Vital Sign Measurement Across the Lifespan - 1st Canadian edition

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JENNIFER L. LAPUM, MARGARET VERKUYL, WENDY GARCIA, OONA ST-AMANT, ANDY TAN

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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

Introduction

The purpose of this textbook is to help you develop best practices in **vital sign measurement**. It 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 such as nursing, medicine, pharmacy, midwifery, paramedics, physiotherapy, occupational therapy, and massage therapy. 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.

This book is **best viewed via the online, pressbooks format**. However, a pdf format is made available.

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 nosocomial 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

Figure 1.2: Hand washing

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.

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 worst? 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 (when did the pain begin? is it constant?)
- 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.

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.

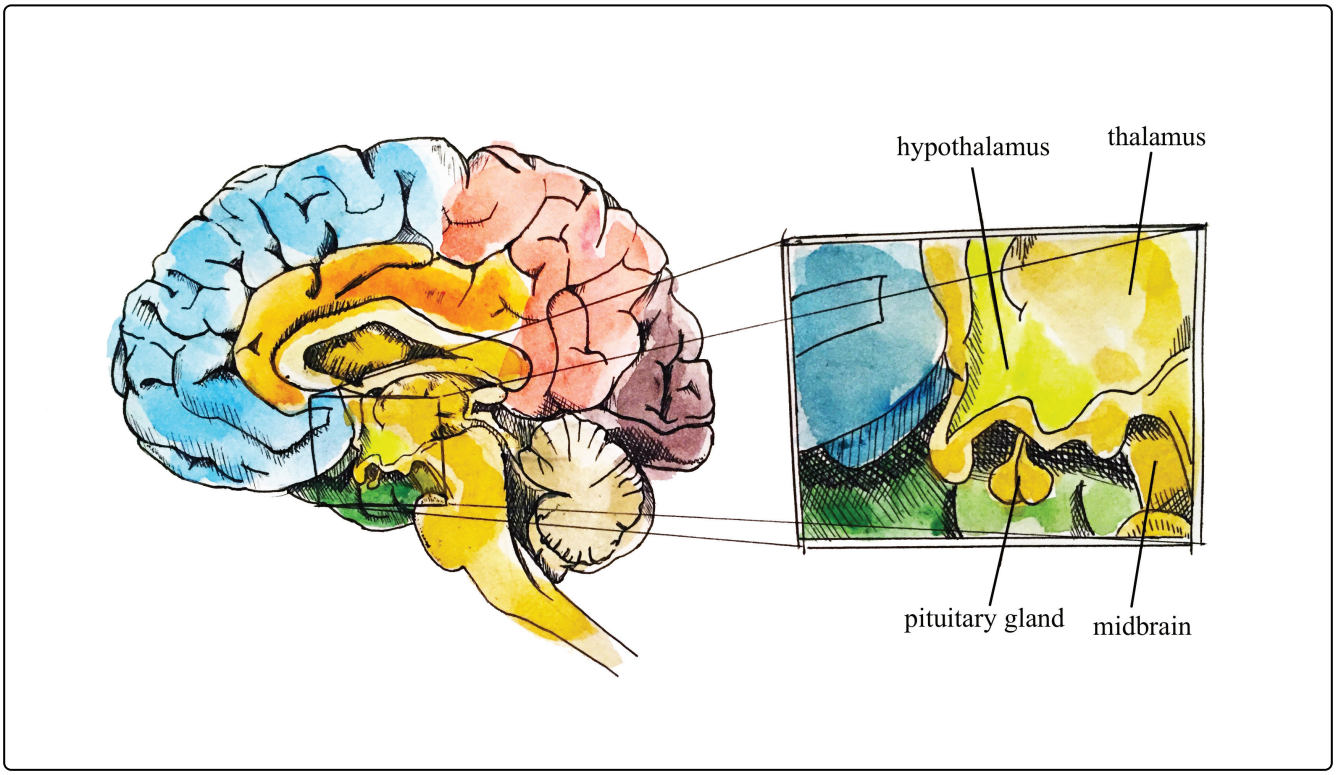

Figure 2.1: Hypothalamus (Illustration credit: Hilary Tang)

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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.

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**, **temporal artery** 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.

Temporal artery temperature is not a common method of measurement, but may be used in some agencies; this process involves 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 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.

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 each of the 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. As a healthcare provider, it is important to determine the significance of the temperature by 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.

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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. However, certain factors can lead to an inaccurate oral temperature, including recent consumption of hot or cold food or a beverage, chewing gum, and smoking prior to measurement. Healthcare providers should wait up to 15 minutes to take the oral temperature if the client is eating hot or cold food or drinking a hot or cold beverage and about 5 minutes if the client is chewing gum or has just smoked. Alternatively, a different method is used to measure temperature. 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.

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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.

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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.

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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.

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Finding the Error Activity: Tympanic Temperature

Now you have an opportunity to find errors in measurement techniques. This first activity involves looking at an image.

What error in technique is this healthcare provider making while taking the temperature of an adult client?

Figure 2.8: Error while taking the temperature of an adult

Go to the next page for information about the correct technique in measuring tympanic temperature.

Finding the Error Activity: Tympanic Temperature – Feedback

An **incorrect technique** is being demonstrated in Figure 2.9 because the helix is not being pulled up and back. For an adult/older child, the **correct technique** (Figure 2.10) involves gently pulling the helix up and back so that the ear canal is visualized and the light can reflect off of the tympanic membrane.

Incorrect technique of taking tympanic temperature

Figure 2.9: Incorrect technique

Correct technique of taking tympanic temperature

For an adult/older child, gently pull the helix up and back while stabilizing the client’s head with your hand.

Figure 2.10: Correct technique

Try it Out

Next, you have an opportunity to watch film clips on accurate measurement techniques. There are three activities that involve film clips that you can watch, and then try out yourself. Check it out!

Try it Out: 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. You can watch the clip and practice as many times as you like.

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

Film clip 2.1: Oral temperature

Try it Out: 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. You can watch the clip and practice as many times as you like.

Alternatively, if viewing textbook as a pdf, use this link: https://www.youtube.com/embed/cVusEmUWTC8?rel=0

Film clip 2.2: Tympanic temperature

Try it Out: 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. You can watch the clip and practice as many times as you like.

Alternatively, if viewing textbook as a pdf, use this link: https://www.youtube.com/embed/m71ISuIJRlA?rel=0

Film clip 2.3: Axilla temperature

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). *Write your answers down on a piece of paper.*

1. What is the most accurate way to take the temperature of a one-year-old client?

a. Oral temperature

b. Rectal temperature

c. Axillary temperature

d. Tympanic temperature

2. An adult client is drinking coffee. How should the healthcare provider measure the client's temperature? *Select all that apply.*

a. Take the client's oral temperature right away

b. Take the client's axillary temperature right away

c. Take the client's tympanic temperature right away

d. Take the client's rectal temperature in five minutes

e. Wait two minutes and take the client's oral temperature

3. What is the best way to measure temperature in a client who is confused? *Select all that apply.*

a**.** Oral temperature

b. Rectal temperature

c. Axillary temperature

d. Tympanic temperature

e. Temporal artery temperature

4. An infant's tympanic temperature is 37.7°C. How should the healthcare provider respond?

a. Apply a cold compress

b. Re-take in the other ear

c. Recognize this as normal

d. Take a rectal temperature

5. How should the healthcare provider take the temperature of an adult client who is post-operation day two following oral surgery?

a. Avoid measuring temperature

b. Take rectal temperature once a shift

c. Take tympanic temperature as necessary

d. Take oral temperature every four hours

Go to the next page to check your answers.

Test Yourself: Answers

1. What is the most accurate way to take the temperature of a one-year-old client?

a. Oral temperature

b. Rectal temperature **

c. Axillae temperature

d. Tympanic temperature

Rationale: The correct answer is **b (rectal temperature)**. Rectal temperature is the most accurate measurement method for children under two years of age, who are not able to readily follow directions.

2. An adult client is drinking coffee. How should the healthcare provider measure the client's temperature? *Select all that apply*.

a. Take the client's oral temperature right away

b. Take the client's axillary temperature right away **

c. Take the client's tympanic temperature right away **

d. Take the client's rectal temperature in five minutes

e. Wait two minutes and take the client's oral temperature

Rationale: The correct answers are **b** and **c (take the client's axillary or tympanic temperature right away)**. Recent consumption of a hot drink or cold drink alters a client's oral temperature. Thus, temperature is taken via the axillary or tympanic route if a client has recently had a hot or cold drink. You can take an oral temperature if you wait 15 minutes after hot drink consumption.

3. What is the best way to measure temperature in a client who is confused? *Select all that apply.*

a. Oral temperature

b. Rectal temperature

c. Axillary temperature **

d. Tympanic temperature **

e. Temporal artery temperature **

Rationale: The correct answers are **c**, **d**, and **e (axillary, tympanic and temporal artery temperature)**. A client who is confused often cannot follow directions, so they may not follow directions to close their mouth as required when taking an oral temperature. Additionally, it is not safe to measure rectal temperature when a client is confused. Thus, it is best to measure axillary, tympanic, or temporal artery temperature.

4. An infant's tympanic temperature is 37.7°C. How should the healthcare provider respond?

a. Apply a cold compress

b. Re-take in the other ear

c. Recognize this as normal **

d. Take a rectal temperature

Rationale: The correct answer is **c (recognize this as normal)**. A temperature of 37.7°C is normal for an infant, so no further action is required.

5. How should the healthcare provider take the temperature of an adult client who is post-operation day two following oral surgery?

a. Avoid measuring temperature

b. Take rectal temperature once a shift

c. Take tympanic temperature as needed **

d.Take oral temperature every four hours

Rationale: The correct answer is **c (tympanic temperature)**. Taking oral temperature is avoided after oral surgery, and taking rectal temperature is avoided in the adult population. Thus, the best method is to measure tympanic temperature.

