropriate introduction is:

> "Hello, I am XXX (state first and last name). I am a XXX (state designation, e.g., I am a registered nurse). Today, I am here to take your vital signs. It will involve me touching your arm, are you okay with that?"

It is also important to ensure the client's privacy by closing the curtains or the door to the room.

Infection Prevention and Control

Clean hands and clean equipment are essential to infection prevention and control when measuring vital signs. Ensuring cleanliness helps reduce communicable and infectious diseases, particularly health care-associated infections, which are infectious organisms acquired by a client while in hospital. Common infections include clostridium difficile (C. diff), vancomycin-resistant enterococcus (VRE), and methicillin-resistant staphylococcus aureus (MRSA).

Ensuring your hands are clean is the best way to prevent and control infection. **Hand hygiene** can include cleansing with **hand gel** (see **Figure 1.1**) and **hand washing**. (see **Figure 1.2**). Use an alcohol-based sanitizer before and after contact with clients. Place gel on your hands and rub all hand surfaces for at least fifteen seconds. When washing hands using soap and water, wet your hands and apply soap. Rub all hand surfaces for about fifteen seconds, then rinse your hands. If the tap is not automatic, then turn it off with a paper towel.

Points to Consider

Hand gel is the preferred method of hand hygiene because it kills more bacteria and is easily accessible to healthcare providers. Soap and water is used when hands/gloves come into contact with bodily fluids.

Figure 1.1: Hand gel.

Test Yourself!

While watching the interactive video on applying hand gel, apply your knowledge and critical thinking skills by answering the questions throughout the video. Please note: there is **no** sound in this video.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=28#h5p-2

Figure 1.2: Hand washing.

Test Yourself!

While watching the interactive video on hand washing, perform the skill along with the student while applying your knowledge and critical thinking skills to answer the questions throughout the video. Please note: there is **no** sound in this video.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=28#h5p-3

Equipment

Healthcare providers always inspect equipment before use to ensure it is in good working condition. Equipment (e.g., stethoscopes, pulse oximeters) can be cleaned with alcohol-based solutions to disinfect the surfaces. Automated devices should be regularly serviced to ensure accuracy. Biomedical technicians/experts are responsible for preventative maintenance and calibration to optimize functioning.

Click on the hotspots to learn about the following pieces of equipment:

An interactive H5P element has been excluded from this version of the text. You can view it online here: *https://opentextbc.ca/vitalsignmeasurement/?p=28#h5p-4*

Pain Assessment

A pain assessment is conducted in conjunction with the measurement of vital signs because pain can influence the findings. Pain can activate the sympathetic nervous system and increase pulse, respiration, and blood pressure. Pain is a complex issue, and a comprehensive discussion of pain assessment is beyond the scope of this e-book.

Briefly, because pain is subjective, self-reports are the most effective way to assess pain. The choice of pain assessment tool depends on the client situation: healthcare providers frequently use a numeric rating scale such as "rate your pain on a scale of 0 to 10 with zero being no pain and ten being the very worst pain that you have ever felt." The response is often recorded on the vital sign record and expanded on in the narrative notes. Another common tool is the PQRSTU mneumonic in which each letter corresponds to a series of questions.

- P – Provocative/Palliative (e.g., What makes the pain worse? What makes the pain better?)
- Q – Quality/Quantity (e.g., Can you describe what the pain feels like? How bad is the pain?)
- R – Region/Radiation (e.g., Where is the pain located? Does it radiate anywhere else?)
- S – Severity (as noted above, rate the pain on a scale of zero to ten)
- T – Timing/Treatment (When did the pain begin? Is it constant? Have you taken anything to help the pain? If so, what?)
- U – Understanding (What do you think is causing the pain?)

Order of Vital Sign Measurement

The order of vital sign measurement is influenced by the client situation. Healthcare providers often place the pulse oximeter probe on a client while proceeding to take pulse, respiration, blood pressure, and temperature. However, in some situations this order is modified and the healthcare provider needs to critically assess the situation to prioritize the vital sign measurement order. For example, with newborns/infants, it is best to proceed from least invasive to most invasive, so it is best to begin with respiration, pulse, oxygen saturation, temperature and if required, blood pressure. In an emergency situation or if a person loses consciousness, it is best to begin with pulse and blood pressure. Generally, it is important to conduct a complete set of vital signs unless otherwise indicated.

Significance of Measurements

Determining the significance of vital sign measurements involves a process of diagnostic reasoning. The healthcare provider analyzes client data and makes decisions about whether the vital signs are normal or abnormal and whether the findings are significant: the following chapters provide normal vital sign ranges. The healthcare provider also considers agency policy, if applicable, about vital sign ranges to assess any abnormal variations and clinical significance. Additionally, the healthcare provider considers the client's baseline vital signs to obtain a better sense of the client's 'normal' and allow comparison (e.g., of trends) over time. The diagnostic reasoning process also involves considering other available objective and subjective data.

Documentation

Timely documentation of vital sign measurements is imperative as a form of communication, to observe trends in vital sign measurements, and to ensure effective intervention when needed. Documentation occurs on paper-based vital sign records or electronic systems depending on the agency. Healthcare providers follow the agency's documentation policy and the professional standards of practice. If using a vital sign record, healthcare providers use the symbols noted on the legend of the record.

Test Your Knowledge

Please answer the seven questions in the following question set.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=28#h5p-5

Chapter 2: Temperature

What is Temperature?

Temperature refers to the degree of heat or cold in an object or a human body. In humans, the brain's **hypothalamus** acts as the body's thermostat and is responsible for regulating its temperature (OER #2). See **Figure 2.1** of the hypothalamus.

The human body is constantly adapting to internal health states and environmental conditions, and the hypothalamus is programmed to tell the body to generate heat if the body temperature is low. For example, the hypothalamus can activate peripheral vasoconstriction and shivering (contraction of skeletal muscles) to prevent a decrease in body temperature. The hypothalamus can also reduce heat if the body temperature is too high. For example, it can activate peripheral vasodilation to increase heat loss and cause a person to perspire, which cools the body.

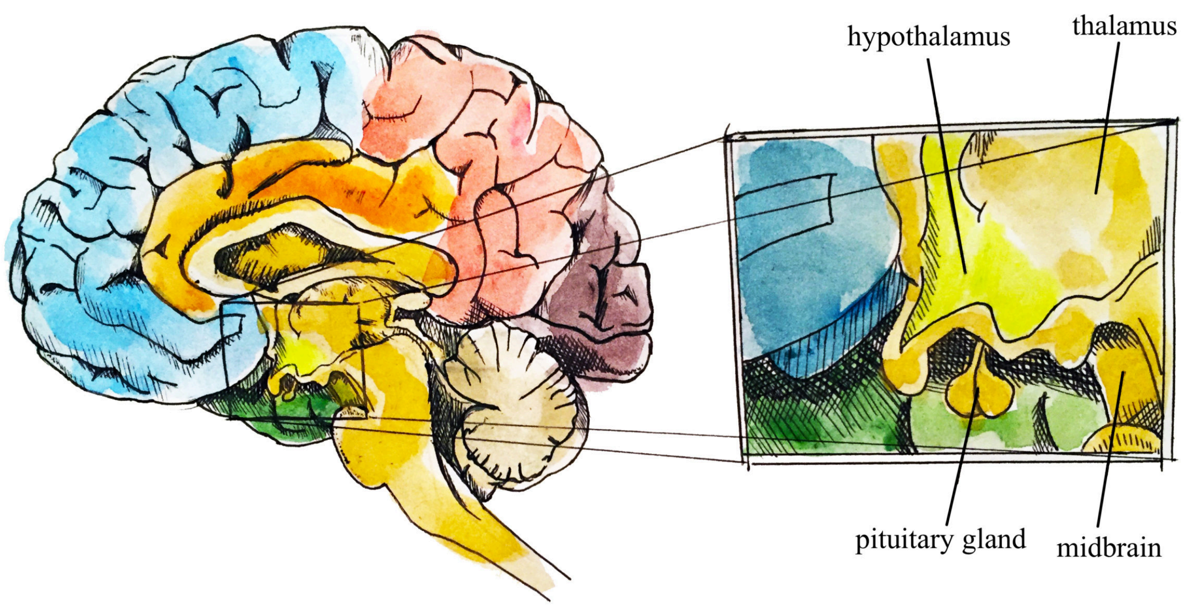

Figure 2.1: Hypothalamus. (Illustration credit: Hilary Tang)

Chapter Attributions

Part of this content was adapted from OER #2 (as noted in brackets above):

Why is Temperature Measured?

Healthcare providers measure a client's temperature because it can give information about their state of health and influence clinical decisions. Accurate measurements and interpretation are vital so that **hyperthermia** and **hypothermia** can be identified and appropriate interventions determined.

Hyperthermia refers to an elevated body temperature. It can be related to an internal or external source. External sources that increase body temperature could include exposure to excessive heat on a hot day or being in a sauna or hot tub. Internal sources that may increase body temperature include fever caused by an infection or tissue breakdown associated with physical trauma (e.g., surgery, myocardial infarction) or some neurological conditions (e.g., cerebral vascular accident, cerebral edema, brain tumour). Hyperthermia that is associated with an infectious agent, such as a bacteria or virus (e.g., the flu) is referred to as **febrile**. Unresolved hyperthermic body states can lead to cell damage.

Hypothermia refers to a lowered body temperature. It is usually related to an external source such as being exposed to the cold for an extended period of time. Hypothermia is sometimes purposefully induced during surgery, or for certain medical conditions, to reduce the body's need for oxygen. Unresolved hypothermic body states can slow cellular processes and lead to loss of consciousness.

Test Your Knowledge

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=34#h5p-6

Methods of Measurement

Methods of measuring a client's body temperature vary based on developmental age, cognitive functioning, level of consciousness, state of health, safety, and agency/unit policy. The healthcare provider **chooses the best method** after considering client safety, accuracy, and least invasiveness, all contingent on the client's health and illness state. The most accurate way to measure core body temperature is an invasive method through a pulmonary artery catheter. This is only performed in a critical care area when constant measurements are required along with other life-saving interventions.

Methods of measurement include **oral**, **axillary**, **tympanic**, **rectal**, and **dermal routes**.

Oral temperature can be taken with clients who can follow instructions, so this kind of measurement is common for clients over the age of four, or even younger children if they are cooperative. Another route other than oral (e.g., tympanic or axillary) is preferable when a client is on oxygen delivered via a face mask because this can alter the temperature.

For children younger than four, axillary temperature is commonly measured unless a more accurate reading is required.

Rectal temperature is an accurate way to measure body temperature (Mazerolle, Ganio, Casa, Vingren, & Klau, 2011). The rectal route is recommended by the Canadian Pediatric Society for children under two years of age (Leduc & Woods, 2017). However, this method is not used on infants younger than thirty days or premature infants because of the risk of rectal tearing. If the rectal method is required, the procedure is generally only used by nurses and physicians.

Dermal routes are alternative methods of measurement that may be used in some agencies and practice areas. This method can involve holding the device and sliding it over the skin of the forehead and then down over the temporal artery in one motion. Dermal strips can also be placed on the forehead to measure skin temperature, but are not yet widely used, and the accuracy of this method has not yet been verified. More recently, there has been an increase in non-contact infrared thermometers particularly in the era of COVID-19 and other highly transmissible diseases. Depending on the type, these thermometers can be held at a short distance from the forehead or temporal area to measure temperature. Alternatively, some handheld thermal scanners that use an infrared camera can be held at a greater distance to screen large masses of people. Please refer to the manufacturer's suggested reference range for non-contact infrared thermometers and thermal scanners.

Test Yourself!

While watching the interactive video on measuring temperature with a non-contact infrared thermometer, apply your knowledge and critical thinking skills to answer the questions throughout the video. Please note: there is **no** sound in this video.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=36#h5p-7

Points to Consider

The accuracy of measurements is most often influenced by the healthcare provider's adherence to the correct technique.

The following pages detail the normal temperature ranges and techniques associated with oral, axillary, tympanic, and rectal temperature methods.

What are Normal Temperature Ranges?

The human body's core temperature (internal body temperature) is measured in degrees Celsius (ºC) or Fahrenheit (ºF). In Canada, degrees Celsius is most commonly used.

In adults, the **normal core body temperature** (referred to as normothermia or afebrile) is 36.5–37.5ºC or 97.7–99.5ºF (OER #2).

A wider temperature range is acceptable in **infants and young children**, and can range from 35.5–37.7ºC or 95.9–99.8ºF. Infants and children have a wider temperature range because their heat control mechanisms are less effective. They are at risk for heat loss for many reasons including having less subcutaneous fat than adults, a larger body surface area in comparison to weight (and larger head size in proportion to the rest of the body), immature metabolic mechanisms (e.g., they may be unable to shiver), and limited ability to produce heat through activity. They are also at risk of excessive heat production due to crying and restlessness as well as external factors such as being wrapped in too many blankets.

Older adults tend to have lower body temperatures and are at risk for hypothermic states; reasons for this may include having less subcutaneous tissue acting as insulation, loss of peripheral vasoconstriction capacity, decreased cardiac output with resultant lowered blood flow to the extremities, decreased muscle mass resulting in reduced heat production capacity, and decreased metabolic responses.

Points to Consider

It is important to monitor and regulate temperature in newborns and infants because of the temperature fluctuations that place them at higher risk for hypothermia and hyperthermia, whereas temperature changes in older adults are often minimal.

See **Table 2.1** for **normal temperature ranges** based on **method**. The normal ranges vary slightly for each of the methods. It is important to consider a client's baseline temperature as some individuals present with a temperature slightly above or below these ranges. To make an informed clinical judgement, examine the client's records to determine a trend in temperature. A pattern of high or low temperature findings may reveal a baseline for your client. As a healthcare provider, it is important to determine the significance of the temperature by also considering influencing factors and the client's overall state of health.

Table 2.1: Normal Temperature Ranges

Method	Range
Oral	35.8–37.3ºC
Axillary	34.8–36.3ºC
Tympanic	36.1–37.9ºC
Rectal	36.8–38.2ºC

Other factors that influence temperature include diurnal rhythm, exercise, stress, menstrual cycle, and pregnancy. The diurnal cycle causes a fluctuation of 1ºC, with temperatures lowest in the early morning and highest in the late afternoon. During exercise, body temperature rises because the body is using energy to power the muscles. Temperature can rise as a result of stress and anxiety, due to stimulation of the sympathetic nervous system and increased secretion of epinephrine and norepinephrine. Body temperature varies throughout a woman's menstrual cycle due to hormonal fluctuations, rising after ovulation until menstruation by about 0.5–1ºC. Body temperature is slightly elevated during pregnancy as a result of increased metabolism and hormone production such as progesterone.

Test Your Knowledge

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=38#h5p-8

Chapter Attributions

Part of this content was adapted from OER #2 (as noted in brackets above):

Oral Temperature

The normal oral temperature is 35.8–37.3ºC (OER #1) or 96.4–99.1ºF. Oral temperature measurement is common and reliable because it is close to the sublingual artery. An oral thermometer is shown in **Figure 2.2**. The device has **blue colouring**, indicating that it is an oral or axillary thermometer as opposed to a rectal thermometer, which has red colouring.

Figure 2.2: Oral thermometer.

Technique

Remove the probe from the device and place a probe cover (from the box) on the oral thermometer without touching the probe cover with your hands. Place the thermometer in the client's mouth under the tongue and instruct client to keep mouth closed and not to bite on the thermometer (OER #1). Ensure the thermometer probe is in the posterior sublingual pocket under the tongue, slightly off-centre. Leave the thermometer in place for as long as is indicated by the device manufacturer (OER #1). The thermometer will beep within a few seconds when the temperature has been taken: most oral thermometers are electronic and provide a digital display of the reading. Discard the probe cover in the garbage (without touching the cover) and place the probe back into the device. See **Figure 2.3** of an oral temperature being taken.

Figure 2.3: Oral temperature being taken.

Technique Tips

Putting the probe cover on takes practice. You need to ensure that it snaps onto the probe. Sometimes the device will turn off after you take the probe out of the device if you take too long to put the probe cover on or insert it in the client's mouth. If so, discard the probe cover and re-insert the probe into the device to reset it. Then try again.

What should the healthcare provider consider?

Healthcare providers often measure the oral temperature, particularly when the client is conscious and can follow directions. Measurement of the oral temperature is not recommended for individuals who are unconscious, unresponsive, confused, have an endotracheal tube secured in the mouth, and cannot follow instructions.

Certain factors render the oral route less accurate with the potential for falsely high or falsely low findings. If the client has recently consumed hot or cold food or beverage, chewing gum, or has smoked prior to measurement, the healthcare provider should use another route such as tympanic or axillary. Selecting an alternate route under the aforementioned circumstances is most conducive to a fast-paced clinical environment and most respectful of the client's time. If another route is not available, healthcare providers should wait 15 to 25 minutes to take the oral temperature following consumption of a hot or cold beverage/food. The temperature of the beverage/food also factors into the wait period, as extreme heat or cold will require longer wait times for oral temperature assessment. Healthcare providers should wait about 5 minutes if the client is chewing gum or has just smoked since both of these activities can increase temperature.

Test Yourself!

While watching the interactive video on measuring temperature with an oral thermometer, apply your knowledge and critical thinking skills to answer the questions throughout the video. Please note: there is **no** sound in this video.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=42#h5p-9

Test Your Knowledge

Please answer the three questions in the following question set.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=42#h5p-10

Chapter Attributions

Part of this content was adapted from OER #1 (as noted in brackets above):

-

Tympanic Temperature

The normal tympanic temperature is usually 0.3–0.6°C higher than an oral temperature (OER #1). It is accurate because the tympanic membrane shares the same vascular artery that perfuses the hypothalamus (OER #1). A tympanic thermometer is shown in **Figure 2.4**.

Figure 2.4: Tympanic thermometer.

Technique

Remove the tympanic thermometer from the casing and place a probe cover (from the box) on the thermometer tip without touching the probe cover with your hands. Only touch the edge of the probe cover (if needed), to maintain clean technique. Turn the device on. Ask the client to keep head still. For an adult or older child, gently pull the helix up and back to visualize the ear canal. For an infant or younger child (under 3), gently pull the lobe down. The probe is inserted just inside the opening of the ear. Never force the thermometer into the ear and do not occlude the ear canal (OER #1). Only the tip of the probe is inserted in the opening – this is important to prevent damage to the ear canal. Activate the device; it will beep within a few seconds to signal it is done. Discard the probe cover in the garbage (without touching the cover) and place the device back into the holder. See **Figure 2.5** of a tympanic temperature being taken.

Figure 2.5: Tympanic temperature being taken.

Technique Tips

The technique of pulling the helix up and back (adult) or the lobe down (child under 3) is used to straighten the ear canal so the light can reflect on the tympanic membrane. If this is not correctly done, the reading may not be accurate. The probe tip is gently inserted into the opening to prevent damage to the ear canal. The ear canal is a sensitive and a highly innervated part of the body, so it is important not to force the tympanic probe into the ear.

What should the healthcare provider consider?

The tympanic temperature method is a quick and minimally invasive way to take temperature. Although research has proven the accuracy of this method, some pediatric institutions prefer the accuracy of the rectal temperature. The Canadian Pediatric Society found equal evidence for and against the use of tympanic temperature route (Leduc & Woods, 2017). It concluded that tympanic temperature is one option for use with children, but suggested using rectal temperature for children younger than two, particularly when accuracy is vital. The tympanic temperature is not measured when a client has a suspected ear infection. It is important to check your agency policy regarding tympanic temperature.

Test Yourself!

While watching the interactive video on measuring temperature with a tympanic thermometer, apply your knowledge and critical thinking skills to answer the questions throughout the video. Please note: there is **no** sound in this video.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=46#h5p-11

Test Your Knowledge

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Chapter Attributions

Part of this content was adapted from OER #1 (as noted in brackets above):

Axillary Temperature

The normal axillary temperature may be as much as 1ºC lower than the oral temperature (OER #1). An axillary thermometer is the same electronic device as an oral thermometer, and both have a **blue end**.

Technique

Remove the probe from the device and place a probe cover (from the box) on the thermometer without touching the cover with your hands. Ask the client to raise the arm away from his/her body. Place the thermometer in the client's armpit (OER #1), on bare skin, as high up into the axilla as possible, with the point facing behind the client. Ask the client to lower his/her arm and leave the device in place for as long as is indicated by the device manufacturer (OER #1). Usually the device beeps in 10–20 seconds. Discard the probe cover in the garbage (without touching the cover) and place the probe back into the device. See **Figure 2.6** of an axillary temperature being taken.

Figure 2.6: Axillary temperature being taken.

What should the healthcare provider consider?

The axillary route is a minimally invasive way to measure temperature. It is commonly used in children. It is important to ensure that the thermometer is as high up in the axilla as possible with full skin contact and that the client's arm is then lowered down.

Test Yourself!

While watching the interactive video on measuring temperature with an axillary thermometer, apply your knowledge and critical thinking skills to answer the questions throughout the video. Please note: there is **no** sound in this video.

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Chapter Attributions

Part of this content was adapted from OER #1 (as noted in brackets above):

Rectal Temperature

The normal rectal temperature is usually 1ºC higher than oral temperature (OER #1). A rectal thermometer has a **red end** to distinguish it from an oral/axillary thermometer. A rectal thermometer is shown in **Figure 2.7**.

Figure 2.7: Rectal thermometer.

Technique

First, ensure the client's privacy. Wash your hands and put on gloves. For infants, lie them down in a supine position and raise their legs up toward the chest. You can encourage a parent to hold the infant to decrease movement and provide a sense of safety. With older children and adults, assist them into a side lying position. Remove the probe from the device and place a probe cover (from the box) on the thermometer. Lubricate the cover with a water-based lubricant, and then **gently insert the probe 2–3 cm inside the rectal opening of an adult, or less depending on the size of the client**. The device beeps when it is done.

What should the healthcare provider consider?

Measuring rectal temperature is an invasive method. Some suggest its use only when other methods are not available (OER #1), while others suggest that the rectal route is a gold standard in the infant population because of its accuracy. The Canadian Pediatric Society (Leduc & Woods, 2017) has referred to research indicating that rectal temperatures may remain elevated after a client's core temperature has started to return to normal, but after reviewing all available evidence, still recommends measuring rectal temperature for children under the age of two, particularly when accuracy is vital. Rectal temperature is not measured in infants under one month of age or premature newborns.

Test Your Knowledge

Please answer the four questions in the following question set.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=52#h5p-14

Chapter Attributions

Part of this content was adapted from OER #1 (as noted in brackets above):

Finding the Error Activity: Tympanic Temperature

Which is the correct technique for measuring the tympanic temperature?

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An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://opentextbc.ca/vitalsignmeasurement/?p=54#h5p-17

Try it Out

Next, there are three activities that involve film clips that you can watch and then try out yourself. You can watch the clips and practice as many times as you like.

Oral Temperature

Watch this short **film clip 2.1** and see how oral temperature is taken correctly. After watching the clip, try the technique yourself.

Film clip 2.1: Oral temperature

A YouTube element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=56

Alternatively, if viewing textbook as a PDF, use this link: https://www.youtube.com/embed/HVpjXk0B6SA?rel=0

Tympanic Temperature

Watch this short **film clip 2.2** and see how tympanic temperature is taken correctly. After watching the clip, try the technique yourself.

Film clip 2.2: Tympanic temperature

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Axilla Temperature

Watch this short **film clip 2.3** and see how axilla temperature is taken correctly. After watching the clip, try the technique yourself.

Film clip 2.3: Axilla temperature

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Test Yourself

Multiple Choice

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An interactive H5P element has been excluded from this version of the text. You can view it online here:
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List the Steps

List the steps below in the correct order for each of the following techniques.

Oral Temperature Technique

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https://opentextbc.ca/vitalsignmeasurement/?p=62#h5p-23

Tympanic Temperature Technique

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://opentextbc.ca/vitalsignmeasurement/?p=62#h5p-24

Axillary Temperature Technique

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://opentextbc.ca/vitalsignmeasurement/?p=62#h5p-25

Rectal Temperature Technique

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https://opentextbc.ca/vitalsignmeasurement/?p=62#h5p-26

Chapter Summary

Temperature is an important vital sign because it provides current data about the client's health and illness state. Changes in body temperature act as a cue for healthcare providers' diagnostic reasoning.

There are many ways to measure temperature. In determining the best method, the healthcare provider considers agency policy, the client's age and health and illness state, and the reason for taking the temperature. Healthcare providers must **use the correct technique** when measuring temperature, because this can influence client data.

When determining the relevance of the temperature, the healthcare provider considers the client's baseline data and the situation. Diagnostic reasoning about temperature always involves considering additional data including other vital sign measurements and subjective and objective client data.

Chapter 3: Pulse and Respiration

What is Pulse?

Pulse refers to a pressure wave that expands and recoils the artery when the heart contracts/beats. It is palpated at many points throughout the body. The most common locations to accurately assess pulse as part of vital sign measurement include **radial**, **brachial**, **carotid**, and **apical pulse** as shown in **Figure 3.1**. The techniques vary according to the location, as detailed later.

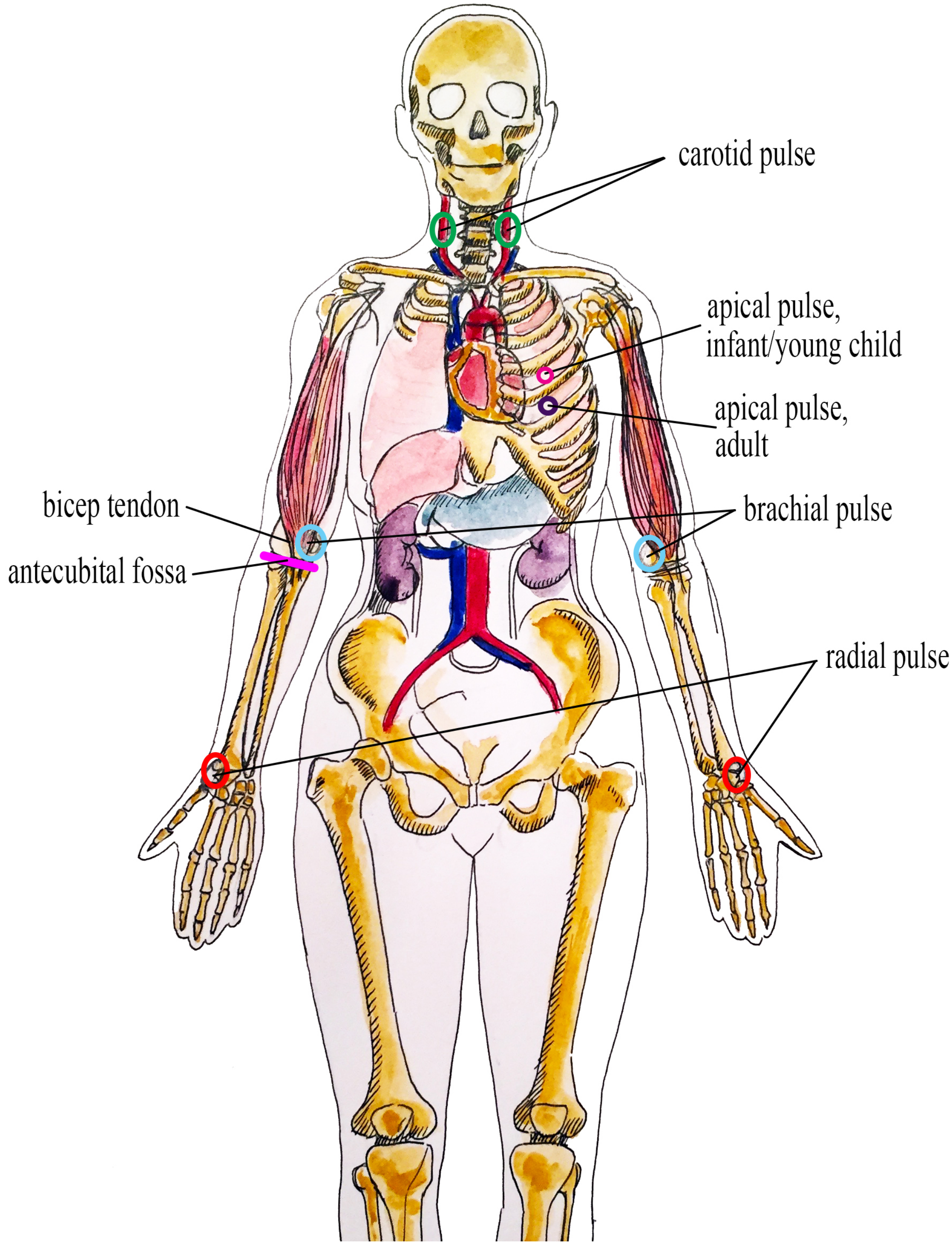

Figure 3.1: Radial, brachial, carotid and apical pulse. (Illustration credit: Hilary Tang)

The heart pumps a volume of blood per contraction into the aorta. This volume is referred to as stroke volume. Age is one factor that influences stroke volume, which ranges from 5–80 mL from newborns to older adults.

Pulse is measured in beats per minute, and the normal adult pulse rate (heart rate) at rest is 60–100 beats per minute (OER #1, OER #2). Newborn resting heart rates range from 100–175 bpm. Heart rate gradually decreases until young adulthood and then gradually increases again with age (OER #2). A pregnant women's heart rate is slightly higher than her pre-pregnant value (about 15 beats). See **Table 3.1** for normal heart rate ranges based on age.

Table 3.1 Heart Rate Ranges

Age	Heart rate (beats per minute)
Newborn to one month	100–175
One month to two years	90–160
Age 2–6 years	70–150
Age 7–11 years	60–130
Age 12–18 years	50–110
Adult and older adult	60–100

Points to Consider

The **ranges noted in Table 3.1 are generous**. It is important to consider each client and situation to determine whether the heart rate is normal. For example, heart rate is considered in the context of a client's baseline heart rate. The healthcare provider also considers the client's health and illness state and determinants such as rest/sleep, awake/active, and presence of pain. You can expect higher pulse values when a client is in a stressed state such as when crying or in pain; this is particularly important in the newborn. It is best to complete the assessment when the client is in a resting state. If you obtain a pulse when the client is not in a resting state, document the circumstances (e.g. stress, crying, or pain) and reassess as needed.

Please answer the two questions in the following question set.

An interactive H5P element has been excluded from this version of the text. You can view it online here: *https://opentextbc.ca/vitalsignmeasurement/?p=70#h5p-27*

Chapter Attributions

Why is Pulse Measured?

Healthcare providers measure pulse because it provides information about a client's state of health and influences diagnostic reasoning and clinical decision-making.

Tachycardia

Tachycardia refers to an elevated heart rate, typically above 100 bpm (OER #2) for an adult. Developmental considerations are important to consider, such as higher resting pulse rates in infants and children. For adults, tachycardia is not normal in a resting state but may be detected in pregnant women or individuals experiencing extreme stress (OER #2). Tachycardia can be benign, such as when the sympathetic nervous system is activated with exercise and stress. Caffeine intake and nicotine can also elevate the heart rate. Tachycardia is also correlated with fever, anemia, hypoxia, hyperthyroidism, hypersecretion of catecholamines, some cardiomyopathies, some disorders of the valves, and acute exposure to radiation (OER #2).

Bradycardia

Bradycardia is a condition in which the resting heart rate drops below 60 bpm (OER #2) in adults. In newborns, a resting heart rate below 100 bpm is considered bradycardia. However, a sleeping neonate's pulse may be as low as 90 bpm. People who are physically fit (e.g., trained athletes) typically have lower heart rates (OER #2). If the client is not exhibiting other symptoms, such as weakness, fatigue, dizziness, fainting, chest discomfort, palpitations, or respiratory distress, bradycardia is generally not considered clinically significant (OER #2). However, if any of these symptoms are present, this may indicate that the heart is not providing sufficient oxygenated blood to the tissues (OER #2). Bradycardia can be related to an electrical issue of the heart, ischemia, metabolic disorders, pathologies of the endocrine system, electrolyte imbalances, neurological disorders, prescription medications, and prolonged bedrest, among other conditions (OER #2). Bradycardia is also related to some medications, such as beta blockers and digoxin.