Test Yourself: List in the Correct Order

List the steps below in the correct order for each of the following techniques. *Write your list on a piece of paper.*

Oral Temperature Technique

- Place the thermometer in the mouth under the tongue in the posterior sublingual pocket (slightly off-centre) and instruct client to keep mouth closed and not to bite on the thermometer
- 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
- Note the temperature on the digital display of the device
- Remove the thermometer when the device beeps
- Place the probe back into the device
- Discard the probe cover in the garbage (without touching the cover)

Tympanic Temperature Technique

- Turn the device on
- 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
- Activate the device
- Gently insert the probe into the opening of the ear
- 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.
- Discard the probe cover in the garbage (without touching the cover) and place the device back into the holder
- Note the temperature on the digital display of the device

Axillary Temperature Technique

- 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 his/her arm
- 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
- Discard the probe cover in the garbage (without touching the cover) and place the probe back into the device
- Note the temperature on the digital display of the device

Rectal Temperature Technique

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

Go to the next page to see the correct order of steps for these techniques.

Test Yourself: List in the Correct Order – Answers

The steps are listed in the correct order for each of the following techniques. These are **printable flashcards** to help you memorize and practice the techniques.

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

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

Pulse and respiration are discussed together in this chapter because these vital signs are taken in succession.

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.

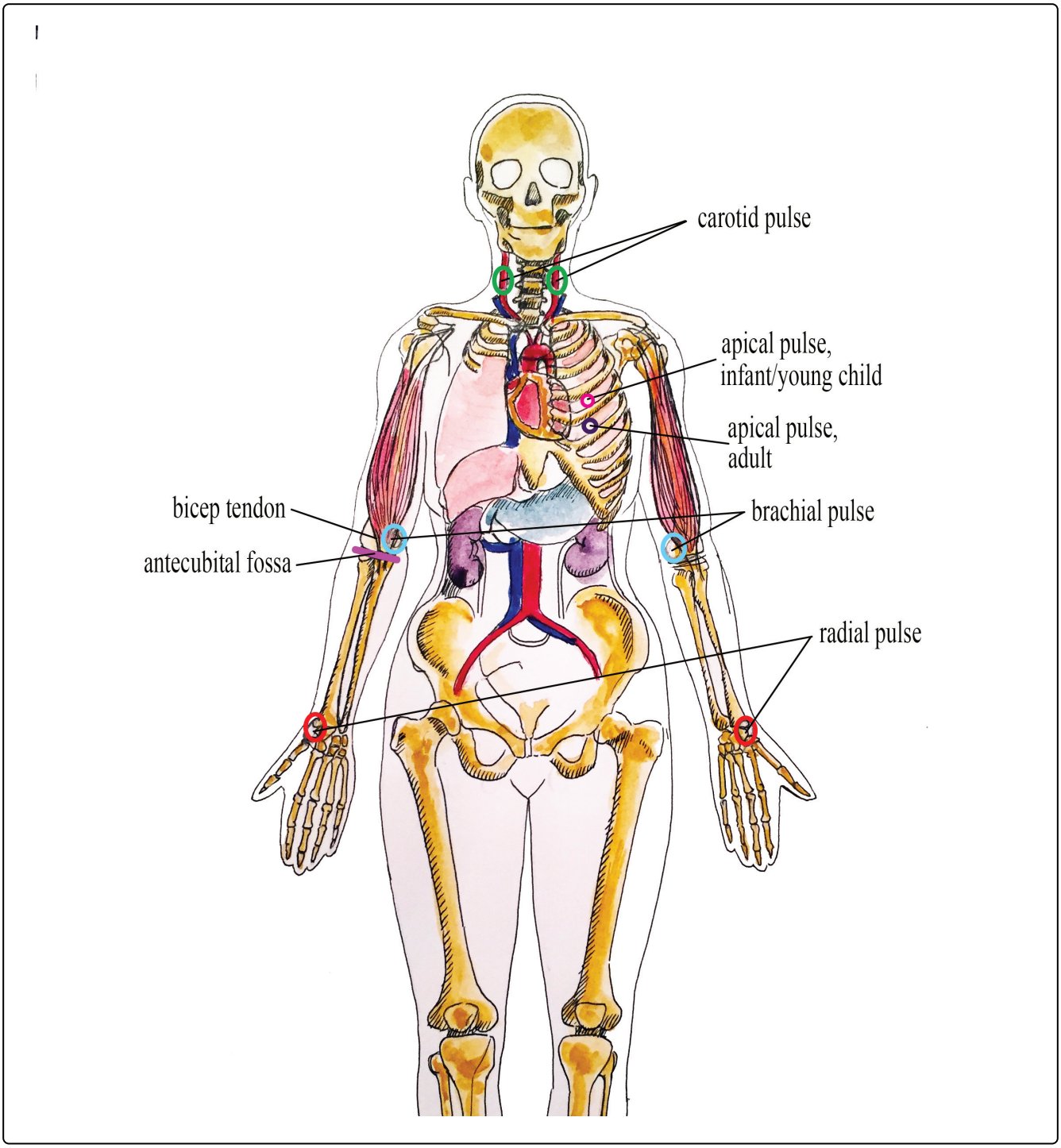

Figure 3.1: Radial, brachial, carotid and apical pulse (Illustration credit: Hilary Tang)

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.

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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.

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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.

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.

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.

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.

Film clip 3.1: Use of doppler device

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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.

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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.

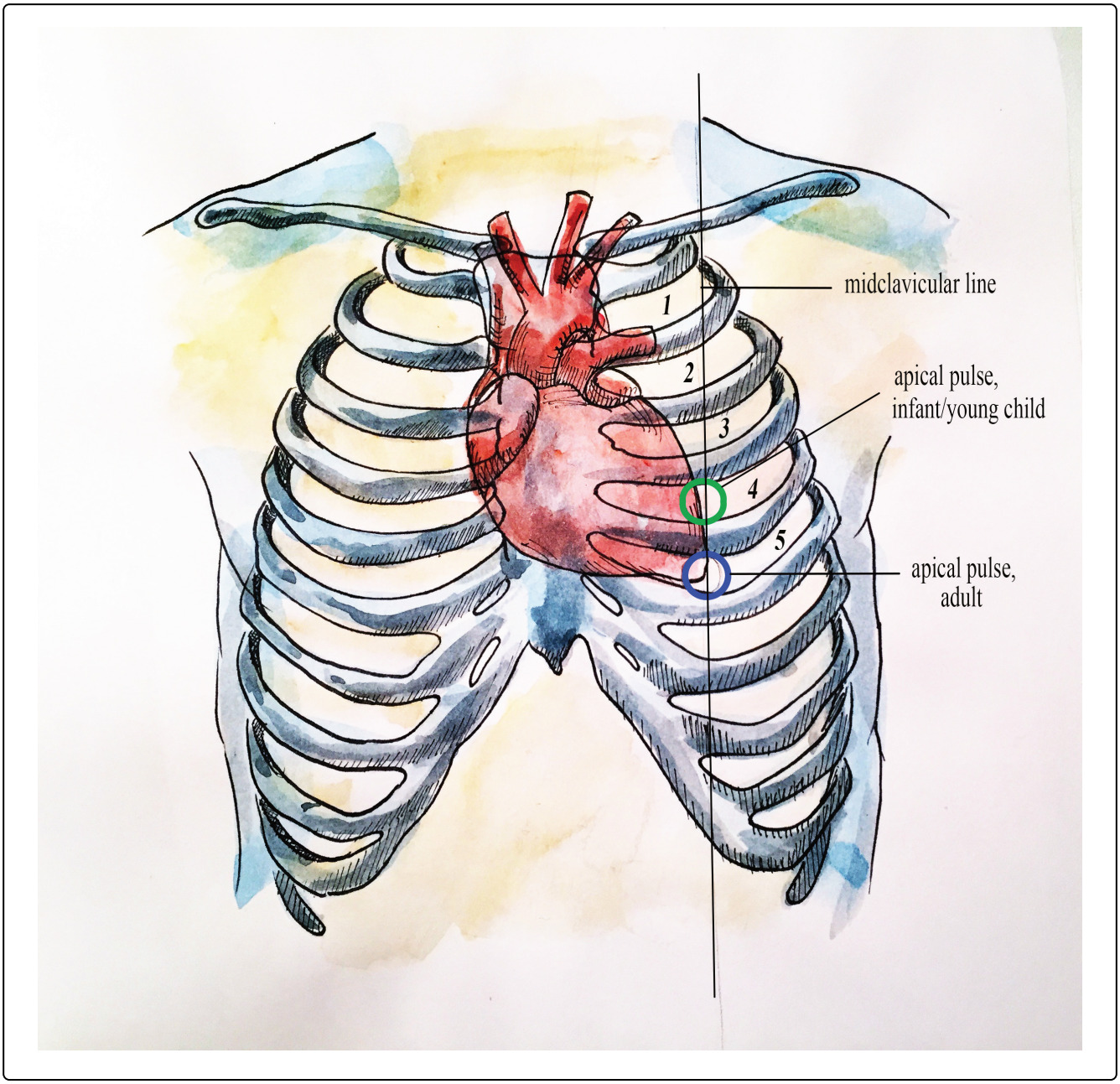

Figure 3.5: Apical Pulse (Illustration credit: Hilary Tang)

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. See **Figure 3.6** below. 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. Upon auscultating the apical pulse, you will hear the sounds "lub dup" – this counts as one beat. **Count the apical pulse for one minute**. Note the rate and rhythm.

Figure 3.6: Female client re-positioning her breast in order to auscultate the apical pulse

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**). The reported apical rate in **Audio clip 3.1** is: 60 bpm (30 x 2) with a regular rhythm

Audio clip 3.1: Counting apical pulse rate

Alternatively, if viewing textbook as a pdf, use this link: https://www.youtube.com/embed/yL4E_6PaPgg?rel=0

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.

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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). The normal respiratory rate for children decreases from birth to adolescence (OER #2). 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). 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

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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.