Points to Consider

It is vital that healthcare providers assess clients with tachycardia or bradycardia to determine whether the findings are significant and require intervention.

Chapter Attributions

Part of this content was adapted from OER #2 (as noted in brackets above):

What Pulse Qualities are Assessed?

The pulse rhythm, rate, force, and equality are assessed when palpating pulses.

Pulse Rhythm

The normal **pulse rhythm** is regular, meaning that the frequency of the pulsation felt by your fingers follows an even tempo with equal intervals between pulsations. If you compare this to music, it involves a constant beat that does not speed up or slow down, but stays at the same tempo. Thus, the interval between pulsations is the same. However, sinus arrhythmia is a common condition in children, adolescents, and young adults. Sinus arrhythmia involves an irregular pulse rhythm in which the pulse rate varies with the respiratory cycle: the heart rate increases at inspiration and decreases back to normal upon expiration. The underlying physiology of sinus arrhythmia is that the heart rate increases to compensate for the decreased stroke volume from the heart's left side upon inspiration.

Points to Consider

If a pulse has an irregular rhythm, it is important to determine whether it is regularly irregular (e.g., three regular beats and one missed and this is repeated) or if it is irregularly irregular (e.g., there is no rhythm to the irregularity). Irregularly irregular pulse rhythm is highly specific to atrial fibrillation. Atrial fibrillation is an arrhythmia whereby the atria quiver. This condition can have many consequences including decreased stroke volume and cardiac output, blood clots, stroke, and heart failure.

Pulse Rate

The **pulse rate** is counted by starting at one, which correlates with the first beat felt by your fingers. Count for thirty seconds if the rhythm is regular (even tempo) and multiply by two to report in beats per minute. Count for one minute if the rhythm is irregular. In children, pulse is counted for one minute considering that irregularities in rhythm are common.

Pulse Force

The **pulse force** is the strength of the pulsation felt when palpating the pulse. For example, when you feel a client's pulse against your fingers, is it gentle? Can you barely feel it? Alternatively, is the pulsation very forceful and bounding into your fingertips? The force is important to assess because it reflects the volume of blood, the heart's functioning and cardiac output, and the arteries' elastic properties. Remember, stroke volume refers to the volume of blood pumped with each contraction of the heart (i.e., each heart beat). Thus, pulse force provides an idea of how hard the heart has to work to pump blood out of the heart and through the circulatory system.

Pulse force is recorded using a four-point scale:

- 3+ Full, bounding
- 2+ Normal/strong
- 1+ Weak, diminished, thready
- 0 Absent/non-palpable

Practice on many people to become skilled in measuring pulse force. While learning, it is helpful to assess pulse force along with an expert because there is a subjective element to the scale. A 1+ force (weak and thready) may reflect a decreased stroke volume and can be associated with conditions such as heart failure, heat exhaustion, or hemorrhagic shock, among other conditions. A 3+ force (full and bounding) may reflect an increased stroke volume and can be associated with exercise and stress, as well as abnormal health states including fluid overload and high blood pressure.

Pulse Equality

Pulse equality refers to whether the pulse force is comparable on both sides of the body. For example, palpate the radial pulse on the right and left wrist at the same time and compare whether the pulse force is equal. Pulse equality is assessed because it provides data about conditions such as arterial obstructions and aortic coarctation. However, **the carotid pulses should never be palpated at the same time** as this can decrease and/or compromise cerebral blood flow.

These are the upper body pulse points that will be covered in the following sections.

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Radial Pulse

Technique

Use the pads of your first three fingers to gently palpate the radial pulse (OER #1). The pads of the fingers are placed along the radius bone, which is on the lateral side of the wrist (the thumb side; the bone on the other side of the wrist is the ulnar bone). Place your fingers on the radius bone close to the flexor aspect of the wrist, where the wrist meets the hand and bends. See **Figure 3.2** for correct placement of fingers. Press down with your fingers until you can best feel the pulsation. Note the rate, rhythm, force, and equality when measuring the radial pulse (OER #1).

Figure 3.2: Correct placement of fingers.

Technique Tips

Note the first beat felt in your fingers as “1” and then continue to count. Alternatively, start counting at “0” when your watch is at zero and then continue to count.

Test Yourself!

While watching the interactive video on pulse and respiration measurement, apply your knowledge and critical thinking skills to answer the questions throughout the video.

This video is also at the end of the chapter, uninterrupted, to enable seamless practice.

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What should the healthcare provider consider?

You may need to adjust the pressure of your fingers when palpating the radial pulse if you cannot feel the pulse. For example, sometimes pressing too hard can obliterate the pulse (make it disappear). Alternatively, if you do not press hard enough, you may not feel a pulse. You may also need to move your fingers around slightly. Radial pulses are difficult to palpate on newborns and children under five, so healthcare providers usually assess the apical pulse or brachial pulse of newborns and children.

Points to Consider

You can use a Doppler ultrasound device if you are struggling to feel the pulse and are concerned about perfusion into the limbs. This is a handheld device that allows you to hear the whooshing sound of the pulse. The Doppler device is also used following surgery or insertion of a central line to assess blood flow. These devices are most commonly used when assessing peripheral pulses in the lower limbs, such as the dorsalis pedis pulse or the posterior tibial pulse. See **Film clip 3.1** for use of a Doppler device. The doppler device is also used to locate the brachial pulse and assess blood pressure in infants.

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Film clip 3.1: Use of doppler device

Alternatively, if viewing textbook as a PDF, use this link: https://www.youtube.com/embed/cn3aA0G1mgc?rel=0

Chapter Attributions

Part of this content was adapted from OER #1 (as noted in brackets above):

Carotid Pulse

May be taken when radial pulse is not present or is difficult to palpate (OER #1).

Technique

Ask the client to sit upright. Locate the carotid artery medial to the sternomastoid muscle (between the muscle and the trachea at the level of the cricoid cartilage, which is in the middle third of the neck). With the pads of your three fingers, gently palpate the carotid artery, one at a time. See **Figure 3.3** for correct placement of fingers.

Figure 3.3: Correct placement of fingers.

What should the healthcare provider consider?

Although other pulses can be taken simultaneously to assess equality, the **carotid pulses are NEVER taken at the same time**. Gently palpate one artery at a time so that you do not stimulate the vagus nerve and compromise arterial blood flow to the brain. Avoid palpating the upper third of the neck, because this is where the carotid sinus area is located. You want to avoid pressure on the carotid sinus area because this can lead to vagal stimulation, which can slow the heart rate, particularly in older adults.

Technique Tips

Never palpate the carotid pulses simultaneously as this will reduce and/or compromise cerebral blood flow.

Chapter Attributions

Part of this content was adapted from OER #1 (as noted in brackets above):

Brachial Pulse

Brachial pulse rate is indicated during some assessments, such as with children, in whom it can be difficult to feel the radial pulse. A Doppler can be used to locate the brachial pulse if needed.

Technique

The brachial pulse can be located by feeling the bicep tendon in the area of the antecubital fossa. Move the pads of your three fingers medial (about 2 cm) from the tendon and about 2–3 cm above the antecubital fossa to locate the pulse. See **Figure 3.4** for correct placement of fingers along the brachial artery.

Figure 3.4: Correct placement of fingers.

What should the healthcare provider consider?

It can be helpful to hyper-extend the arm in order to accentuate the brachial pulse so that you can better feel it. You may need to move your fingers around slightly to locate the best place to most accurately feel the pulse. You will usually need to press fairly firmly to palpate the brachial pulse.

Apical Pulse

Apical pulse is auscultated with a stethoscope over the chest where the heart's mitral valve is best heard. In infants and young children, the apical pulse is located at the fourth intercostal space at the left midclavicular line. In adults, the apical pulse is located at the fifth intercostal space at the left midclavicular line (OER #1). See **Figure 3.5** below.

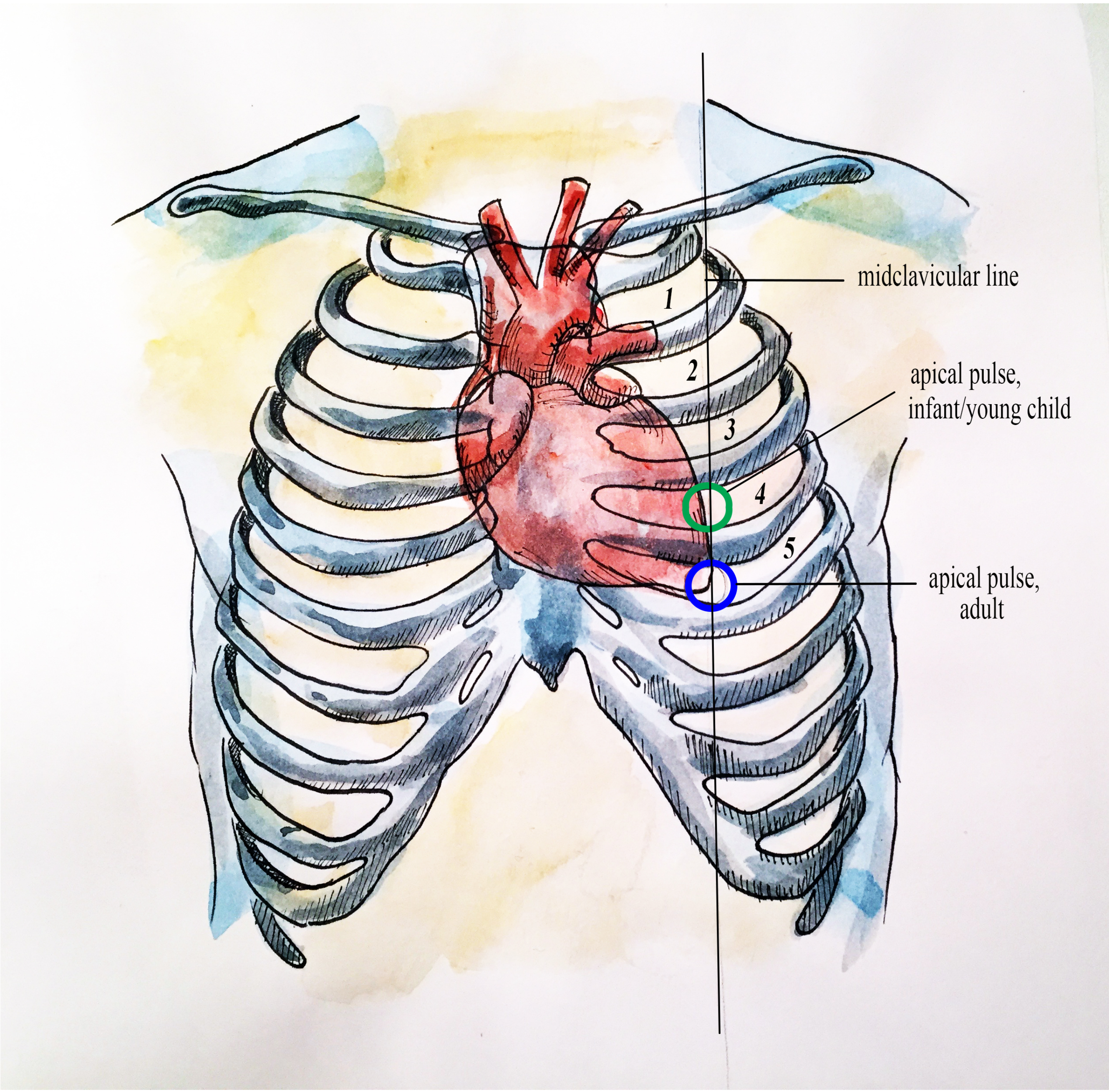


Figure 3.5: Apical Pulse. (Illustration credit: Hilary Tang)

Apical pulse rate is indicated during some assessments, such as when conducting a cardiovascular assessment and when a client is taking certain cardiac medications (e.g., digoxin) (OER #1). Sometime the apical pulse is auscultated pre and post medication administration. It is also a best practice to assess apical pulse in infants and children up to five years of age because radial pulses are difficult to palpate and count in this population. It is typical to assess apical pulses in children younger than eighteen, particularly in hospital environments. Apical pulses may also be taken in obese people, because their peripheral pulses are sometimes difficult to palpate.

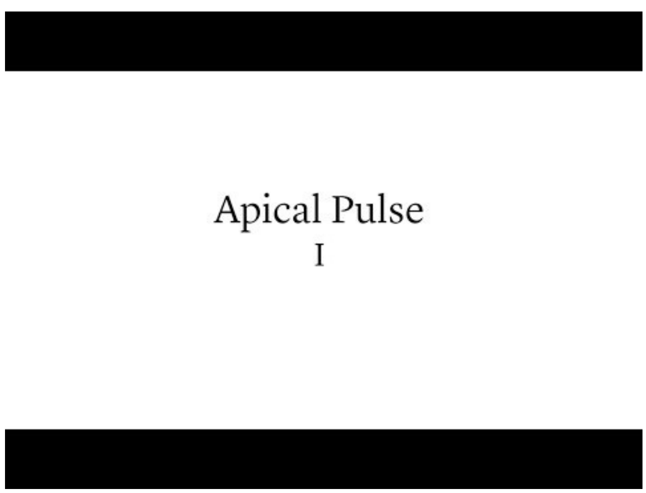
Technique

Position the client in a supine (lying flat) or in a seated position. Physically palpate the intercostal spaces to locate the landmark of the apical pulse. Ask the female client to re-position her own breast tissue to auscultate the apical pulse. For example, the client gently shifts the breast laterally so that the apical pulse landmark is exposed. Alternatively, the healthcare provider can use the ulnar side of the hand to re-position the breast tissue and auscultate the apical pulse. Ensure draping to protect the client's privacy.

Either the bell or diaphragm are used to auscultate the client's heart rate and rhythm. There is a pediatric-size stethoscope for infants. Typically, apical pulse rate is taken for a full minute to ensure accuracy; this is particularly important in infants and children due to the possible presence of sinus arrhythmia. In adults, if you are assessing the apical pulse due to an irregular rhythm then count for one minute. Upon auscultating the apical pulse, you will hear the sounds "lub dup" – this counts as one beat. Continue counting the apical pulse and note the rate and rhythm.

Listen to **Audio clip 3.1** and count the apical pulse. For practice, we have made this clip 30 seconds so you will need to multiply it by two to report it as beats per minute (but remember, **the most accurate measurement is to count the apical pulse for one minute**).

Audio clip 3.1: Counting apical pulse rate



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What should the healthcare provider consider?

Although pulses are best measured at rest, sometimes this is not possible. It is important to document other factors such as when a person is in pain or an infant/child is crying.

Technique Tips

Feel the intercostal spaces to accurately locate the apical pulse and obtain a physical landmark. There is a space below the clavicle, but the first intercostal space is located below the first rib. You can also slide your fingers down the manubrium where it meets the sternum: this is called the sternal angle (angle of Louis). The second rib extends out from the sternal angle.

Pulse Check! Test Your Knowledge

Now, you find the four pulse points.

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Please answer the seven questions in the following question set.

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Chapter Attributions

Part of this content was adapted from OER #1 (as noted in brackets above):

What is Respiration?

Respiration refers to a person's breathing and the movement of air into and out of the lungs (OER #2). The respiratory system provides oxygen to body tissues for cellular respiration, removes the waste product carbon dioxide, and helps maintain acid–base balance (OER #2). Inspiration is the process that causes air to enter the lungs, and expiration is the process that causes air to leave the lungs (OER #2). A respiratory cycle (or one breath while you are measuring respiratory rate) is one sequence of inspiration and expiration (OER #2).

Respiration is assessed for **quality**, **rhythm**, and **rate**.

The **quality** of a person's breathing is normally relaxed and silent. Healthcare providers assess use of accessory muscles in the neck and chest and indrawing of intercostal spaces (also referred to as intercostal tugging), which can indicate respiratory distress. Respiratory distress can also cause nasal flaring, and the person often moves into a tripod position. The tripod position involves leaning forward and placing arms/hands and/or upper body on one's knees or on the bedside table.

Respiration normally has a regular **rhythm**. A regular rhythm means that the frequency of the respiration follows an even tempo with equal intervals between each respiration. If you compare this to music, it involves a constant beat that does not speed up or slow down, but stays at the same tempo.

Respiratory **rates** vary based on age. The normal resting respiratory rate for adults is 10–20 breaths per minute (OER #1). Children younger than one year normally have a respiratory rate of 30–60 breaths per minute, but by the age of ten, the normal rate is usually 18–30 (OER #2). By adolescence, the respiratory rate is usually similar to that of adults, 12–18 breaths per minute (OER #2). The normal respiratory rate for children decreases from birth to adolescence (OER #2). Respiratory rates often increase slightly over the age of sixty-five.

Estimated respiratory **rates** vary based on the source. **Table 3.2** lists a generous range of normal respiratory rates based on age. It is important to consider the client and the situation to determine whether the respiratory rate is normal. Healthcare providers take into consideration the client's health and illness state and determinants such as rest/sleep, awake/active, presence of pain, and crying when assessing the respiratory rate.

Table 3.2: Respiratory Rate Ranges

Age	Rate (breaths per minute)
Newborn to one month	30–65
One month to one year	26–60
1–10 years	14–50
11–18 years	12–22
Adult and older adult	10–20

Chapter Attributions

Respiration Technique

Technique

The respiratory rate is counted after taking the pulse rate so that the client is not aware that you are taking it (OER #1). Once you have finished counting the pulse, leave your fingers in place and then begin assessing respiration. Observe the chest or abdomen rise and fall. One respiration includes a full respiratory cycle (including both inspiration and expiration). Thus, the rise and the fall of the abdomen or chest is counted as one full breath. Count for 30 seconds if the rhythm is regular or for a full minute if irregular (OER #1). Report the respiration as breaths per minute, as well as whether breathing is relaxed, silent, and has a regular rhythm. Report whether chest movement is symmetrical.

What should the healthcare provider consider?

Assess the movement of the chest with adults, and the movement of the abdomen with newborns and infants. Adults are normally thoracic breathers (the chest moves) while infants are normally diaphragmatic breathers (the abdomen moves). Some adults are abdominal breathers. Breathing rates are counted for one minute with infants because the respiratory rhythm (tempo) can vary significantly. For example, the breathing rates of infants can speed up and slow down with some short periods of apnea (pauses in breathing).

When assessing respiration, ensure that thick and bulky clothing is removed so you can clearly see the rise and fall of the chest or abdomen. Although respiratory rates are best counted at rest, sometimes this is not possible (e.g., in an emergency situation and with a child who is crying). In this case, document the situation. While assessing respirations, it is important to note signs of respiratory distress, which can include loud breathing, nasal flaring, and intercostal retractions. See **Figure 3.7** for signs of respiratory distress. These signs require further assessment and intervention.

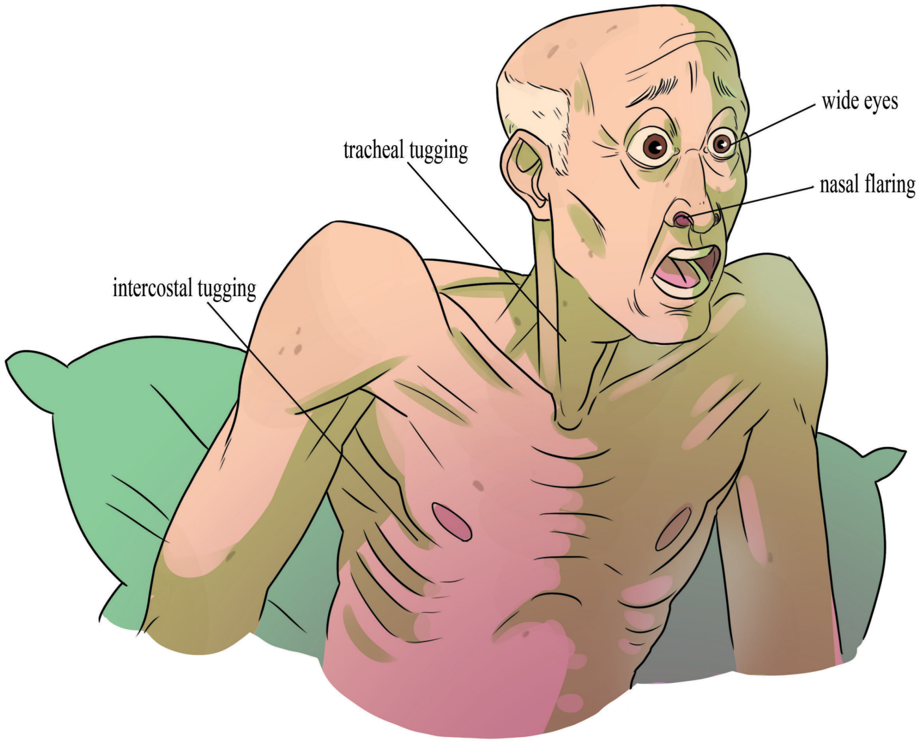

Figure 3.7: Signs of respiratory distress. (Illustration credit: Paige Jones)

Test Your Knowledge

Now, you try it!

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Please answer the three questions in the following question set.

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Chapter Attributions

Part of this content was adapted from OER #1 (as noted in brackets above):

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Finding the Error Activity

Radial Pulse

Which is the correct technique for measuring the radial pulse?

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An interactive H5P element has been excluded from this version of the text. You can view it online here: *https://opentextbc.ca/vitalsignmeasurement/?p=93#h5p-37*

An interactive H5P element has been excluded from this version of the text. You can view it online here: *https://opentextbc.ca/vitalsignmeasurement/?p=93#h5p-38*

Infant Apical Pulse

Which image shows the correct method for measuring the apical pulse on a toddler?

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Adult Apical Pulse

Which image shows the correct method for measuring the apical pulse on an adult?

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An interactive H5P element has been excluded from this version of the text. You can view it online here:
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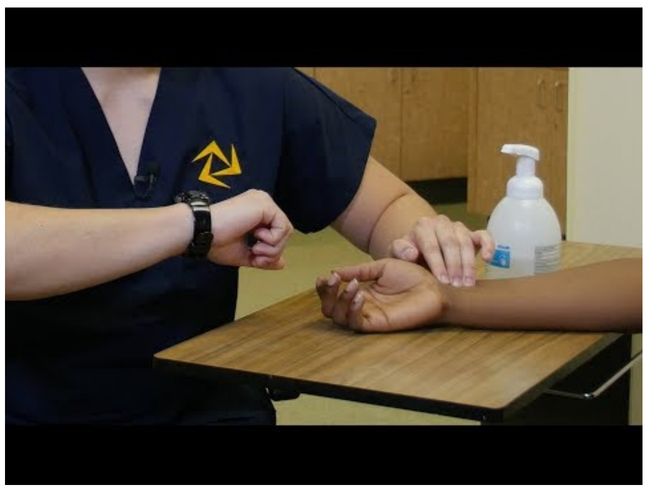
Try it Out

Next, there are two activities that involve two film clips that you can watch and then try out yourself. You can watch the clips and practice as many times as you like.

Radial Pulse and Respiration

Watch this short **film clip 3.2** and see how to measure radial pulse and respiration correctly. After watching the clip, try the technique yourself.

Film clip 3.2: Pulse and respiration measurement



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Alternatively, if viewing textbook as a PDF, use this link: https://www.youtube.com/embed/yxSoB3BiDLo?rel=0

Apical Pulse

Watch this short **film clip 3.3** and see how to measure an apical pulse correctly. After watching the clip, try the technique yourself.

Film clip 3.3: Correct measurement of apical pulse

A YouTube element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=99

Alternatively, if viewing textbook as a PDF, use this link: https://www.youtube.com/embed/JJ9VEymVl8Q?rel=0

Test Yourself

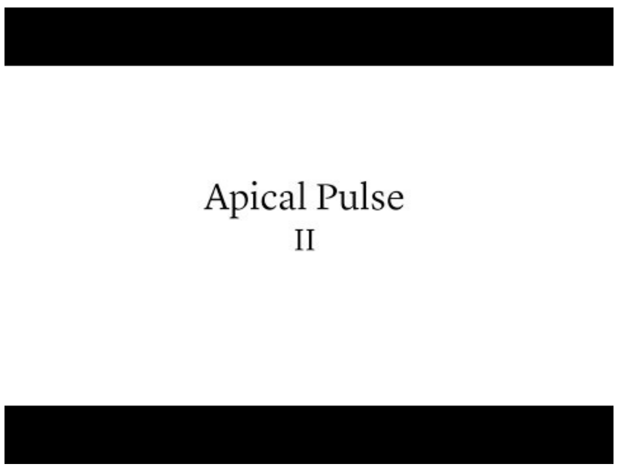
Now that you have completed this chapter, it's time to test your knowledge. Try to answer the following questions (you may want to review parts of the chapter before answering).

Pulse

What is the apical pulse rate?

Listen to the audio clip of the apical pulse. Count the pulse for 30 seconds and report the rate as beats per minute. (NOTE: Although this clip only allows you to count for 30 seconds, remember, **it is best to count the apical pulse for one minute.**)

Audio clip 3.2: Apical pulse



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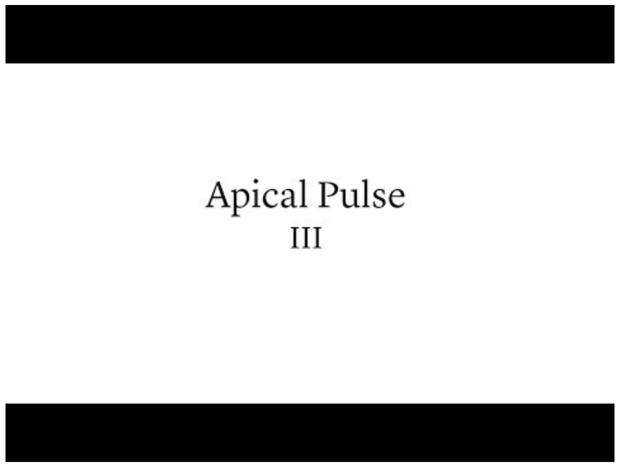
What is the apical pulse rate?

Listen to the audio clip of the apical pulse. Count the pulse for 30 seconds and report the rate as beats per minute. (NOTE: although this clip only allows you to count for 30 seconds, remember, **it is best to count the apical pulse for one minute.**)

Audio clip 3.3: Apical pulse



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Respirations

Count the respirations, then click on the hand icon on the video to submit your answer. Please note: there is **no** sound in this video.

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Technique

Put the steps in the correct order for each of the pulse and respiration techniques.

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Chapter Summary

Measurement of pulse and respiration is important because these vital signs provide current data about the client's health and illness state. Changes in pulse and respiration act as cues for healthcare providers' diagnostic reasoning.

Pulse can be measured in many locations. When determining the best location, healthcare providers consider the client's age and health and illness state, as well as the reason for taking the pulse.

When determining the relevance of pulse and respiration data, healthcare providers consider the client's baseline data and the situation. Diagnostic reasoning about pulse and respiration always considers additional information, including other vital sign measurements and subjective and objective client data.

Chapter 4: Oxygen Saturation

Oxygen Saturation

What is Oxygen Saturation?

Oxygen saturation refers to the percentage of hemoglobin molecules saturated with oxygen. Hemoglobin molecules can each carry four oxygen molecules; the oxygen binds or attaches to hemoglobin molecules. Oxygen saturation provides information about how much hemoglobin is carrying oxygen, compared to how much hemoglobin is not carrying oxygen.

Why is Oxygen Saturation Measured?

Healthcare providers measure oxygen saturation because it provides information about a client's state of health. The body's tissues and organs require oxygen for metabolism, and oxygen saturation can reveal whether there is sufficient oxygen in the blood or whether the client is in a state called hypoxemia (insufficient oxygen in the blood).

Oxygen saturation levels can influence clinical decisions about whether the client is receiving sufficient oxygen and/or requires supplemental oxygen. Oxygen saturation levels are also monitored during and after surgeries and treatments and to assess a client's capacity for increased activity.

How is Oxygen Saturation Measured?

Oxygen saturation can be measured using a pulse oximetry device, which is a non-invasive method to measure arterial oxygen saturation level. See **Figure 4.1** for a pulse oximeter. In critically ill clients, a more invasive and continuous monitoring system is used to measure arterial blood gases through an arterial line. An arterial line is a catheter that is inserted into an artery, usually the radial artery. It provides a way to access blood gases including arterial oxygen saturation (SaO2). Here, we focus on pulse oximetry because it is identified as a vital sign.

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Figure 4.1: A pulse oximeter

A pulse oximetry device includes a sensor that measures light absorption of hemoglobin and represents arterial SpO2 (OER #1). Oxyhemoglobin and unoxygenated hemoglobin absorb light differently. The sensor measures "the relative amount of light absorbed by oxyhemoglobin and unoxygenated (reduced) hemoglobin" and compares the amount of "light emitted to light absorbed" (Jarvis, 2014, p. 164). This comparison is then converted to a ratio and is expressed as a percentage of Sp02.

Points to Consider

A pulse oximeter reading reflects arterial oxygen saturation levels, as opposed to venous oxygen saturation levels, because the device only measures light absorption of pulsatile flow: the **'p' in Sp02 refers to pulse or pulsatile flow**. If pulsatile flow is limited or obstructed, an oxygen saturation level will not be accurate. For example, the compression of a blood pressure cuff will obliterate the pulsatile flow so blood pressure and pulse oximetry should not be taken simultaneously on the same limb.

The sensor is attached using various devices. One is a spring-loaded clip attached to a finger or toe as shown in **Figure 4.1**. It is used when an intermittent measurement is required. However, this clip is too large for newborns and young children, so for this population, the sensor is taped to a finger or toe. See **Figure 4.2**. This technique is also used for clients who require continuous monitoring.

Figure 4.2: Pulse oximeter with sensor taped around finger.

An earlobe clip is another useful device for clients who cannot tolerate the finger or toe clip or have a condition that could affect the results, such as vasoconstriction and poor peripheral perfusion. Another type of device is taped across the forehead and left in place for continuous monitoring. See **Figure 4.3**.

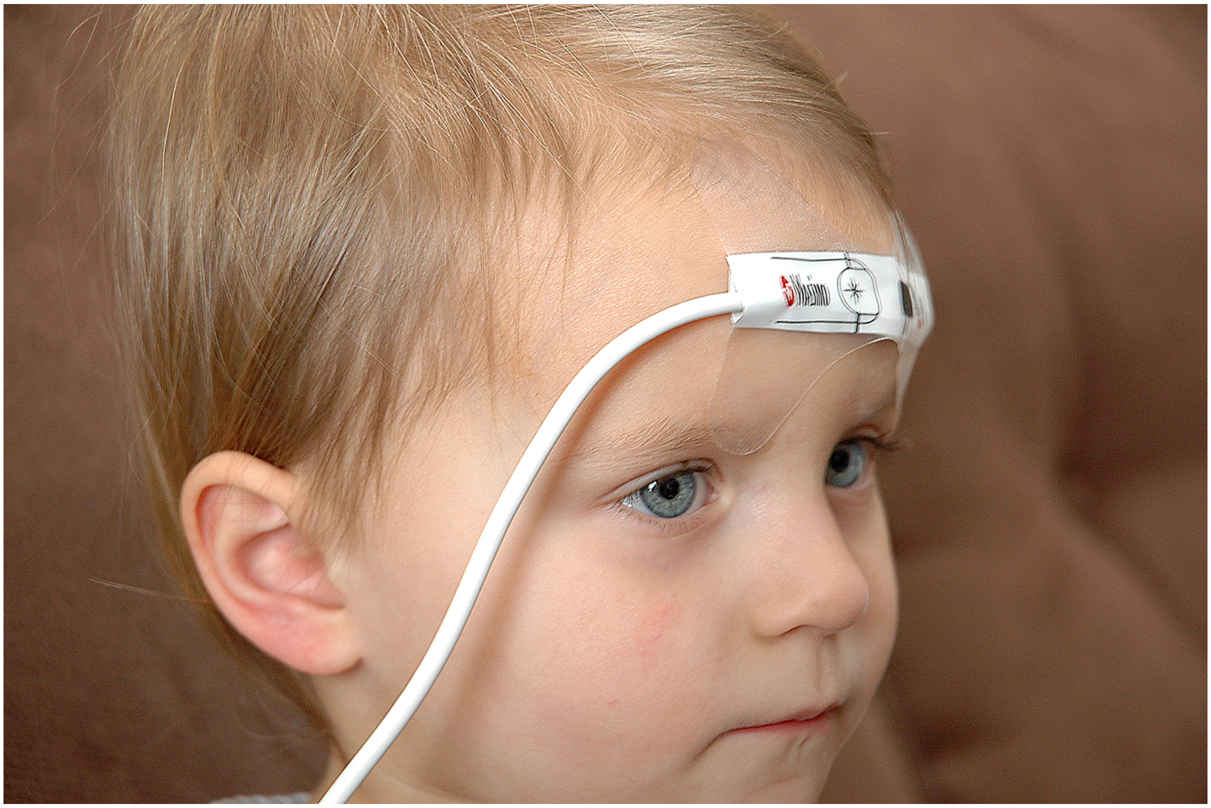

Figure 4.3: Pulse oximeter with device across forehead.