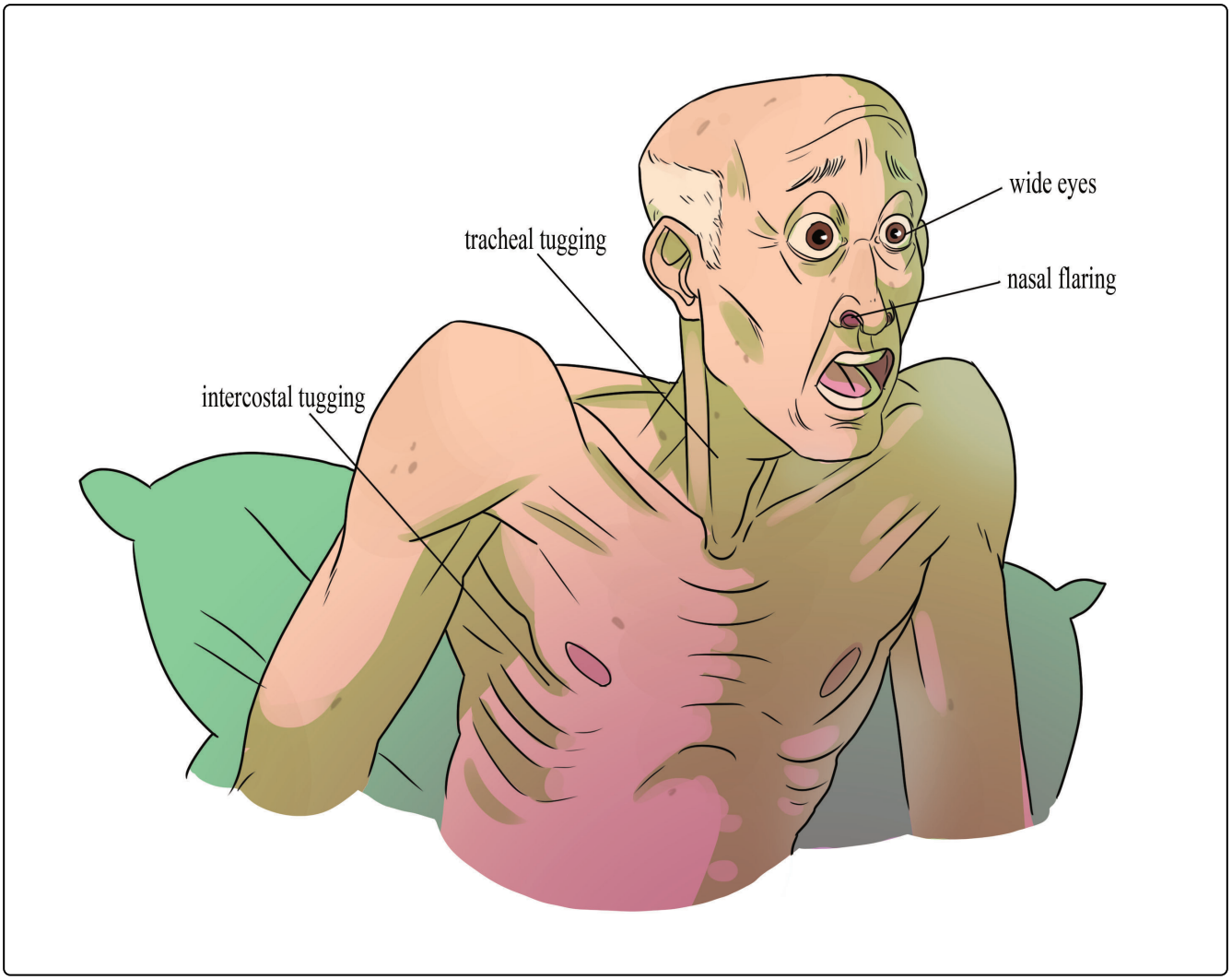

Figure 3.7: Signs of respiratory distress (Illustration credit: Paige Jones)

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Finding the Error Activity: Radial Pulse

Now you have an opportunity to find errors in measurement techniques. This activity involves looking at an image.

What error in technique is this healthcare provider making while measuring the radial pulse of a client?

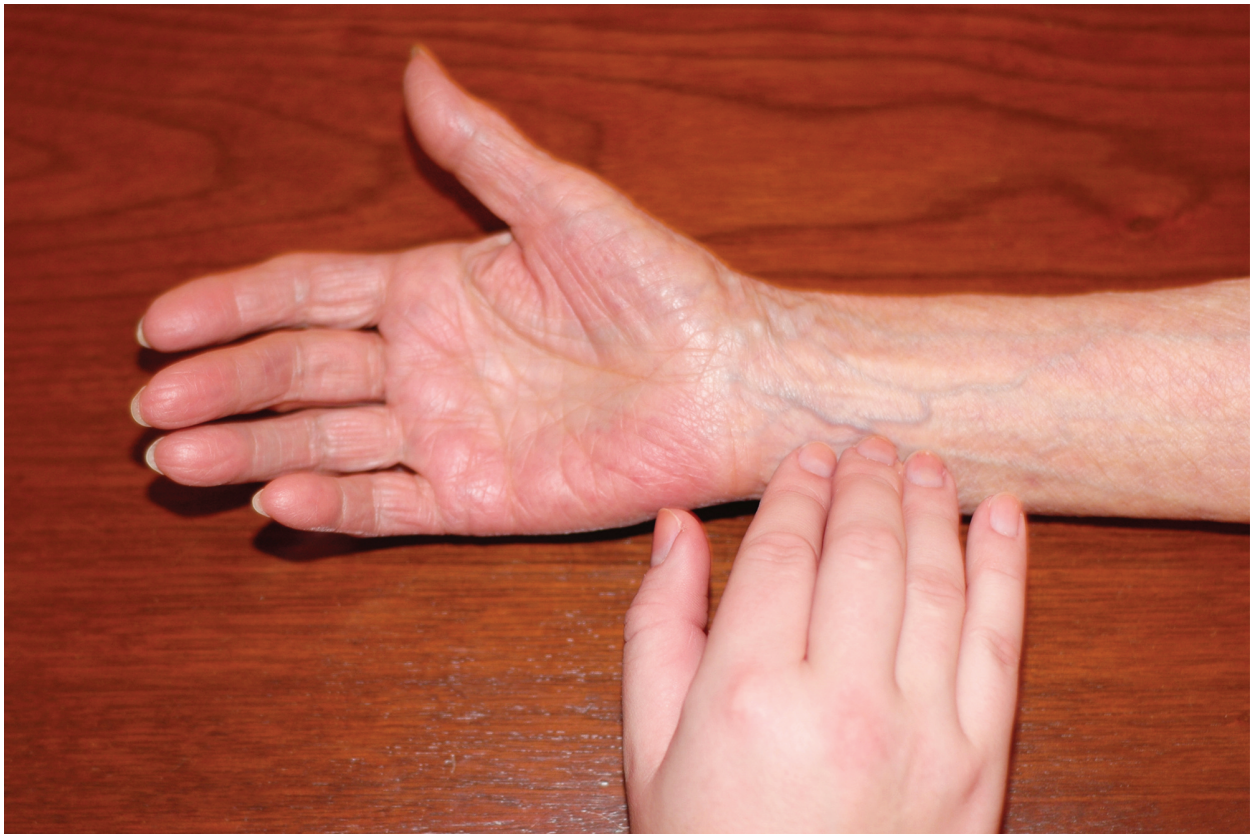

Figure 3.8: Error in technique while measuring the radial pulse

Go to the next page for information about the correct technique for measuring radial pulse.

Finding the Error Activity: Radial Pulse – Feedback

As per Figure 3.8, an **incorrect technique** is being demonstrated because the pads of the three fingers are being placed on the ulnar side of the wrist. The **correct technique** (Figure 3.9) to palpate the radial pulse involves placing the pads of the three fingers along the radius which is on the lateral side of the wrist (the thumb side). The pads of the fingers are placed on the radius bone close to the flexor aspect of the wrist.

Incorrect placement of fingers

Figure 3.8: Incorrect placement of fingers

Correct placement of fingers

While palpating the pulse, gently place the pads of your three fingers along the radial bone at the flexor aspect of the wrist (the thumb side).

Figure 3.9: Correct placement of fingers

Finding the Error Activity: Infant Apical Pulse

Now you have an opportunity to find errors in measurement technique. This activity involves looking at an image.

What error in technique is this healthcare provider making while measuring the apical pulse of an infant?

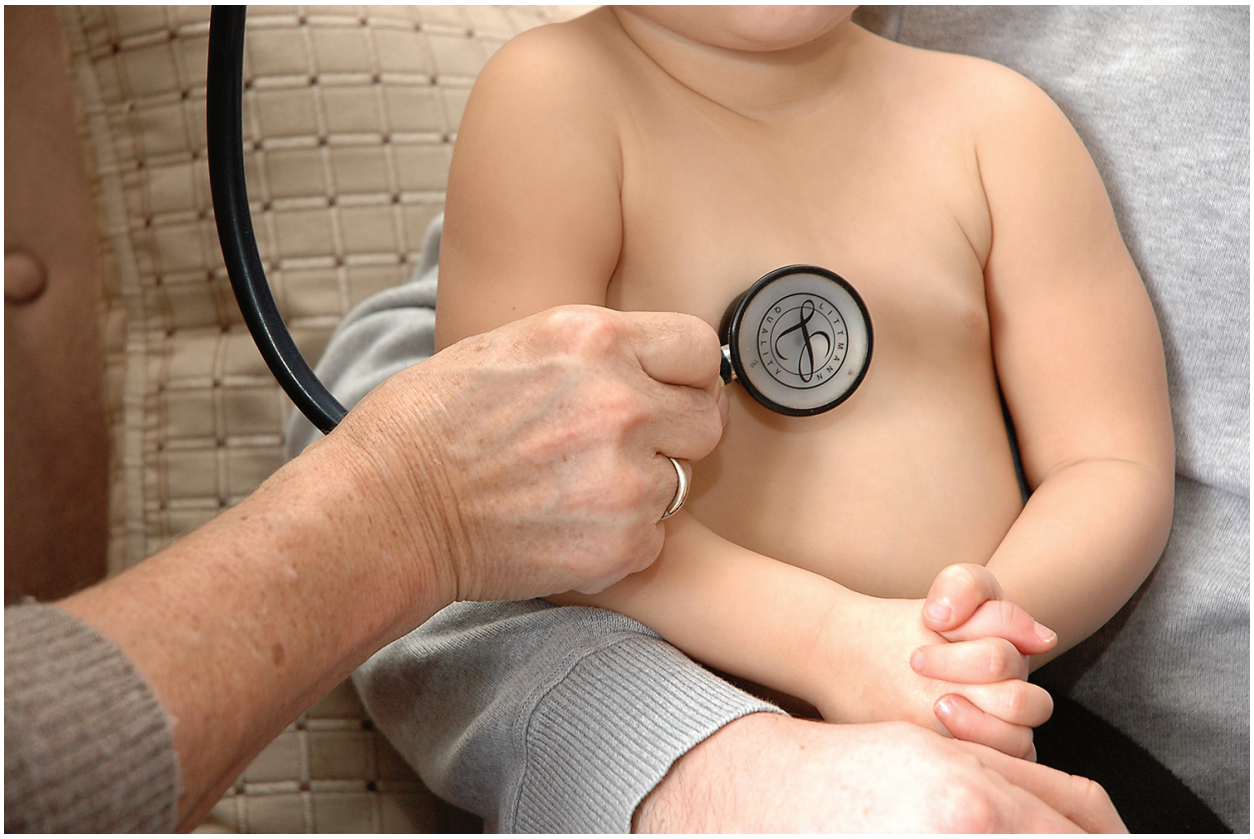

Figure 3.10: Error in technique while measuring the apical pulse

Go to the next page for information about the correct technique for measuring apical pulse in an infant.

Finding the Error Activity: Infant Apical Pulse – Answer

As per Figure 3.11, an **incorrect technique** is being demonstrated because the stethoscope is placed on the incorrect side of the chest. The **correct technique** (Figure 3.12) to auscultate the apical pulse of an infant is to place the stethoscope at the left midclavicular line in the fourth intercostal space.

Incorrect placement of stethoscope

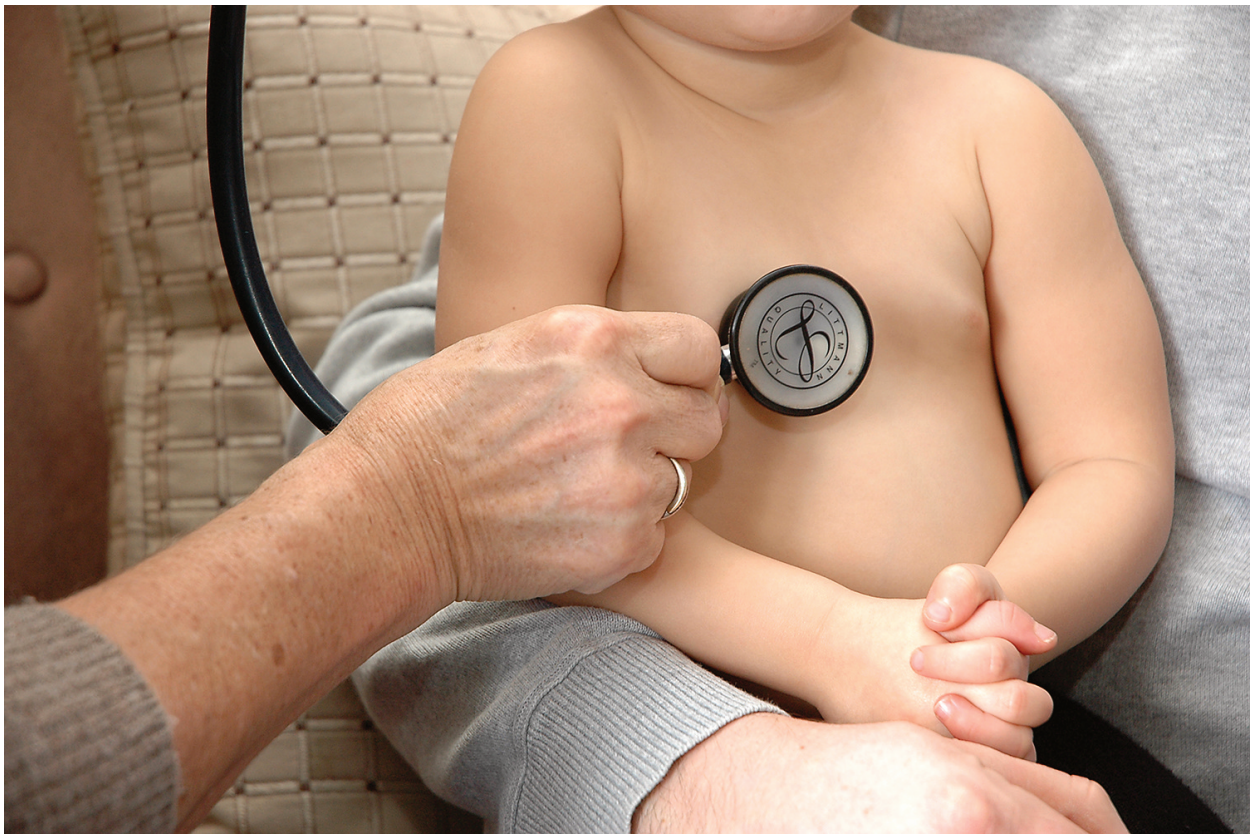

Figure 3.11: Incorrect placement of stethoscope

☑ Correct placement of stethoscope

While taking the apical pulse of an infant, place the stethoscope at the fourth intercostal space at the left mid-clavicular line.

Figure 3.12: Correct placement of stethoscope

Try it Out

Next, you have an opportunity to watch film clips on accurate measurement techniques. There are two activities that involve two film clips that you can watch and then try out yourself. Check it out!

Try it Out: 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. You can watch the clip and practice as many times as you like.

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

Film clip 3.2: Pulse and respiration measurement

Try it Out: 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. You can watch the clip and practice as many times as you like.

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

Film clip 3.3: Correct measurement of apical pulse

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). *Write your answers down on a piece of paper.*

1. 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

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

2. 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

Alternatively, if viewing textbook as a pdf, use this link: https://www.youtube.com/embed/Hxd68qJfzhQ?rel=0

3. How should a healthcare provider respond when a newborn has an apical heart rate of 120 beats per minute?

a. Re-take the rate at the brachial location

b. Document the rate and assess it as normal

c. Document the rate and identify it as tachycardia

d. Notify the physician and identify it as bradycardia

4. Which findings should be of most concern to the healthcare provider in an adolescent client?

a. Pulse 40 bpm and respiration 34

b. Respiration 16 and pulse 82 bpm

c. Pulse 68 bpm and sinus arrhythmia

d. Pulse 2+, 78 bpm, and regular rhythm

5. Match the findings that are typically normal for the person listed:

Sinus arrhythmia	Athlete

Bradycardia	Newborn
Abdominal breather	Adolescent

Go to the next page to check your answers.

Test Yourself: Answers

1. 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**).

The pulse rate is 76 bpm (38 x 2) with a regular rhythm

2. What is the apical pulse rate?

The pulse rate is 114 bpm (57 x 2) with a regular rhythm

2. How should a healthcare provider respond when a newborn has an apical heart rate of 120 beats per minute?

a. Re-take the rate at the brachial location

b. Document the rate and assess it as normal **

c. Document the rate and identify it as tachycardia

d. Notify the physician and identify it as bradycardia

Rationale: The correct answer is **b (document the rate and assess it as normal).** An apical heart rate of 120 bpm falls within the normal range for newborns. Newborns have a faster apical heart rate than adults because they have smaller and less muscular hearts. As a result, their stroke volume (volume of blood per contraction) is smaller than that of adults and their hearts must beat faster to pump sufficient blood, oxygen, and nutrients to the body.

3. Which findings in an adolescent client is of most concern to a healthcare provider?

a. Pulse 40 bpm and respiration 34 **

b. Respiration 16 and pulse 82 bpm

c. Pulse 68 bpm and sinus arrhythmia

d. Pulse 2+, 78 bpm, and regular rhythm

Rationale: The correct answer is **a (pulse 40 bpm and respiration 34).** In adolescents, a pulse of 40 bpm is low and a respiration rate of 34 is high. All of the other findings are normal for adolescents, including sinus arrhythmia, which is common in children and adolescents.

4. Match the findings that are typically normal for the person listed:

Bradycardia————————-Athlete

Abdominal breather———Newborn

Sinus arrhythmia————Adolescent

Rationale: Bradycardia (low pulse) is common in athletes because their hearts are more muscular and pump a larger stroke volume per contraction. As a result, the heart contracts/beats less to pump sufficient blood, oxygen and nutrients. Newborns are abdominal breathers, meaning that the abdomen moves up and down when breathing, as opposed to the thorax. Sinus arrhythmia is common in adolescents. It involves an irregular pulse rhythm in which the pulse rate varies with the respiratory cycle; the heart speeds up 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 left side of the heart upon inspiration.

Test Yourself: List in the Correct Order

List the steps below in the correct order for each of the following techniques. *Write your list on a piece of paper.*

Radial Pulse Technique

- Note the rate, rhythm, force, and equality when measuring the radial pulse
- 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
- Press down with your fingers until you can best feel the pulsation

Carotid Pulse Technique

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

Apical Pulse Technique

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

Brachial Pulse Technique

- Move your fingers medial from the tendon and about one inch above the antecubital fossa to locate the brachial pulse

- Palpate the bicep tendon in the area of the antecubital fossa
- Note the rate and rhythm

Respiration Technique

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

Go to the next page to see the correct order of steps for these techniques.