Chapter Attributions

Part of this content was adapted from OER #1 (as noted in brackets above):

What are Normal Oxygen Saturation Levels?

The acceptable oxygen saturation range is **97–100%** (OER #1).

Older adults typically have lower oxygen saturation levels than younger adults. For example, someone older than 70 years of age may have an oxygen saturation level of about 95%, which is an acceptable level.

It is important to note that the oxygen saturation level **varies** considerably based on a person's state of health. Thus, it is important to understand both **baseline readings** and **underlying physiology** associated with certain conditions to interpret oxygen saturation levels and changes in these levels.

- People who are obese and/or have conditions such as lung and cardiovascular diseases, emphysema, chronic obstructive pulmonary disease, congenital heart disease and sleep apnea tend to have lower oxygen saturation levels.
- Smoking can influence the accuracy of pulse oximetry in which the the SpO2 is low or falsely high depending on whether hypercapnia is present. With hypercapnia, it is difficult for the pulse oximeter to differentiate oxygen in the blood from carbon monoxide (caused by smoking).
- Oxygen saturation levels may decrease slightly when a person is talking.
- Oxygen saturation may remain normal (e.g., 97% and higher) for people with anemia. However, this may not indicate adequate oxygenation because there are less hemoglobin to carry an adequate supply of oxygen for people who have anemia. The inadequate supply of oxygen may be more prominent during activity for people with anemia.
- Falsely low oxygen saturation levels may be associated with hypothermia, decreased peripheral perfusion, and cold extremities. In these cases, an ear lobe pulse oximeter device or arterial blood gases would provide a more accurate oxygen saturation level. However, arterial blood gases are usually only taken in critical care or emergency settings.

Points to Consider

In practice, the SpO2 range of 92–100% is generally acceptable for most clients. Some experts have suggested that a SpO2 level of at least 90% will prevent hypoxic tissue injury and ensure client safety (Beasley, et al., 2016).

Please answer the four questions in the following question set.

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Chapter Attributions

Part of this content was adapted from OER #1 (as noted in brackets above):

Oxygen Saturation Technique

Technique

The pulse oximeter probe is clipped onto or taped around a client's finger, as shown in **Figure 4.4**. The device displays an oxygen saturation level and a pulse within a few seconds. Palpate the client's radial pulse (taken for 30 seconds if regular and one minute if irregular) while the oximeter is attached to the finger. The healthcare provider can have confidence in the accuracy of the measurement of the oxygen saturation level if the pulse displayed on the oximeter coincides with the radial pulse.

Figure 4.4: Measuring oxygen saturation.

Points to Consider

Nail polish or artificial nails can interact with the absorption of light waves and influence the accuracy of the SpO2 measurement when using a probe clipped on the finger. Remove nail polish or use an alternative method.

While watching the following interactive video, apply your knowledge and critical thinking skills to answers the questions throughout the video. This video is repeated, uninterrupted, at the end of the chapter to facilitate seamless practice.

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What should the healthcare provider consider?

Many factors can influence accuracy when measuring oxygen saturation levels via pulse oximetry. Certain conditions, including poor circulation and peripheral vasoconstriction, can lead to inaccurate oxygen saturation measurements when the device is attached to a finger or toe. Vasoconstriction involves narrowing of the vessels, so blood flow is reduced to the peripheries. This can reduce the accuracy of the reading and reduce the oximeter's capacity to detect a signal. Readings may also be inaccurate (low) if a client's hands or feet are cold or they have poor circulation. In cases like these, use an alternate method of measurement, like clipping a device to the earlobe or taping it to the forehead.

The healthcare provider cannot have confidence in measurement accuracy when the radial pulse does not coincide with the pulse displayed on the oximeter. It is also important to note that the pulse oximeter device cannot provide an accurate reading when oxygen saturation is below 75% (Shah & Shelley, 2013). Oxygen saturation levels in the 70s indicate that a client is decompensating and immediate intervention is required. Thus, it is important to confirm accuracy via additional assessments, such as assessing for respiratory distress, drawing arterial blood gases and/or checking for machine error.

The significance of the oxygen saturation level is interpreted in the context of the client's baseline measurements, other data including vital signs and other objective and subjective findings, and the client's overall health and wellness state.

Test Your Knowledge

Please answer the three questions in the following question set.

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Finding the Error Activity

Now you have an opportunity to find errors in measurement techniques. The first activity involves watching a short film clip.

What error in technique is this healthcare provider making while measuring oxygen saturation in Film clip 4.1?

Film clip 4.1 Oxygen saturation taken incorrectly

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Now you have an opportunity to find errors in measurement techniques by looking at an image.

Which image shows the correct technique while measuring oxygen saturation?

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Try it Out

Next, you have an opportunity to watch a short film clip on accurate measurement techniques. Watch this **film clip 4.2** to see how to measure oxygen saturation correctly using a pulse oximeter. After the clip, try the technique yourself. You can watch the clip and practice as many times as you like.

Film clip 4.2: Oxygen saturation taken correctly

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Alternatively, if viewing textbook as a PDF, use this link: https://www.youtube.com/embed/6KTG1lWQ8bs?rel=0

Test Yourself

Now that you have completed this chapter, it's time to test your knowledge. Try to answer the following questions.

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Chapter Summary

Measuring oxygen saturation via pulse oximetry is a non-invasive way to quickly assess a client's oxygen level. The results reflect a person's oxygenation status and provide data for healthcare providers' diagnostic reasoning.

The sensor can be attached in many ways, including clipping and taping probes to the finger, toe, earlobe, and forehead. The type and location of the apparatus is selected based on the client's age, the presence of vasoconstriction, the adequacy of peripheral perfusion, whether intermittent or continuous monitoring is required, and the client's health and illness state.

When determining the relevance of the oxygen saturation reading, healthcare providers consider the client's health and wellness state. Specifically, they consider other data related to oxygenation including respiratory quality, rate, and rhythm; pulse; skin colour and temperature; and the client's subjective description of ease or difficulty breathing. Decreases in oxygen saturation readings are potentially life-threatening and require immediate intervention.

Chapter 5: Blood Pressure

What is Blood Pressure?

Blood pressure is the force of blood exerted against the arterial walls, and is reported in millimetres of mercury (mm Hg). Try turning your kitchen tap on just a little bit, and then full blast. Compare the varying forces of water pressure as you adjust the tap. This comparison will give you a better sense of blood pressure.

The pressure against the arterial walls (the blood pressure) changes depending on whether the heart is contracting and pushing blood out into the arteries or whether the heart is in a resting phase and filling with blood. There is always force against the arterial walls, even when the heart is in a resting phase. The **systolic pressure** is the maximum pressure on the arteries during left ventricular contraction (systole) (OER #1). The left ventricle is a lower chamber of the heart responsible for pumping blood out to the body. The **diastolic pressure** is the resting pressure on the arteries between each cardiac contraction (OER #1) when the heart's chambers are filling with blood (diastole).

Stroke volume is the amount of blood ejected from the left ventricle in a single contraction. Stroke volume provides information about the functioning of the heart. Stroke volume is influenced by age and typically ranges from 5–80 mL. Newborns have a stroke volume of about 5 mL per contraction while adults have a stroke volume of about 30–70 mL per contraction; the stroke volume increases as individuals grow and their hearts become stronger and can pump more volume per contraction. Direct measurement of stroke volume involves an invasive approach in which a catheter is passed into the pulmonary artery via a large neck vein; this monitoring device is only used during critical care situations.

Indirect measurement of stroke volume involves assessing the **pulse pressure**, which is the difference between the systolic and diastolic values and signifies the force required by the heart each time it contracts. For example, if someone's blood pressure is 120/80 mm Hg, the pulse pressure is 40 mm Hg. A higher pulse pressure can indicate arterial stiffness, which often happens as a result of aging or cardiovascular disease. A higher pulse pressure can also be indicative of aortic valvular insufficiency where the diastolic pressure is unusually low and the systolic pressure is mildly elevated or unchanged. A lower pulse pressure can be a marker of poor heart function, where cardiac output is decreased.

Test Your Knowledge

Please answer the four questions in the following question set.

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Chapter Attributions

Part of this content was adapted from OER #1 (as noted in brackets above):

Why is Blood Pressure Measured?

- A person's blood pressure provides insight into the functioning of the body
- Healthy body functioning is influenced by healthy blood pressure
- The findings can provide information about the integrity of arteries and heart functioning, which can lead the healthcare provider to conduct additional assessments
- High blood pressure can cause the arteries to become weak and damaged and cause the heart to become weak and enlarged
- Low blood pressure can decrease perfusion of nutrients and oxygen to the body's cells, influencing ability to function and potentially cellular death
- Chronic high blood pressure can contribute to conditions such as vascular disease, myocardial infarction, cerebral stroke, kidney disease, and dementia

Factors That Influence Blood Pressure

Five factors influence blood pressure:

1. Cardiac output
2. Peripheral vascular resistance
3. Volume of circulating blood
4. Viscosity of blood
5. Elasticity of vessels walls

Blood pressure increases with increased cardiac output, peripheral vascular resistance, volume of blood, viscosity of blood and rigidity of vessel walls.

Blood pressure decreases with decreased cardiac output, peripheral vascular resistance, volume of blood, viscosity of blood and elasticity of vessel walls.

Cardiac Output

Cardiac output is the volume of blood flow from the heart through the ventricles, and is usually measured in litres per minute (L/min). Cardiac output can be calculated by the stroke volume multiplied by the heart rate. Any factor that causes cardiac output to increase, by elevating heart rate or stroke volume or both, will elevate blood pressure and promote blood flow. These factors include sympathetic stimulation, the catecholamines epinephrine and norepinephrine, thyroid hormones, and increased calcium ion levels. Conversely, any factor that decreases cardiac output, by decreasing heart rate or stroke volume or both, will decrease arterial pressure and blood flow. These factors include parasympathetic stimulation, elevated or decreased potassium ion levels, decreased calcium levels, anoxia, and acidosis.

Peripheral Vascular Resistance

Peripheral vascular resistance refers to compliance, which is the ability of any compartment to expand to accommodate increased content. A metal pipe, for example, is not compliant, whereas a balloon is. The greater the compliance of an artery, the more effectively it is able to expand to accommodate surges in blood flow without increased resistance or blood pressure. Veins are more compliant than arteries and can expand to hold more blood. When vascular disease causes stiffening of arteries (e.g., atherosclerosis or arteriosclerosis), compliance is reduced and resistance to blood flow is increased. The result is more turbulence, higher pressure within the vessel, and reduced blood flow. This increases the work of the heart.

Volume of Circulating Blood

Volume of circulating blood is the amount of blood moving through the body. Increased venous return stretches the walls of the atria where specialized baroreceptors are located. Baroreceptors are pressure-sensing receptors. As the atrial baroreceptors increase their rate of firing and as they stretch due to the increased blood pressure, the cardiac centre responds by increasing sympathetic stimulation and inhibiting parasympathetic stimulation to increase HR. The opposite is also true.

Viscosity of Blood

Viscosity of blood is a measure of the blood's thickness and is influenced by the presence of plasma proteins and formed elements in the blood. Blood is viscous and somewhat sticky to the touch. It has a viscosity approximately five times greater than water. Viscosity is a measure of a fluid's thickness or resistance to flow, and is influenced by the presence of the plasma proteins and formed elements within the blood. The viscosity of blood has a dramatic effect on blood pressure and flow. Consider the difference in flow between water and honey. The more viscous honey would demonstrate a greater resistance to flow than the less viscous water. The same principle applies to blood.

Elasticity of Vessel Walls

Elasticity of vessel walls refers to the capacity to resume its normal shape after stretching and compressing. Vessels larger than 10 mm in diameter are typically elastic. Their abundant elastic fibres allow them to expand as blood pumped from the ventricles passes through them, and then to recoil after the surge has passed. If artery walls were rigid and unable to expand and recoil, their resistance to blood flow would greatly increase and blood pressure would rise to even higher levels, which would in turn require the heart to pump harder to increase the volume of blood expelled by each pump (the stroke volume) and maintain adequate pressure and flow. Artery walls would have to become even thicker in response to this increased pressure.

Test Your Knowledge

Please answer the two questions in the following question set.

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Chapter Attributions

All content on this page was adapted from OER #2:

What are Blood Pressure Ranges?

Blood pressure is reported in mm Hg (pronounced millimetres of mercury), in which the systolic is the numerator and diastolic is the denominator. See **Table 5.1** for an overview of estimated blood pressure ranges for healthy individuals.

Table 5.1: Estimated Blood Pressure Ranges (mm Hg)

Age	Systolic Range	Diastolic Range
Newborn to 6 months	45–90	30–65
6 months to 2 years	80–100	40–70
Children (2–13 years)	80–120	40–80
Adolescent (14–18 years)	90–120	50–80
Adult (19–40 years)	95–135	60–80
Adult (41–60 years)	110–145	70–90
Older adult (61 years and older)	95–145	70–90

Points to Consider

The average blood pressure for an adult is sometimes noted as **120/80 mm Hg**. However, this is only an average and the healthcare provider needs to consider acceptable ranges for individual clients. For example, in adults, normal blood pressure can range from 95–145/60–90 mm Hg. The healthcare provider considers the client's baseline blood pressure and the client's current health state in conjunction with subjective data and other objective data. For example, a blood pressure of 90/50 mm Hg may be normal for a healthy, asymptomatic 20-year-old adult.

Factors that influence blood pressure include age, sex, ethnicity, weight, exercise, emotions/stress, pregnancy, and diurnal rhythm as well as medication use and disease processes.

- The general pattern is that blood pressure rises with age, so normal variations tend to be higher for older adults.
- Blood pressure is similar in childhood for males and females. After puberty, females have lower blood pressure than males, whereas after menopause females have higher blood pressure than males.
- Research has revealed that ethnicity may be a predictor of blood pressure, but this causation

is not necessarily biological, but rather sociocultural. When determining risk for high blood pressure, it is important to consider ethnicity as a contributing factor.

- The diurnal cycle influences blood pressure to be lower in the morning and increase throughout the day until early evening. Try it out: take your blood pressure when you wake up in the morning and then again in late afternoon, and note the difference. This is one reason why healthcare providers document the time a client's blood pressure is taken.
- Blood pressure can be higher in people who are obese because the heart has to work harder to perfuse the body's tissues.
- The sympathetic nervous system is stimulated by exercise, stress, anxiety, pain, anger, and fear, which increases blood pressure. Blood pressure returns to baseline within five minutes of rest following activity. Try it out. Have a peer take your blood pressure. Then, run on the spot or do some other cardiac activity for five minutes. Have the peer take your blood pressure again, and then lie down and rest for five minutes. Take the blood pressure again. Note the changes.
- Blood pressure varies throughout the duration of pregnancy. It decreases about halfway through the first trimester until mid-pregnancy due to progesterone effects that relax the walls of blood vessels, causing decreased peripheral vascular resistance. It returns to pre-pregnancy values toward the end of pregnancy.

Points to Consider

White coat syndrome refers to elevated blood pressure due to nervousness or anxiety when clients have their blood pressure taken by a healthcare provider. This occurs in approximately 20% of clients. Key message: have the client take their blood pressure at home with an automatic home blood pressure cuff and compare the findings. Alternatively, you can ask the client to sit quietly and leave the room while an automatic cuff takes a client's blood pressure. The automatic cuff can be programmed to take three measurements and the blood pressure documented is an average of the three readings.

Test Your Knowledge

Please answer the seven questions on the following cards.

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How is Blood Pressure Measured?

Blood pressure is measured in many ways including manual/auscultatory, automatic/electronic, cellular phone applications, and arterial catheters. Whatever method is used, blood pressure must be measured using validated equipment. It has been found that blood pressure is often not measured accurately in clinical practice, particularly when using the auscultatory/manual method. It is important to ensure correct technique to obtain an accurate measurement. Hypertension Canada (2020) recommends electronic blood pressure measurement as the preferred method in clinical practice.

Points to Consider

Take blood pressure in both arms when you measure a client's blood pressure for the first time. A small difference in blood pressure between the arms is often normal. Differences of greater than 10 mm Hg systolic between the arms are investigated further because this finding has been associated with vascular disease and mortality outcomes. Measure subsequent blood pressures in the arm with the higher blood pressure.

Client Positioning

Blood pressure is generally taken in a sitting or supine position with the bare arm at heart level (OER #1). Certain health states prevent some clients from sitting, such as clients who are critically ill, unstable, or postoperative. Thus, healthcare providers document the client's positioning (e.g., sitting, supine, standing). If sitting, the feet are placed flat on the floor with the back resting comfortably against a chair. The healthcare provider checks to ensure that the client's legs are not crossed, because this can increase blood pressure. The client sits resting for five minutes before you take the blood pressure. **This waiting period is not feasible when the client's condition is deteriorating or a STAT blood pressure is required**. Because the client should be resting, you should ask them not to talk or move. Additionally, you should not ask them to hold any of your equipment during the blood pressure measurement.

Cuff Types and Sizes

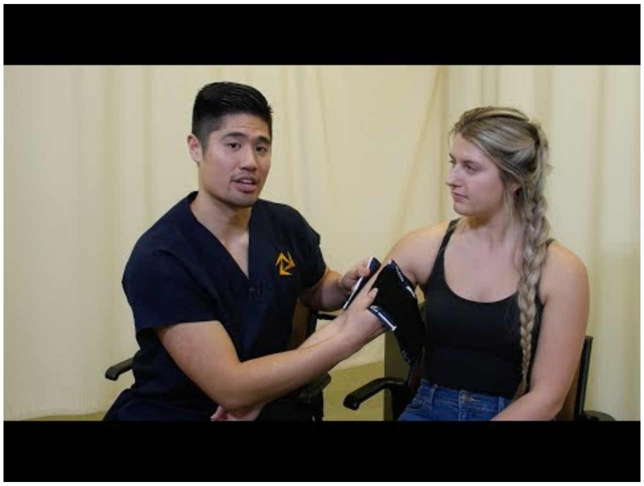
Manual and automatic blood pressure measurement involves using a blood pressure cuff with a sphygmomanometer. Many cuff sizes are available to fit newborns, children, adults, people with small and larger arms, and people with cone-shaped arms. The cuff is typically wrapped around the upper arm. However, there is also a cuff that can be placed on the thigh when the arm is not feasible. See **Figure 5.1** of varying blood pressure cuff sizes. Wrist devices can be used for blood pressure estimation when clients have a large upper arm circumference (Nerenberg, 2018). When taking the measurement, make sure that the arm and wrist are supported at heart level (Nerenberg, 2018).

Figure 5.1: Varying blood pressure cuff sizes.

It is important to choose a cuff size that matches the client's arm size, rather than their age. See **Table 5.2** about cuff sizing. See **Film Clip 5.1** of a demonstration of accurate cuff sizing.

Table 5.2: Cuff Sizing

Cuff Sizing
The width of the cuff is 40% of the person's arm circumference
The length of the cuff's bladder is 80–100% of the person's arm circumference



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Film clip 5.1: Accurate cuff sizing

Alternatively, if viewing textbook as a PDF, use this link: https://www.youtube.com/embed/uNTMwoJTfFE?rel=0

Before placing the blood pressure cuff on the client's arm, palpate the brachial artery using three fingers (not your thumb) just above the antecubital fossa medially (OER #1). To do this, palpate the bicep tendon at the antecubital fossa. Move 2 cm medially from the tendon and 2–3 cm above the antecubital fossa. Press firmly to feel the brachial pulse. Wrap the blood pressure cuff securely and evenly around the client's upper, bare arm (not over clothing) with the cuff's artery marker aligned with the brachial artery and about 3cm above the antecubital fossa.

Technique Tips

Thigh blood pressure is indicated when blood pressure cannot be taken on the arm, such as when clients have bilateral amputation or burns. Thigh blood pressure is also done on children and adolescents with unusually high blood pressure in the arm and to compare differences between upper and lower extremities. In such cases, coarctation of the aorta (a congenital narrowing of the aorta) is possible. The thigh systolic blood pressure is 10–40 mm Hg higher than the arm systolic blood pressure, while the thigh diastolic blood pressure is approximately the same as the arm. To obtain thigh blood pressure, the client must be in prone position. Place the cuff around the bottom third of the client's thigh. The cuff's artery line is aligned with the popliteal artery. The popliteal artery can be located in the popliteal fossa. Palpate the medial tendon and move the pads of your three fingers lateral to the tendon. Press your fingers into the femur or tibia bone. Continue with the same process as noted above in terms of taking blood pressure.

Blood Pressure Methods

Manual blood pressure measurement is taken using a blood pressure cuff with a sphygmomanometer and a stethoscope. **See Figure 5.2**. This technique is detailed on next page.

Figure 5.2: Blood pressure cuff with a sphygmomanometer and a stethoscope.

Automatic blood pressure cuffs are a digital way to measure blood pressure. See **Figure 5.3**. After positioning the client and the blood pressure cuff on the arm, press the start button on the monitor. The cuff is automatically inflated and then deflates at a rate of 2 mm Hg per second. The monitor has a digital display that shows the blood pressure reading when done. Automatic cuffs can be programmed to take a series of blood pressure readings in a row. If the healthcare provider is concerned about an initial high blood pressure reading on a client, the accuracy of the blood pressure is verified with the following actions:

- have the client sit in a room by themselves
- quiet the room
- dim the lights
- allow the client to sit quietly, without talking
- then take three measurements, a few minutes apart, with the automatic cuff. The blood pressure displayed is an average of the three readings.

Figure 5.3: Automatic blood pressure cuff.

Clients can monitor their own blood pressure at home with an automatic digital blood pressure monitoring device. Clients are advised to use a device that meets the standards of the Association for the Advancement of Medical Instrumentation, the requirements of the British Hypertension Society protocol, or the International Protocol for Validation of Automated Blood Pressure Measuring Devices. The cuff is applied around the client’s upper arm or wrist. Similar to the automatic cuff noted above, the client presses the start button and the cuff inflates and deflates based on programmed levels displaying a digital reading. Clients are encouraged to document their blood pressure or use a device with data-recording capabilities to increase the reliability of their reported home blood pressure monitoring. These data can be shared with the client’s primary care provider.

Arterial catheters are an invasive way to measure blood pressure and are only used in critical care situations when continuous blood pressure monitoring and arterial blood gas draws are required. This involves insertion of a catheter (similar to an intravenous) into the artery. The catheter is connected to a pressure transducer and monitor that provide a digital blood pressure reading.

Cellular phone applications have been developed to measure blood pressure, but the accuracy of this technology is still being investigated.

Points to Consider

Avoid using an automatic blood pressure cuff if the systolic pressure is less than 90 mm Hg in an adult, the pulse is rapid or the rhythm is irregular, and/or the client is experiencing shivers or tremors. It is best to also complete a manual blood pressure measurement to validate the accuracy of the automatic blood pressure measurement.

Chapter Attributions

Part of this content was adapted from OER #1 (as noted in brackets above):

Manual Blood Pressure Measurement

A healthcare provider uses a stethoscope and a blood pressure cuff with a sphygmomanometer to measure blood pressure manually. The stethoscope is used to listen to the blood pressure sounds, which are called Korotkoff sounds.

Stethoscope Usage and Korotkoff Sounds

The stethoscope is used on bare skin so that a client's clothing does not affect the sounds. The stethoscope does not make sounds louder; it simply blocks out extraneous noises so you can better hear the Korotkoff sounds. These sounds are heard through a stethoscope applied over the brachial artery when the blood pressure cuff is deflating. You will not hear anything when you first place the stethoscope over the brachial artery because unobstructed blood flow is silent. The Korotkoff sounds appear after you inflate the cuff (which compresses the artery/blood flow) and then begin to deflate the cuff. The Korotkoff sounds are the result of the turbulent blood caused by the inflated cuff compressing the artery and oscillations of the arterial wall when the heart beats during cuff deflation.

Here are a few tips:

- Use a high quality stethoscope with durable, thick tubing. Avoid stethoscopes with long tubing because this can distort sounds.
- Ensure quiet surroundings so that you can better hear the Korotkoff sounds.
- Make sure that the slope of the stethoscope earpieces point forward or toward your nose.
- Use a stethoscope that has both bell and diaphragm capacity. See **Figure 5.4** for bell and diaphragm.

Figure 5.4: Stethoscope with bell and diaphragm. (Illustration credit: Hilary Tang)

- Cleanse the stethoscope prior to use including the ear pieces and the bell and diaphragm.
- The bell of the stethoscope is suggested because it is used for low-pitched sounds like blood pressure. However, some healthcare providers use the diaphragm for several reasons: that is how they learned to take blood pressure; they believe this helps them hear the Korotkoff sounds better; and the diaphragm covers a larger surface area than the bell.
- Hold the bell lightly against the skin with a complete seal or hold the diaphragm firmly against the skin with a complete seal.
- You must ensure that the bell or diaphragm is open before using. See **Film Clip 5.2** on how to open and close the bell and diaphragm.

A YouTube element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=148

Film clip 5.2: Opening and closing the bell and diaphragm

Alternatively, if viewing textbook as a PDF, use this link: https://www.youtube.com/embed/rp_4h-tCmvs?rel=0

Determining Maximum Inflation Pressure

Healthcare providers determine the maximum inflation pressure before they take blood pressure. The maximum inflation pressure is the number on the sphygmomanometer that the cuff is inflated to when measuring blood pressure. If you do not determine the maximum pressure inflation, an auscultatory gap could go unrecognized, and as a result the blood pressure could be underestimated (lower than the actual value).

An auscultatory gap is a silent interval when the Korotkoff sounds go absent and then reappear while you are deflating the cuff during blood pressure measurement. This gap is an abnormal finding and can occur due to arterial stiffness and arteriosclerotic disease. It is typically observed in people with a history of hypertension who have been treated with prolonged antihypertensive medication.

To determine the maximum inflation pressure, start by palpating the brachial or radial pulse while inflating the cuff. Inflate the cuff 30 mm Hg quickly past the point when you obliterate the pulse (ie., you no longer feel the pulse). If you still cannot feel the pulse, use that value to start auscultating – that value is the maximum inflation pressure number.

When taking blood pressure, if an auscultatory gap is observed, document the first systolic sound and diastolic sound only. Report the presence of an auscultatory gap in narrative notes.

Points to Consider

Generally, auscultatory gaps do not interfere with automatic blood pressure measurements (Fech, et al., 2012). However, if a client's blood pressure reading is suspiciously high or low, the healthcare provider takes blood pressure manually.

Blood Pressure Measurement Techniques

For novices, it is a good idea to start with the two-step technique and then move onto the one-step technique as you develop your skills.

Two-step technique

First step: Determining maximum pressure inflation

Palpate the radial or brachial artery, inflate the blood pressure cuff until the pulse is obliterated, and then continue to inflate 30 mm Hg more (OER #1). Note this number – it is considered the maximum pressure inflation. Next, deflate the cuff quickly.

Second step: Measure blood pressure

Now, you can start to measure blood pressure. Place the bell of the cleansed stethoscope over the brachial artery (OER #1) using a light touch and complete seal. Inflate the cuff to the maximum pressure inflation number (OER #1). Open the valve slightly. Deflate the cuff slowly and evenly (OER #1) at about 2 mm Hg per second. See **Film Clip 5.3** which focuses on the speed of the needle when deflating the blood pressure cuff.

Note the points at which you hear the first appearance of Korotkoff sounds (systolic blood pressure) (OER #1) and the point at which the Korotkoff sounds go silent (diastolic blood pressure) (Hypertension Canada, 2020). These sounds are called Korotkoff sounds and vary in quality from tapping, swooshing, muffled sounds, and silence. The pressure at which the first Korotkoff sound is noted signifies the systolic pressure, while the pressure at which the Korotkoff sounds are no longer heard marks the diastolic pressure.

See **Audio Clip 5.1** to listen to Korotkoff sounds and noting systolic and diastolic blood pressure. Alternatively, if viewing textbook as a PDF, use this link: https://www.youtube.com/embed/lPlYNt8cVnI?rel=0

A YouTube element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=148

Film clip 5.3: Deflation rate of sphygmomanometer

Alternatively, if viewing textbook as a PDF, use this link: https://www.youtube.com/embed/QbGPzUluT5c?rel=0

Test Yourself!

While watching the interactive video on blood pressure measurement using the two-step technique, apply your knowledge and critical thinking skills to answer the questions throughout the video. Please note: there is **no** sound in this video.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=148#h5p-86

One-step technique: Determining maximum pressure inflation and taking blood pressure

Palpate the radial or brachial artery, inflate the blood pressure cuff until the pulse is obliterated (OER #1), and then quickly continue to inflate 30 mm Hg more (Hypertension Canada, 2020). Place the bell of the cleansed stethoscope over the brachial artery (OER #1) using a light touch with a complete seal. Open the valve slightly. Deflate the cuff slowly and evenly (OER #1) at about 2 mm Hg per second. Note the points at which you hear the first Korotkoff sound (systolic blood pressure) (OER #1) and the point in which the Korotkoff sounds go silent (diastolic blood pressure) (Hypertension Canada, 2020). These sounds are called Korotkoff sounds and vary in quality from tapping, swooshing, muffled sounds, and silence. The first Korotkoff sound is the systolic pressure, and the diastolic pressure is when the Korokoff sounds go silent.

A YouTube element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=148

Audio clip 5.1: Korotkoff sounds with blood pressure

Alternatively, if viewing textbook as a PDF, use this link: https://www.youtube.com/embed/MTYfYnX6FH0?rel=0

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=148#h5p-87

Test Yourself!

While watching the interactive video on blood pressure measurement using the one-step technique, apply your knowledge and critical thinking skills to answer the questions throughout the video. Please note: there is **no** sound in this video.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=148#h5p-88

Points to Conisder

Korotkoff sounds are the sounds of blood flow through the artery as you are listening to blood pressure. Korotkoff sounds are not the same thing as the heart beat or the pulse. They disappear as the cuff is inflated and reappear as the cuff is deflated. They also cannot be heard when the cuff is fully deflated because unobstructed and healthy blood flow is silent. When deflating the cuff, the first Korotkoff sound is systolic and the point in which the Korotkoff sounds are no longer heard is diastolic (Hypertension Canada, 2020). In rare cases, the Korotkoff sounds continue to 0 mm Hg. In this case, the diastolic pressure should be measured when the Korotkoff sounds become muffled (Hypertension Canada, 2020).

Test Your Knowledge

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=148#h5p-89

Chapter Attributions

Part of this content was adapted from OER #1 (as noted in brackets above):

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What Should the Healthcare Provider Consider?

Manual blood pressure is reported in even numbers. Healthcare providers **always measure blood pressure with pulse** because these vital signs are closely related and data from both are needed to make accurate and informed clinical decisions.

What Should You Do if You Cannot Feel the Brachial Pulse?

- To locate the brachial pulse, palpate the bicep tendon, move medially about 2 cm, and move up about 2–3 cm
- Use three fingers including your index and middle finger to feel for the pulse
- You will usually need to press fairly firmly to palpate the brachial pulse and may need to modify the pressure. If you press too hard, you will obliterate the pulse (make it disappear) and if you press too lightly, you will not be able to feel the pulse
- You may need to reposition your fingers to find the best place to feel the pulse along the brachial artery
- Place the client's arm with the palm up and elbow extended. You can flex the elbow in varying degrees to relax the muscle and accentuate the pulse
- Cup your opposite hand under the client's elbow

What Should You Do if You Cannot Hear the Korotkoff Sounds?