Test Yourself: List in the Correct Order – Answers

The steps are listed in the correct order for each of the following techniques. These are **printable flashcards** to help you memorize and practice the techniques.

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

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

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.

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**.

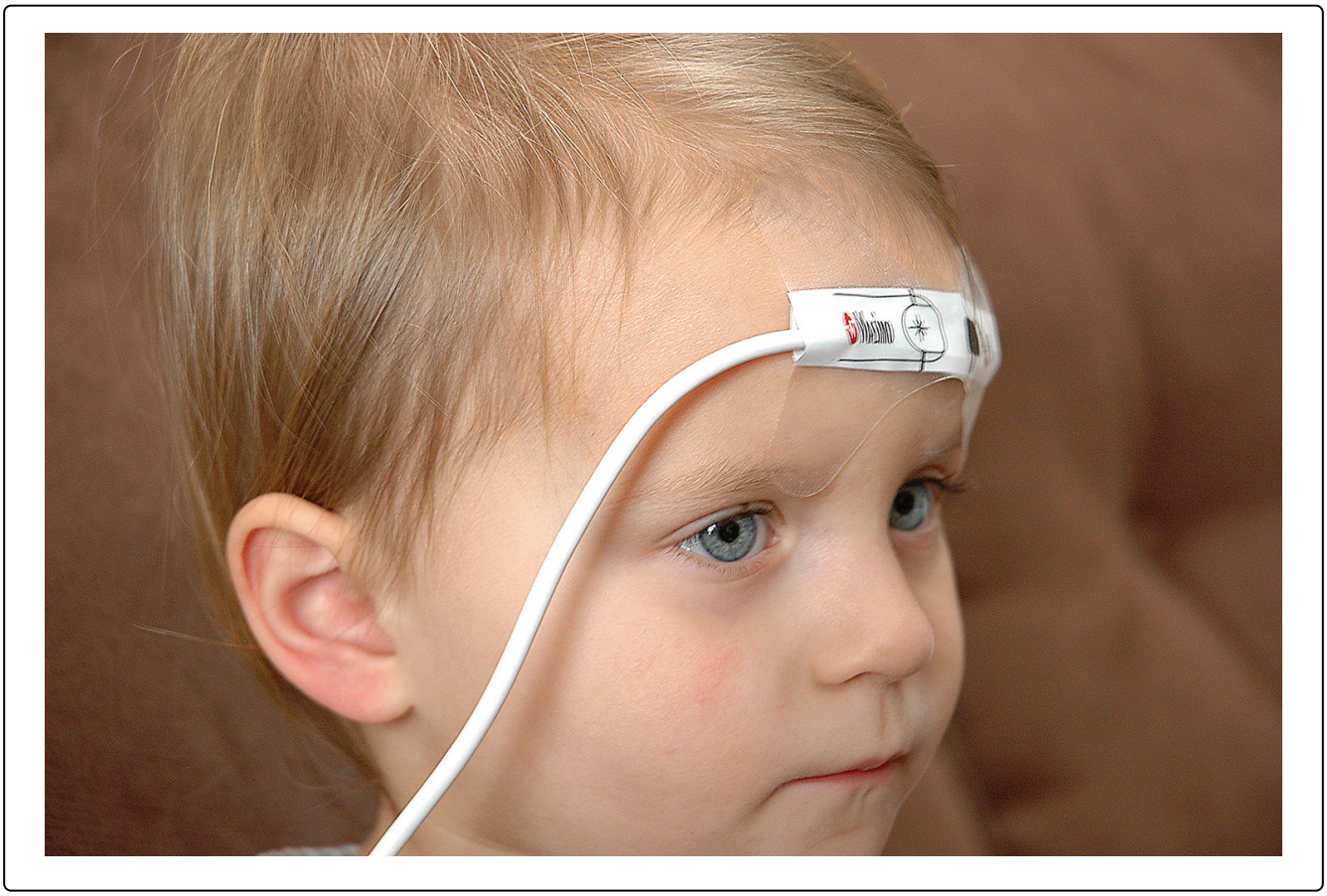

Figure 4.3: Pulse oximeter with device across forehead

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What are Normal Oxygen Saturation Levels?

The normal oxygen saturation level 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 also 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).
- Additionally, 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).

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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.

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.

Finding the Error Activity 1: Pulse Oximetry

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

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

Alternatively, if viewing textbook as a pdf, use this link: https://www.youtube.com/embed/bbm3hOPFjQg?rel=0

Film clip 4.1 Oxygen saturation taken incorrectly

Go to the next page for information about the correct technique for measuring oxygen saturation.

Finding the Error Activity 1: Pulse Oximetry – Feedback

In the **film clip 4.1**, the healthcare provider did not confirm the accuracy of the pulse displayed on the pulse oximeter with the radial pulse. Healthcare providers always assess the radial pulse and ensure that it coincides with the pulse displayed on the oximeter to ensure the accuracy of the oxygen saturation level.

Finding the Error Activity 2: Pulse Oximetry

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

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

Figure 4.5: Error in technique while measuring oxygen saturation

Go to the next page for information about the correct technique for measuring oxygen saturation.

Finding the Error Activity 2: Pulse Oximetry – Feedback

An **incorrect technique** is demonstrated in Figure 4.6 because the healthcare provider is using the pulse oximeter device on a client who has nail polish on her fingers. Nail polish can affect accuracy, so healthcare providers remove nail polish when pulse oximetry is measured on the fingers. Alternatively, the pulse oximetry could be measured using a device attached to the earlobe. The **correct technique** is demonstrated in Figure 4.7 in which the nail polish is removed. It is also important to note that healthcare providers need to ensure the radial pulse aligns with the pulse displayed on the pulse oximeter.

Incorrect technique of measuring pulse oximetry

Figure 4.6: Error in technique while measuring oxygen saturation

☑ Correct technique of measuring pulse oximetry

Figure 4.7: Correct technique of measuring pulse oximetry

Try it Out: Pulse Oximetry

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.

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

Film clip 4.2: Oxygen saturation taken correctly

Test Yourself

Now that you have completed this chapter, it's time to test your knowledge. Try to answer the following questions. *Write your answers down on a piece of paper.*

1. Match each person with the estimated SpO2.

Healthy adolescent	92% SpO2
Adult with lung disease	95% SpO2
80-year-old adult	97% SpO2

2. A client's oxygen saturation is measured via pulse oximetry using a finger probe. The radial pulse does not coincide with the pulse displayed on the oximeter. How should the healthcare provider respond?

a. Notify the most responsible provider

b. Document the findings in the client's chart

c. Assume the client has hypoxic tissue injury

d. Repeat the measurements using an earlobe probe

3. The physician asks for an oxygen saturation report on a client who has peripheral limb tremors. What is the best location to place the probe?

a. Ear

b. Toe

c. Finger

d. Thumb

4. A person’s oxygen saturation is 89% and the pulse displayed on the pulse oximeter is aligned with the radial pulse. How should the healthcare provider respond?

a. Give oxygen to the client

b. Raise up the head of the client’s bed

c. Ask the client, “are you having any difficulty breathing?”

d. Note this finding as normal and continue with assessment

Go to the next page to check your answers.

Test Yourself: Answers

1. Match each person with the estimated SpO2.

Healthy adolescent————————97% SpO2

Adult with lung disease————————92% SpO2

80-year-old adult————————95% SpO2

2. A client's oxygen saturation is measured via pulse oximetry using a finger probe. The radial pulse does not coincide with the pulse displayed on the oximeter. How should the healthcare provider respond?

a. Notify the most responsible provider

b. Document the findings in the client's chart

c. Assume the client has hypoxic tissue injury

d. Repeat the measurements using an earlobe probe **

Rationale: The correct answer is **d (repeat the measurements using an earlobe probe)**. Repeat the measurements using an ear probe. The O2 saturation reading is inaccurate when the palpable pulse does not coincide with the pulse displayed on the pulse oximeter. This could be caused by conditions related to poor circulation and/or peripheral vasoconstriction. The best action is to use an alternate method to obtain the O2 saturation such as an earlobe probe.

3. The physician asks for an oxygen saturation report on a client who has peripheral limb tremors. What is the best location to place the probe?

a. Ear **

b. Toe

c. Finger

d. Thumb

Rationale: The correct answer is **a (ear)**. Tremors can affect the ability of the pulse oximeter to accurately read the pulsations and oxygen saturations. The toe, finger, and thumb are all affected by the tremors. Therefore, it is best to use the earlobe to measure O2 saturation.

4. A person's oxygen saturation is 89% and the pulse displayed on the pulse oximeter is aligned with the radial pulse. How should the healthcare provider respond?

a. Give oxygen to the client

b. Raise up the head of the client's bed

c. Ask the client, "are you having any difficulty breathing?" **

d. Note this finding as normal and continue with assessment

Rationale: The correct answer is **c (ask the client, "are you having any difficulty breathing?")**. Ask the client if he/she is having any difficulty breathing. This oxygen saturation is considered abnormal. Further assessments need to be completed prior to an intervention. The first assessment starts with the respiratory system including a subjective assessment of the client's breathing and whether he/she is having difficulty breathing. The context of the client's current health state will determine how you proceed with interventions.

Test Yourself: List in the Correct Order

List the steps below in the correct order. *Write your list on a piece of paper.*

- turn oximeter on
- remove client nail polish
- clean oximeter probe with alcohol swab
- take radial pulse (30 seconds if regular and one minute if irregular)
- ensure radial pulse is aligned with pulse displayed on the oximeter
- clip or tape probe onto a client’s finger
- report or document findings

Go to the next page to see the correct order of steps for these techniques.

Test Yourself: List in the Correct Order – Answers

The steps are listed in the correct order below. These are **printable flashcards** to help you memorize and practice the techniques.

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

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.

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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 to 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.

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What are Normal Blood Pressure Ranges?