- Use your bell and make full contact with skin
- Make sure the bell is positioned over the brachial artery
- Ensure the room is quiet
- Concentrate on expected sounds (swooshing, tapping, muffled sounds)
- Try different earbuds (hard or soft) on your stethoscope

Common Errors When Taking Blood Pressure

Many errors must be avoided when measuring blood pressure.

- Failure to determine maximum pressure inflation can produce a falsely low systolic reading.
- Deflating the cuff too slowly can produce a falsely high diastolic, and deflating the cuff too quickly can produce a falsely low systolic or falsely high diastolic reading.

- Inaccurate cuff sizes for the client's arm size and shape can result in measurement error: a cuff that is too narrow can produce a falsely high blood pressure whereas a cuff that is too loose can produce a falsely low blood pressure.
- A falsely low blood pressure can result from the arm being positioned above the level of the heart and a falsely high blood pressure can result from the arm being positioned below the level of the heart.

Hypotension

A number of factors can cause hypotension (low blood pressure). **Hypotension is considered less than 95/60 mm Hg in a normotensive adult**. However, low blood pressure measurements are always interpreted in the context of a client's baseline and past blood pressure readings as well as their current health state. Common symptoms associated with hypotension are lightheadedness, loss of consciousness, blurry vision, clammy skin, and fatigue.

Orthostatic Hypotension

Orthostatic hypotension is a **drop in blood pressure when the client moves from lying to sitting to a standing position**.

Have you ever stood up quickly and felt dizzy for a moment? This is because, for one reason or another, blood is not getting to your brain so it is briefly deprived of oxygen. When you change position from sitting or lying down to standing, your cardiovascular system has to adjust for a new challenge, keeping blood pumping up into the head while gravity is pulling more and more blood down into the legs. The reason for this is a sympathetic reflex that maintains the output of the heart in response to postural change. This sympathetic reflex keeps the brain well oxygenated so that cognitive and other neural processes are not interrupted. Sometimes this does not work properly. If the sympathetic system cannot increase cardiac output, then blood pressure into the brain will decrease, and a brief neurological loss can be felt. This can be brief, such as a slight 'wooziness' when standing up too quickly, or could lead to a loss of balance and neurological impairment for a period of time. The name for this is orthostatic hypotension, which means that blood pressure falls below the homeostatic set point when standing. It can be the result of standing up faster than the reflex can occur, which may cause a benign 'head rush,' or it may be the result of an underlying cause.

There are two basic reasons why orthostatic hypotension occurs. First, blood volume is too low and the sympathetic reflex is not effective. This hypovolemia may be the result of dehydration or medications that affect fluid balance, such as diuretics or vasodilators. The second underlying cause of orthostatic hypotension is autonomic failure. Several disorders can result in compromised sympathetic functions, ranging from diabetes to multiple system atrophy (a loss of control over many systems in the body), and addressing the underlying condition can improve the hypotension. Orthostatic hypotension is more common with advancing age and can be aggravated by antihypertensive medications.

How to Assess Orthostatic Hypotension

Orthostatic hypotension is assessed by measuring orthostatic or postural blood pressure and pulse changes. This procedure is done by assessing when the client moves from supine to sitting to standing. There are variations in how this procedure is done in terms of timing. Here is a common way to proceed:

1. The client rests supine for three minutes.
2. Take blood pressure and pulse in supine position.
3. The client sits up with feet dangling.
4. Take blood pressure and pulse within two minutes of position change.
5. The client stands up.
6. Take blood pressure and pulse within two minutes of position change.

How to Evaluate the Findings

Normal variation is a 10 mm Hg decrease in blood pressure from lying to standing and an increase in pulse of 10–15 bpm.

A decrease in blood pressure from lying to standing of systolic ≥ 20 mm Hg or diastolic ≥ 10 mm Hg is identified as orthostatic hypotension.

An increase in pulse from lying to standing of ≥ 20 bpm is identified as orthostatic pulse.

Technique Tips

The healthcare provider determines the maximum inflation pressure in the supine position and then uses this same number throughout all readings. If a client is unable to stand during the orthostatic blood pressure assessment, have them sit and dangle their legs. To ensure safety, have a safe place for the client to land/sit if dizzy. Leave the blood pressure cuff on the whole time.

Test Your Knowledge

Please answer the five questions in the following question set.

An interactive H5P element has been excluded from this version of the text. You can view it online here: *https://opentextbc.ca/vitalsignmeasurement/?p=152#h5p-90*

Chapter Attributions

The content under the sub-title "Orthostatic Hypotension" was adapted from OER #2 (as noted in brackets above):

Hypertension

Chronically elevated blood pressure is known clinically as hypertension. It is defined as chronic and persistent blood pressure measurements of **140/90 mm Hg or above** (OER #2) in the adult. However, the specific measurement in which hypertension is diagnosed depends on many factors. As per Hypertension Canada (Nerenberg, et al., 2018), some of these factors include whether it is the first or second visit to have blood pressure assessed and whether the blood pressure is assessed using automatic or manual measurement devices. It is always important to look at the most current guidelines related to hypertension. See **Table 5.3** for the guidelines related to management, including monitoring and treatment, recommended by Hypertension Canada (Nerenberg, et al., 2018).

Hypertension is typically a silent disorder, so hypertensive clients may not recognize the seriousness of their condition and not adhere to their treatment plan. The result is often a heart attack or stroke. Hypertension may also lead to an aneurysm (ballooning of a blood vessel caused by a weakening of the wall), peripheral arterial disease (obstruction of vessels in peripheral regions of the body), chronic kidney disease, or heart failure. (OER#2)

Common errors in measurement and natural fluctuations in blood pressure can result in readings that erroneously suggest hypertension. Some of the errors are due to the operator (i.e., the healthcare provider) and others are due to client anxiety and situational determinants. As a healthcare provider, it is important to review your technique to assess possible measurement errors and assess the client for factors that could elevate blood pressure. If the client's blood pressure is elevated, repeat the measurement for accuracy and take the blood pressure in the opposite arm.

Because hypertension is a silent disorder, healthcare providers measure blood pressure at regular intervals. The intervals depend on the client's health status and risk factors. Before a diagnosis of hypertension is made, blood pressure is monitored over days, weeks, or months either in the office using an automatic blood pressure machine, or at home using an ambulatory blood pressure machine.

Clients demonstrating features of a hypertensive urgency or emergency (e.g., hypertensive encephalopathy, acute coronary syndrome, acute ischemic stroke, intracranial hemorrhage) are diagnosed as hypertensive and treated immediately.

Points to Consider

It is important to note the distinction between elevated blood pressure and a diagnosis of hypertension. Elevated blood pressure refers to an isolated reading, whereby the client has an elevated finding. Hypertension refers to a clinical diagnosis whereby the client has met the criteria for chronic elevated blood pressure. Hypertension will precipitate a treatment protocol, whereas an elevated finding may just require monitoring. See **Table 5.3** below for more information on making a determination of hypertension.

Guidelines to Determine Hypertension

Hypertension Canada (Leung, et al., for Hypertension Canada, 2017) states that when assessing chronic high blood pressure, readings must be done under the following conditions:

- No acute anxiety, stress, or pain
- No caffeine, smoking, or nicotine in the preceding 30 minutes
- No use of substances containing adrenergic stimulants such as phenylephrine or pseudoephedrine (may be present in nasal decongestants or ophthalmic drops)
- Bladder and bowel comfortable
- No tight clothing on arm or forearm
- Quiet room with comfortable temperature
- Rest for at least five minutes before measurement
- Ask the client to stay silent prior and during the procedure

Technique Tips

If one of the above conditions is not met, the blood pressure is still taken, but the healthcare provider must take it into consideration. If the blood pressure is elevated, it needs to be repeated to assess the possibility of hypertension.

See **Table 5.3** for the guidelines related to management, including monitoring and treatment, in the adult, recommended by Hypertension Canada (Nerenberg, et al., 2018). These recommendations are based on in-office visit one. At least two or more readings are taken during the same visit. If assessing blood pressure, the first reading is discarded and the latter two readings are averaged. You should wait one minute in between blood pressure measurements (Hypertension Canada, 2020). Additionally, multiple readings may be needed when the client has an arrhythmia (Hypertension Canada, 2020)

Table 5.3: Hypertension Canada Guidelines

Finding	**Management**
Visit 1 Office BP Measurements Manual BP averaged reading ≥130–139/ 85–89 mm Hg (high-normal)	Annual follow-up appointments are recommended so that trends and/or increases in blood pressure are assessed.
Visit 1 Office BP Measurements Manual BP averaged reading ≥140/90 mm Hg (high) Automatic BP reading ≥135/85 mm Hg (high)	A health history and physical examination are performed. **Visit two is scheduled within one month of visit one**. If clinically indicated, diagnostic tests are scheduled prior to visit two to assess cardiovascular risk factors (see **Table 5.4** for modifiable and non-modifiable risk factors) and search for target organ damage (e.g., cerebral vascular, eyes, kidneys, coronary arteries). External, modifiable factors that can increase blood pressure are assessed and removed if possible (certain prescription drugs and other substances like sodium, licorice root, alcohol, and street drugs). Out of office blood pressure measurements (e.g., ambulatory or home blood pressure measurements) are performed before visit two. White coat syndrome/hypertension is diagnosed if the out of office blood pressure measurements are within the normal range, and pharmacologic treatment is not initiated.
Visit 1 Office BP Measurements Automatic or manual BP averaged reading ≥180/110 mm Hg	Hypertension is diagnosed and immediate intervention is required.

The healthcare provider assesses a client's cardiovascular risk factors for atherosclerosis and hypertension. These risk factors are categorized as modifiable and non-modifiable. See **Table 5.4** for an overview of risk factors adapted based on Hypertension Canada guidelines (Leung, et al., for Hypertension Canada, 2017)

Table 5.4: Modifiable and Non-modifiable Risk Factors

Non-modifiable	Modifiable
• Age 55 years or older • Male sex and postmenopausal women • Family history of cardiovascular disease that began in men younger than 55 years and in women younger than 65 years	• Smoking • Stress and anxiety • Sedentary lifestyle (little or no physical activity) • Poor dietary habits (high sugar, high sodium, high fat, high cholesterol) • Abdominal obesity/overweight • Dysglycemia and dyslipidemia • Non-adherence to treatment plans (e.g., medication, diet, exercise regimen) • Alcohol intake

Test Your Knowledge

Please answer the three questions in the following question set.

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://opentextbc.ca/vitalsignmeasurement/?p=154#h5p-91

Chapter Attributions

Part of this content was adapted from OER #2 (as noted in brackets above):

Finding the Error Activity: Blood Pressure

Now you have an opportunity to find the errors in measurement techniques. The first activity involves watching a short film clip. Check it out!

What errors in technique is this healthcare provider making while taking blood pressure?

A YouTube element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=156

Film clip 5.4: Errors in blood pressure measurement

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=156#h5p-92

Alternatively, if viewing textbook as a PDF, use this link: https://www.youtube.com/embed/-NYfBuZMmXo?rel=0

Try it Out: Two-step & One-step Blood Pressure

Next, you have an opportunity to watch film clips on accurate measurement techniques. There are two activities that involve two film clips about blood pressure measurement techniques. Watch each of them and then try it out yourself.

Please note: The first film clip refers to the two-step blood pressure approach. This approach is used for learners. As you become more proficient, you can try the one-step blood pressure approach.

Two-step Blood Pressure

Watch this teaching video of a film clip that shows the two-step blood pressure approach. This approach is best used when you are first learning how to take blood pressure. Watch the clip and then try it out!

A YouTube element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=158

Film clip 5.5: Two-step blood pressure approach

Alternatively, if viewing textbook as a PDF, use this link: https://youtu.be/UbW4viRRvd4

One-step Blood Pressure

Watch this teaching video of a film clip that shows the one-step blood pressure approach. After you become proficient in the two-step approach, you can move on to the one-step blood pressure approach. Watch the clip and then try it out!

A YouTube element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=158

Film clip 5.6: One-step blood pressure approach

Alternatively, if viewing textbook as a PDF, use this link: https://youtu.be/OLdz13c7_vo

Test Yourself

Now that you have completed this chapter, it's time to test your knowledge. Try to answer the following questions (you may want to review parts of the chapter before answering).

1. Watch and listen to the Korotkoff sounds while blood pressure is taken in audio clip 5.2. What is the systolic and diastolic blood pressure?

A YouTube element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=162

Audio clip 5.2: Korotkoff sounds

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=162#h5p-93

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=162#h5p-94

Alternatively, if viewing textbook as a PDF, use this link: https://www.youtube.com/embed/qj6X2nQhqyI?rel=0

2. Watch and listen to the Korotkoff sounds while blood pressure is taken in audio clip 5.3. What is the systolic and diastolic blood pressure?

A YouTube element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=162

Audio clip 5.3: Korotkoff sounds

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=162#h5p-95

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=162#h5p-96

Alternatively, if viewing textbook as a PDF, use this link: https://www.youtube.com/embed/5jIpNADLKHk?rel=0

3. Which one of the two images below (Figure 5.5 or Figure 5.6) demonstrates the correct way of putting the ear pieces of the stethoscope in your ears?

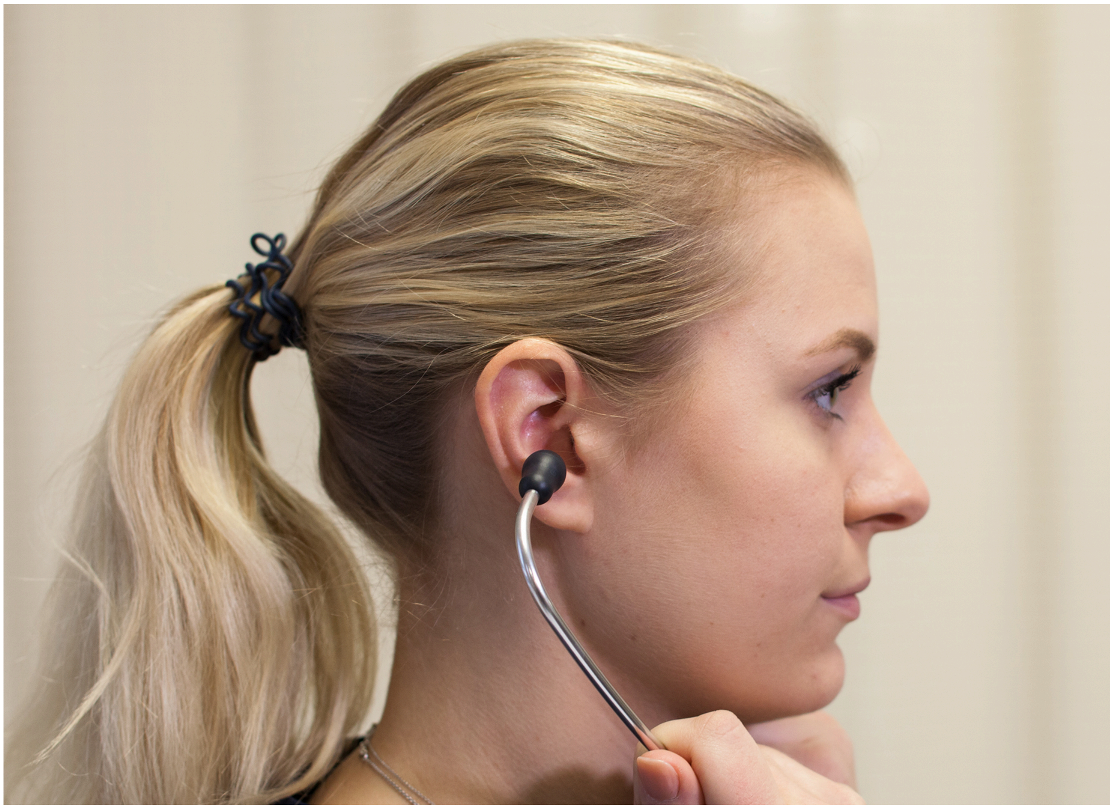

Figure 5.5

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Figure 5.6

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Chapter Summary

Blood pressure measurement is important because it provides objective data about the client's health and illness state. Changes in blood pressure act as a cue for healthcare providers' diagnostic reasoning. Blood pressure fluctuates with internal and external factors. Therefore, it is important to take more than one measurement before making clinical decisions.