Blood pressure is reported in mm Hg, in which the systolic is the numerator and diastolic is the denominator. See **Table 5.1** for an overview of estimated normal blood pressure for age.

Table 5.1: Estimated Normal Blood Pressure for Age

Age	Normal Systolic Range	Normal Diastolic Range
Newborn to 1 month	45–80 mm Hg	30–55 mm Hg
One to 12 months	65–100 mm Hg	35–65 mm Hg
Young child (1–5 years)	80–115 mm Hg	55–80 mm Hg
Older child (6–13 years)	80–120 mm Hg	45–80 mm Hg
Adolescent (14–18 years)	90–120 mm Hg	50–80 mm Hg
Adult (19–40 years)	95–135 mm Hg	60–80 mm Hg
Adult (41–60 years)	110–145 mm Hg	70–90 mm Hg
Older adult (61 and older)	95–145 mm Hg	70–90 mm Hg

Points to Consider

The average blood pressure for an adult is **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.

How is Blood Pressure Measured?

Blood pressure is measured in many ways including manual, automatic, cellular phone applications, and arterial catheters. Whatever method is used, blood pressure must be measured using validated equipment. Studies have repeatedly demonstrated 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.

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**.

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.

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

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 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.

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 cuffs

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.

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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.

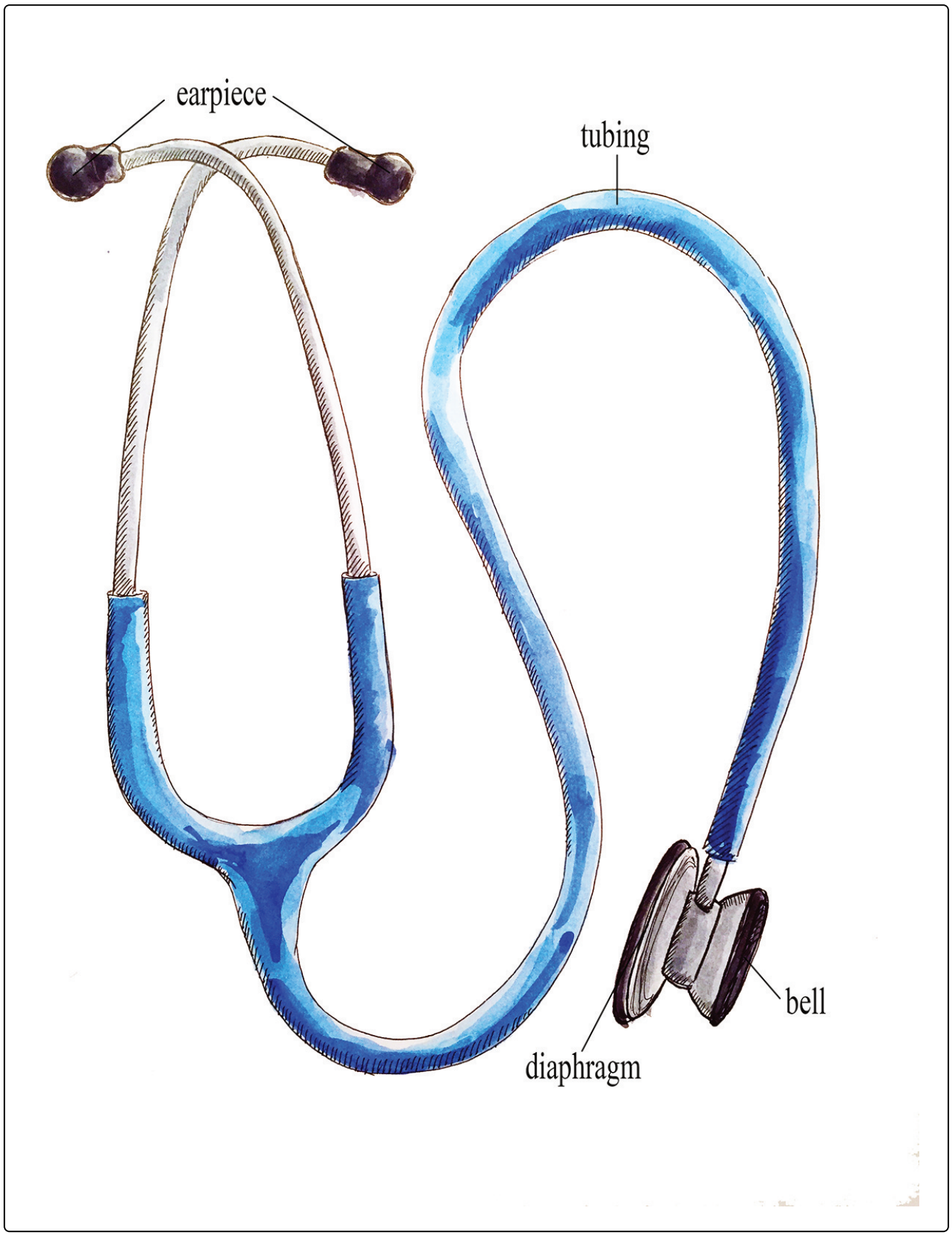

Figure 5.4: Stethoscope with bell and diaphragm (Illustration credit: Hilary Tang)

- 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.

Film clip 5.2: Opening and closing the bell and diaphragm

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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 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 20–30 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 last Korotkoff sound before it goes silent (diastolic blood pressure). 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 last Korotkoff sound is heard before it goes silent 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

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

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, and then continue to inflate 20 to 30 mm Hg more (OER #1). 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 last Korotkoff sound (diastolic blood pressure) before it goes silent. 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 the last Korokoff sound before the sounds go silent.

Audio clip 5.1: Korotkoff sounds with blood pressure of 122/76 mm Hg

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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 or too loose can produce a falsely high 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.

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). However, the specific measurement in which hypertension is diagnosed depends on many factors. As per Hypertension Canada (Leung, et al., for Hypertension Canada, 2017), 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 (Leung, et al., for Hypertension Canada, 2017).

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. See **Table 5.3** below for more information on making a determination of hypertension, which precipitates intervention.

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, recommended by Hypertension Canada (Leung, et al., for Hypertension Canada, 2017). 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 manually, the first reading is discarded and the latter two readings are averaged.

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. A health history and physical examination are performed.
Visit 1 Office BP Measurements	**Visit two is scheduled within one month of visit one**.
Manual BP averaged reading ≥140/90 mm Hg (high)	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).
Automatic BP reading ≥135/85 mm Hg (high)	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

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

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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.

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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?

Film clip 5.4: Errors in blood pressure measurement

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

Go to the next page for information about the correct technique for taking blood pressure.

Finding the Error Activity: Blood Pressure – Feedback

In the previous film clip, a number of **measurement errors were made**. It is important to ensure the following techniques:

- Perform hand hygiene before and after
- Correct cuff placement must be determined by palpating the brachial artery.
- Maximum pressure inflation must be determined before a blood pressure can be accurately taken.
- The cuff is securely fastened around the arm so that only one finger can be placed between the cuff and the client's arm. The cuff should not be moveable.
- The stethoscope is cleansed before using.
- The client should sit still with feet placed flat on the floor while having the blood pressure taken.

Try it Out

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.

Check it out!

Try it Out: 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!

Film clip 5.5: Two-step blood pressure approach

Alternatively, if viewing textbook as a pdf, use this link: https://www.youtube.com/embed/UbW4viRRvd4?rel=0

Try it Out: 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!

Film clip 5.6: One-step blood pressure approach

Alternatively, if viewing textbook as a pdf, use this link: https://www.youtube.com/embed/OLdz13c7_vo?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). Write your answers down on a piece of paper.

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?

Audio clip 5.2: Korotkoff sounds

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?

Audio clip 5.3: Korotkoff sounds

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

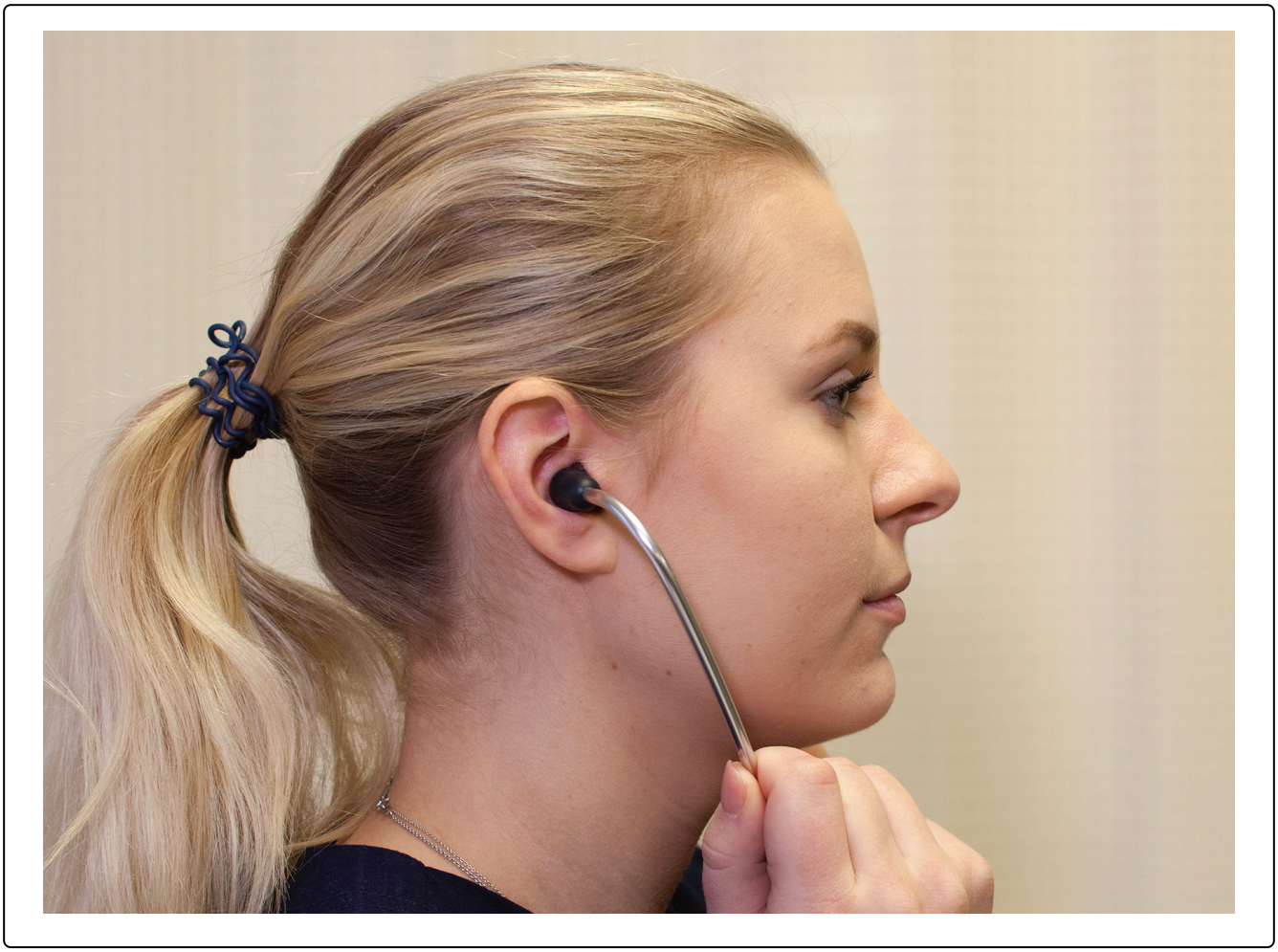


Figure 5.6

4. The bell of the stethoscope is best used to hear Korotkoff sounds.

a. True

b. False

5. In a blood pressure measurement of 110/70, the first number is the _____.

a. systolic pressure

b. diastolic pressure

c. pulse pressure

d. mean arterial pressure

(from OER#2)

6. A healthy elastic artery _____.

a. is compliant

b. reduces blood flow

c. is a resistance artery

d. has a thin wall and irregular lumen

(From OER#2)

7. Which of the following symptoms may be a result of orthostatic hypotension?

a. Fatigue

b. Nocturia

c. Dizziness

d. Chest pain

8. The healthcare provider assesses an older client's blood pressure for the first time at a walk-in clinic. The healthcare provider obtains a reading of 164/84. What should the healthcare provider do first?

a. Take the client's pulse

b. Provide education to the client

c. Inform the most responsible provider

d. Repeat the blood pressure on the other arm

9. A woman's pre-pregnancy pulse and blood pressure are 72 bpm and 112/78. Which findings are of most concern to the healthcare provider?

a. Pulse 82 bpm and BP 108/70 at the end of the first trimester

b. Pulse 68 bpm and BP 118/82 in the first half of the first trimester

c. Pulse 90 bpm and BP 104/68 at the beginning of the second trimester

d. Pulse 90 bpm and BP 138/88 towards the latter half of the final trimester

Go to the next page to check your answers.

Test Yourself – Answers

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

104/84 mm Hg

(NOTE: you should aim to obtain a measurement within 2-4 mm Hg. In this testing environment, it may depend on the quality of your computer speakers. In actual practice, the stethoscope's quality is a main determinant of accuracy)

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?

118/76 mm Hg

(NOTE: you should aim to obtain a measurement within 2-4 mm Hg. In this testing environment, it may depend on the quality of your computer speakers. In actual practice, the stethoscope's quality is a main determinant of accuracy)

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?

☑ The correct way

Figure 5.5: Stethoscope in the ears the correct way

The incorrect way

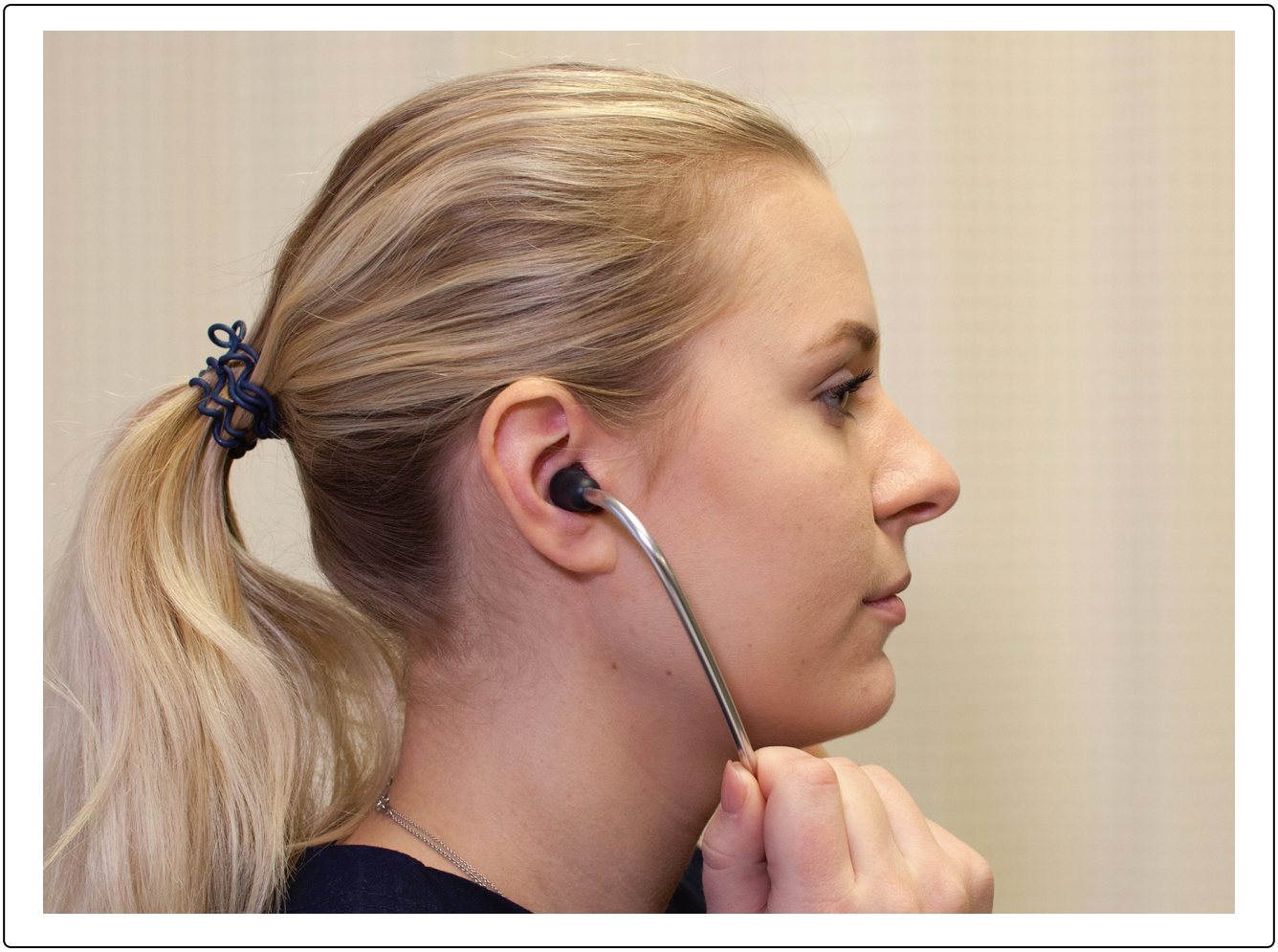


Figure 5.6: Stethoscope in the ears the incorrect way

Rationale: The slope of the stethoscope's ear pieces are inserted at the same angle as the ear canal (e.g., pointing forward or pointing toward the nose) as shown in Figure 5.6. The action shown in 5.7 is incorrect as the ear pieces are pointed straight into the ears.

4. True or False: The bell of the stethoscope is best used to hear Korotkoff sounds.

Rationale: The correct answer is true. You can use the bell or diaphragm to take a blood pressure, but the best way to hear the Korotkoff sounds is with the bell because it is better at picking up low-pitch vascular sounds.

5. In a blood pressure measurement of 110/70, the first number is the _____.

a. systolic pressure **

b. diastolic pressure

c. pulse pressure

d. mean arterial pressure

(from OER#2)

Rationale: The correct answer is **a (systolic pressure)**. When documenting the blood pressure, the first sound heard is the systolic pressure and the last sound heard is the diastolic pressure. Thus, the systolic measurement is reported as the numerator.

6. A healthy elastic artery _____.

a. is compliant **

b. reduces blood flow

c. is a resistance artery

d. has a thin wall and irregular lumen

(From OER#2)

Rationale: The correct answer is **a (is compliant)**. Arteries are able to expand and contract to adjust to pressure and volume changes.

7. Which of the following symptoms may be a result of orthostatic hypotension?

a. Fatigue

b. Nocturia

c. Dizziness **

d. Chest pain

Rationale: The correct answer is **c (dizziness)**. With orthostatic hypotension, the blood vessels fail to constrict effectively when the client moves to an upright position. This causes a decrease in blood flow to the brain.

8. The healthcare provider assesses an older client's blood pressure for the first time at a walk-in clinic. The healthcare provider obtains a reading of 164/84. What should the healthcare provider do first?

a. Take the client's pulse

b. Provide education to the client

c. Inform the most responsible provider

d. Repeat the blood pressure on the other arm **

Rationale: The correct answer is **d (repeat the blood pressure on the other arm)**. An abnormal blood pressure needs to be repeated to determine accuracy before making a clinical decision.