It is always important to ensure **correct techniques** when taking blood pressure.

In determining the relevance of the blood pressure reading, the healthcare provider considers the client's baseline blood pressure, previous readings, and health status. The blood pressure reading is always taken in conjunction with a pulse. Diagnostic reasoning takes into account blood pressure, pulse, and subjective and objective client data.

Chapter 6: Knowledge Integration

Knowledge Integration

In healthcare, knowledge integration involves drawing upon and synthesizing client data to inform diagnostic reasoning and clinical decision-making. Healthcare providers are continually evaluating whether vital sign measurements are normal or abnormal. The analysis takes into consideration the client's baseline vital sign measurements as well as the client's age and health and illness state. Additionally, healthcare providers pay attention to trending, which involves looking at vital signs across time to detect changes. If abnormalities are identified, healthcare providers consider the client context including other subjective and objective data to differentiate relevant from irrelevant data. The analysis of client data influences evidence-informed clinical decision-making in which healthcare providers identify priority actions and treatment options.

This chapter presents seven case studies based on what you learned in chapters 1–5. The case studies are intended to provide an opportunity for you to critically think about client data in the context of a client situation. You will integrate your knowledge about normal and abnormal vital signs and engage in diagnostic reasoning to determine priority actions and next steps based on the client data.

- Case Study: Pediatric Client
- Case Study: Adolescent Client
- Case Study: Pregnant Adult Client
- Case Study: Adult Client
- Case Study: Older Adult Client
- Case Study: Dental Office Visit
- Case Study: Temperature, Pulse & Respiration

Layout

Data about each case study are provided with a series of critical thinking questions. Be sure to answer all the questions before moving forward in the case study.

Case Study: Pediatric Client

Initial Assessment Data

- **Biographical data:** 18-month-old child
- **Reason for seeking care:** Febrile
- **History of presenting illness:** Fever x 2 days, today rash appeared consisting of red spots over the client's body
- **Past history:** No medications, no illnesses

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https://opentextbc.ca/vitalsignmeasurement/?p=170#h5p-107

Use the slider to uncover the correct way to document the following assessment data.

At 1700 hrs on June 20, 20xx

- **Temperature:** 39°C axilla
- **Pulse:** 170 bpm (apical) cyclical increases with inspiration, force 2+, regular rhythm
- **RR** 30 bpm, regular rhythm
- **Spo2** saturation 98%

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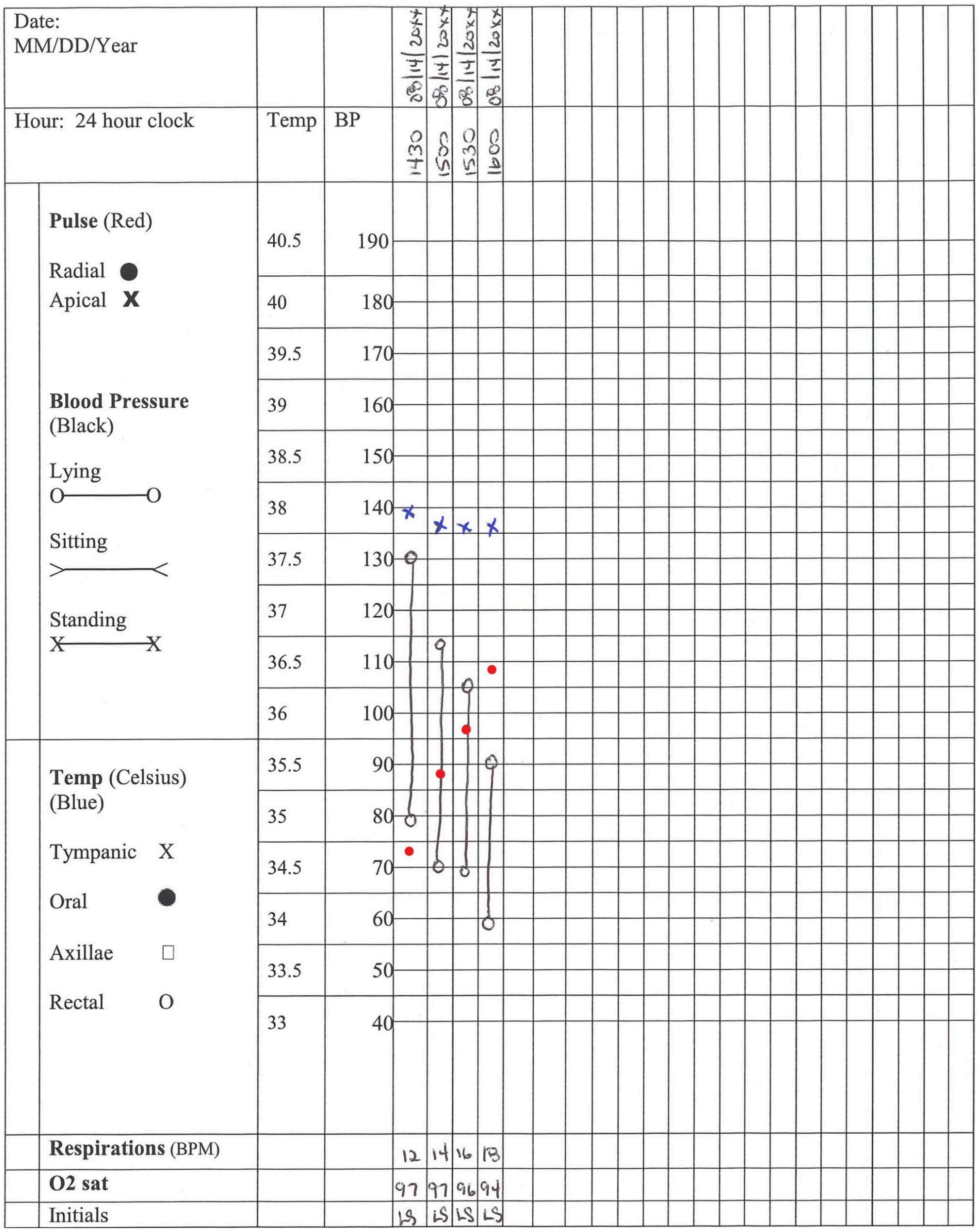
Case Study: Adolescent Client

Initial Assessment Data

- **Biographical data:** Adolescent client (age 14)
- **Reason for seeking care:** Post-op surgery
- **History of health/illness:** Healthy
- **Past history:** No medications, no illnesses
- Client had abdominal surgery and was transferred from the recovery room to the surgical floor. Lethargic and oriented x 3. Awakens when name is called and responds to questions appropriately. Client rates pain 2/10. The healthcare provider assesses client's vital signs every 30 minutes x 2 hours.

Vital Sign Record



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Case Study: Pregnant Adult Client

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https://opentextbc.ca/vitalsignmeasurement/?p=176#h5p-111

Please note: The following documentation exercise has extended columns for interactivity. A vital signs documentation record would have narrow columns and rows as you have seen in previous case studies.

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Case Study: Adult Client

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https://opentextbc.ca/vitalsignmeasurement/?p=178#h5p-113

Case Study: Older Adult Client

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https://opentextbc.ca/vitalsignmeasurement/?p=180#h5p-114

Now review the documentation for Mr. Turner's blood pressure. Examine the following examples of documentation and choose the image that represents the correct way to document the findings. The results were:

- 1050 hrs: BP 160/94, P 72 (right arm)
- 1058 hrs: BP 156/92, P70 (right arm)
- 1100 hrs: BP 148/90, P70 (left arm)
- 1105 hrs: BP 150/86, P66 (right arm)
- 1107 hrs: BP 144/84, P68 (right arm)
- 1109 hrs: BP 156/82, P62 (right arm)

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Case Study: Dental Office

To move to the next part of the scenario, click on “Proceed” in the top right hand corner.

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Case Study: TPR

To move to the next part of the scenario, click on "Proceed" in the top right hand corner.

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://opentextbc.ca/vitalsignmeasurement/?p=184#h5p-121

Chapter 7: Conclusion

Complete Set of Adult Vital Signs

Watch the interactive video on measuring vital signs with an automated vital signs monitor below, noting important considerations as you follow along. Please note: there is **no** sound in this video.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/vitalsignmeasurement/?p=187#h5p-122

Conclusion

As you become more proficient in measuring vital signs and interpreting the findings, you should remember a few key points.

There are many methods to take vitals signs. **The correct technique is essential to obtaining an accurate measurement.**

Vital sign measurements have very little meaning on their own. Healthcare providers engage in critical thinking and correlate these measurements with subjective and other objective data. Thinking critically about these measurements will best inform clinical decision-making. Healthcare providers look holistically at the person and their health and wellness state to determine whether vital sign measurements are within normal limits for this individual person.

It is also essential to acknowledge that clients may have additional information that can provide insight into their body, which may influence the technique and location for measuring vital signs and the significance of the findings. Sharing findings with clients is also a good opportunity for health promotion teaching.

Points to Consider

It is important to document vital signs in a timely manner. The healthcare provider reports any abnormal and unexpected findings to the most responsible provider. For example, students should share the findings with their preceptor or clinical instructor in a timely manner.

Figure 7.1: Cells. (Illustration credit: Hilary Tang)

Artist Statement – Cells

The human body is a messy phenomenon. From the organ to the cell, the brain to the neurotransmitter, like clockwork, everything is constantly happening. Down to our very core, the tiniest components are working in conjunction, harmoniously, to let us eat, breathe, and move. Without our constant consciousness, we are living. What an organized chaos our bodies are.

Printable Flashcards

Temperature

Oral Temperature Technique

1. Remove the probe from the device and place a probe cover (from the box) on the oral thermometer without touching the cover with your hands
2. Place the thermometer in the mouth under the tongue in the posterior sublingual pocket (slightly off-centre) and instruct the client to keep mouth closed and not to bite on the thermometer
3. Remove the thermometer when the device beeps
4. Note the temperature on the digital display of the device
5. Discard the probe cover in the garbage (without touching the cover)
6. Place the probe back into the device

Tympanic Temperature Technique

1. Remove the tympanic thermometer from the casing and place a probe cover (from the box) on the thermometer tip without touching the cover with your hands
2. Turn the device on
3. For an adult or older child, gently pull the helix up and back to visualize the ear canal. For an infant or younger child (under 3), gently pull the lobe down
4. Gently insert the probe into the opening of the ear
5. Activate the device
6. Note the temperature on the digital display of the device
7. Discard the probe cover in the garbage (without touching the cover) and place the device back into the holder

Axillary Temperature Technique

1. Remove the probe from the device and place a probe cover (from the box) on the thermometer

without touching the cover with your hands

2. Ask the client to raise the arm away from his/her body
3. Place the thermometer in the client's armpit as high up as possible into the axillae on bare skin, with the point facing behind the client, and ask the client to lower arm
4. Note the temperature on the digital display of the device
5. Discard the probe cover in the garbage (without touching the cover) and place the probe back into the device

Rectal Temperature Technique

1. Ensure the client's privacy and wash your hands and put on gloves
2. Position the client appropriately
3. Remove the probe from the device and place a probe cover on it
4. Lubricate the cover with a water-based lubricant
5. Gently insert the probe 2–3 cm inside the rectal opening of an adult, or less depending on the size of the client
6. Note the temperature on the digital display of the device when it beeps
7. Discard the probe cover in the garbage (without touching the cover) and place the probe back into the device
8. Remove your gloves and wash your hands

Pulse and Respiration

Radial Pulse Technique

1. Use the pads of your first three fingers to gently palpate the radial pulse along the radius bone close to the flexor aspect of the wrist
2. Press down with your fingers until you can best feel the pulsation
3. Note the rate, rhythm, force, and equality when measuring the radial pulse

Carotid Pulse Technique

1. Ask the client to sit upright
2. Locate the carotid artery medial to the sternomastoid muscle in the middle third of the neck
3. Gently palpate the carotid artery one at a time
4. Note the rate, rhythm, force, and equality when measuring the carotid pulse

Apical Pulse Technique

1. Ask the client to lay flat in a supine position
2. Physically palpate the intercostal spaces to locate the landmark of the apical pulse
3. Auscultate the apical pulse
4. Note the rate and rhythm

Brachial Pulse Technique

1. Palpate the bicep tendon in the area of the antecubital fossa
2. Move your fingers medial from the tendon and about one inch above the antecubital fossa to locate the pulse
3. Note the rate and rhythm

Respiration Technique

1. Leave your fingers in place when you are done counting the pulse, and then begin assessing respiration
2. Observe the rise and fall of the chest or abdomen
3. Count for 30 seconds if the rhythm is regular or for a full minute if it is irregular
4. Report respiration as breaths per minute, as well as whether breathing is relaxed, silent, and has a regular rhythm.

Oxygen Saturation

Pulse Oximeter

1. Remove client nail polish
2. Clean oximeter probe with alcohol swab
3. Clip or tape probe onto a client's finger
4. Turn oximeter on
5. Take radial pulse (30 seconds if regular and one minute if irregular)
6. Ensure radial pulse is aligned with pulse displayed on the oximeter
7. Document or report findings

Blood Pressure

Two-step Blood Pressure Technique

1. Palpate the radial or brachial artery, inflate the blood pressure cuff until the pulse is no longer felt, and then continue to inflate 20–30 mm Hg more: this is the maximum pressure inflation.
2. Deflate the cuff quickly.
3. Now, you can start blood pressure so place the bell of the cleansed stethoscope over the brachial artery using a light touch and complete seal.
4. Inflate the cuff to the maximum pressure inflation number.
5. Open the valve slightly.
6. Deflate the cuff slowly and evenly at about 2 mm Hg per second.
7. Note the points at which you hear the first appearance of Korotkoff sound (systolic blood pressure), and the last Korotkoff sound before it goes silent (diastolic blood pressure).

One-step Blood Pressure Technique

1. Palpate the radial or brachial artery, inflate the blood pressure cuff until the pulse is no longer felt, and then continue to inflate 20–30 mm Hg more.
2. Place the bell of the cleansed stethoscope over the brachial artery using a light touch, but with an airtight seal.

3. Open the valve slightly.
4. Deflate the cuff slowly and evenly at about 2 mm Hg per second.
5. Note the points at which you hear the first appearance of Korotkoff sound (systolic blood pressure), and the last Korotkoff sound before it goes silent (diastolic blood pressure).

References

Beasley, R., Chien, J., Douglas, J., Eastlake, L., Farah, C., King, G., Moore, R., Pilcher, J., Richards, M., Smith, S., & Walters, H. (2016). Target oxygen saturation range: 92–96% versus 94–98%. *Respirology*, 22(1), 200–202

Fech, T., Penrod, J., Battistone, M., Sawitzke, A., & Stults, B. (2012). The prevalence and clinical correlates of an auscultatory gap in systemic sclerosis patients. *International Journal of Rheumatology*, doi: 10.1155/2012/590845

Jarvis (2014). Physical Examination & Health Assessment (2nd Canadian edition). Elsevier Canada: Toronto

Leduc, D., & Woods, S., (2017). Canadian Paediatric Society Position Statement: Temperature measurement in paediatrics. Retrieved from: http://www.cps.ca/en/documents/position/temperature-measurement

Leung, A.A., Daskalopoulou, S.S., Dasgupta, K., McBrien, K., Butalia, S., Zarnke, K., … Rabi, D. for Hypertension Canada. (2017). Hypertension Canada's 2017 Guidelines for Diagnosis, Risk Assessment, Prevention, and Treatment of Hypertension in Adults. *Canadian Journal of Cardiology*, 33 (5), 557–576

Mazerolle, S., Ganio, M., Casa, D., Vingren, J., & Klau, J. (2011). Is oral temperature an accurate measurement of deep body temperature? A systematic review. *Journal of Athletic Training*, 46(5), 566–573.

Shah, A., & Shelley, K. (2013). Is pulse oximetry an essential tool or just another distraction? The role of the pulse oximeter in modern anesthesia care. *J Clin Monit Comput*, 27, 235–242. DOI 10.1007/s10877-013-9428-7

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1.00	2018	First Canadian Edition published in Pressbooks by Ryerson University.	–
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