9. A woman's pre-pregnancy pulse and blood pressure are 72 bpm and 112/78. Which findings are of most concern to the healthcare provider?

a. Pulse 82 bpm and BP 108/70 at the end of the first trimester

b. Pulse 68 bpm and BP 118/82 in the first half of the first trimester

c. Pulse 90 bpm and BP 104/68 at the beginning of the second trimester

d. Pulse 90 bpm and BP 138/88 towards the latter half of the final trimester **

Test Yourself: List in the Correct Order

List the steps below in the correct order for each of the following techniques. *Write your list on a piece of paper.*

Two-step blood pressure technique

- 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.
- Open the valve slightly.
- Deflate the cuff quickly.
- 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.
- Inflate the cuff to the maximum pressure inflation number.
- Deflate the cuff slowly and evenly at about 2 mm Hg per second.
- 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

- Place the bell of the cleansed stethoscope over the brachial artery using a light touch, but with an airtight seal.
- Open the valve slightly.
- 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 mmHg more.
- Deflate the cuff slowly and evenly at about 2 mm Hg per second.
- 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).

Go to the next page to see the correct order of steps for these techniques.

Test Yourself: List in the Correct Order – Answers

The steps are listed in the correct order for each of the following techniques. These are **printable flashcards** to help you memorize and practice the techniques.

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 mmHg 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).

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 five 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 1: Adult client

Case Study 2: Pediatric client

Case Study 3: Pregnant adult client

Case Study 4: Older adult client

Case Study 5: Adolescent client

Layout

Data about each case study are provided with a series of critical thinking questions. The answers are provided on the page following the questions. You will need paper and a pen to write down your answers. For some of the case studies, you will be directed to download a blank vital sign record.

Go to the next page to start Case Study 1.

Case Study 1: Adult Client

Initial Assessment Data

- **Biographical data:** Adult client
- **Reason for seeking care:** Vomiting and diarrhea
- **History of presenting illness:** Vomited x 4 daily x 3 days, diarrhea x 6 daily x 3 days, currently severely nauseated and dizzy, tolerating sips of clear fluid
- **Past history:** No medications, no illnesses

Think about the client data and try to answer the following questions. *Write your answers on a piece of paper.*

1. What infection control measures should the healthcare provider implement?
2. What method should be used to measure temperature for this adult client?
3. What pulse and blood pressure readings should be taken for this adult client?

Go to the next page to check your answers.

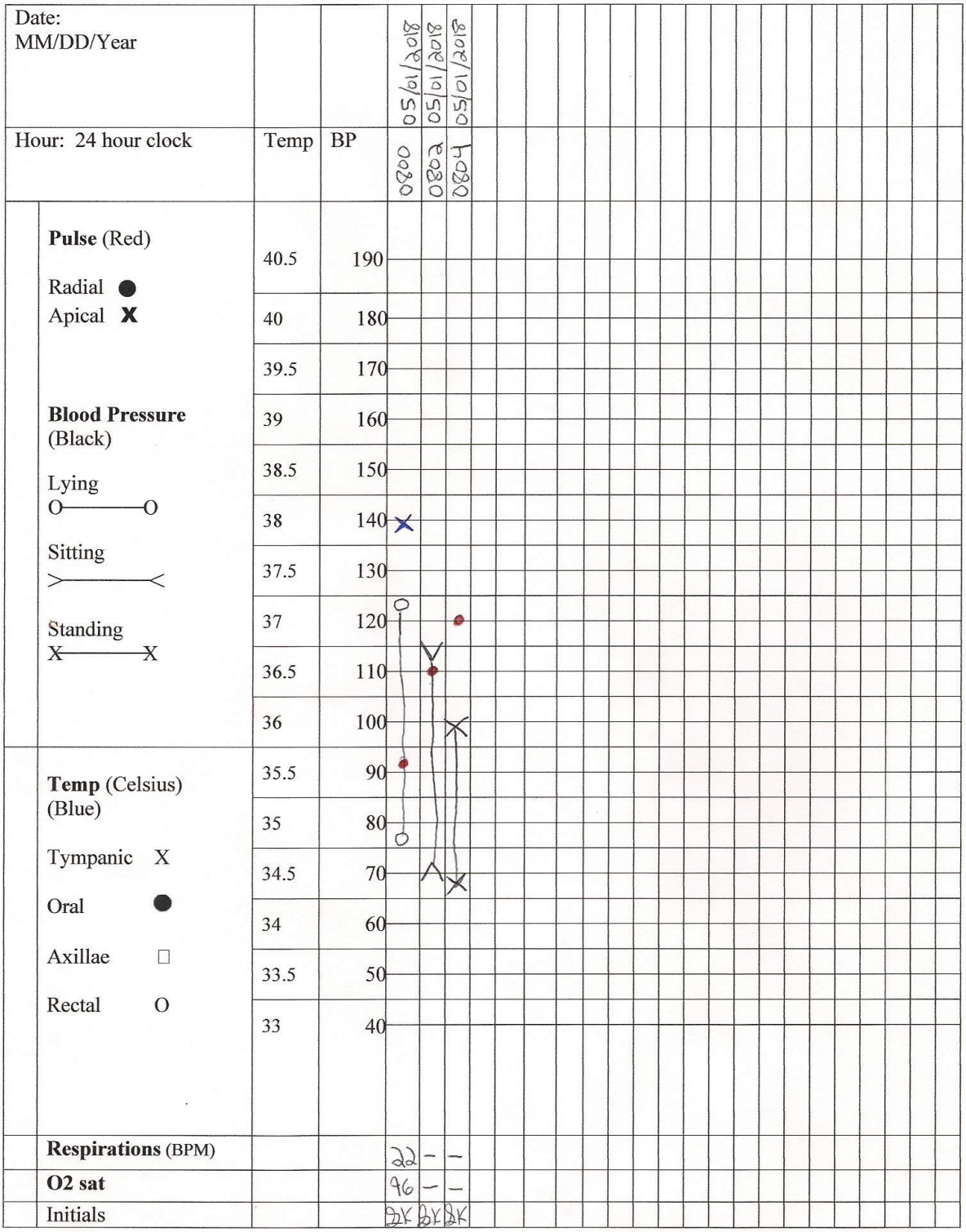
Case Study 1: Adult Client (continued)

1. What infection control measures should the healthcare provider implement?
Use correct handwashing techniques before and after your assessment.

2. What method should be used to measure temperature for this adult client?
Temperature is best taken using the tympanic or axillary route; because the client is nauseated, the oral route could stimulate the gag reflex.

3. What pulse and blood pressure readings should be taken for this adult client?
Orthostatic vital signs (pulse and blood pressure) should be taken because this client is at risk for hypovolemia. The client may be dehydrated as a result of the vomiting and diarrhea and lack of fluid intake. Return to the chapter on blood pressure for more information on hypovolemia and its effects on vital signs.

Next, see and read the vital sign record below. On a piece of paper, write down each of the client's vital sign readings, and if applicable, the route used and the client's position.



Case Study 1 – Adult Client

Go to the next page to view the vital sign readings based on the record above.

Case Study 1: Adult Client (continued)

Vital Sign Measurements

0800 hours, May 1, 2018

- Temperature 37.9°C tympanic
- Pulse Lying 92 bpm (radial)
    - regular rhythm, force 1+, weak and thready, equal radial pulses
- RR 22 bpm irregular rhythm
- BP lying 122/78 mm Hg
- 02 saturations 96%

0802 hours, May 1, 2018

- Pulse sitting 110 bpm (radial)
- BP sitting 112/72 mm Hg

0804 hours, May 1, 2018

- Pulse standing 120 bpm (radial)
- BP standing 98/68 mm Hg

Questions to Reflect On

1. Which findings are considered abnormal for this adult client? What medical terminology is used to define/label these findings?
2. What further assessment should the healthcare provider do based on this adult client's findings?
3. What actions should the healthcare provider take based on this adult client's findings?

Go to the next page to check your answers.

Case Study 1: Adult Client (continued)

1. Which findings are considered abnormal for this adult client? What medical terminology is used to define/label these findings?

- The temperature is higher than expected: hyperthermia/febrile (> 37.3°C)
- The pulse in lying position is within normal limits, but in the sitting and standing position, the pulse is elevated and is identified as tachycardia (> than 100 bpm)
- The pulse increased more than 20 bpm and the systolic BP decreased more than 20 mm Hg when the client moved from lying to standing, indicating orthostatic hypotension
- The pulse is weak and thready at 1+ force, which is abnormal
- The respiration rate is high: tachypnea (> 20 bpm)
- The oxygen saturations are slightly low (< 97%)

2. What further assessment should the healthcare provider do based on this adult client's findings?

Continue to assess for signs of dehydration:

- Dry mucous membranes
- Poor skin turgor
- Decreased and concentrated urine output

3. What actions should the healthcare provider take based on this adult client's findings?

- Notify the most responsible provider such as the physician or nurse practitioner.
- If you are the most responsible provider, discuss and initiate treatments such as fluid rehydration.

Go to the next page to start Case Study 2.

Case Study 2: 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

Think about the client data and try to answer the following questions. *Write your answers on a piece of paper.*

1. What infection control measures need to be taken when interacting with this child and taking the child's vital signs?
2. What developmental considerations need to be considered when taking the child's vital signs?

Go to the next page to check your answers.

Case Study 2: Pediatric Client (continued)

1. What infection control measures need to be taken when interacting with this child and taking the child's vital signs?

The toddler has a fever and an unknown rash, therefore needs to be isolated in a private room, and the healthcare provider must wear a surgical mask, gown, and gloves (contact and droplet precautions). The toddler requires vital signs equipment for use with that client only.

2. What developmental considerations need to be considered when taking this child's vital signs?

- An apical pulse is taken for a full minute due to the client's age.
- An axillary temperature is taken because it is minimally invasive. A rectal temperature may be performed to check for accuracy considering that the client is febrile.
- The SpO2 saturation is taken via ear sensor or a taped finger sensor because the pulse oximeter clip is too large for a young child's finger.

Vital Sign Measurements

1700 hrs, June 12, 2018

- Temperature: 39.8°C axilla
- Pulse: 170 bpm (apical) cyclical increases with inspiration, force 2+, regular rhythm
- RR 30 bpm, regular rhythm
- Spo2 saturation 98%

Print the blank vital sign record and document the findings noted above. Then, go to the next page to see the findings properly documented on the vital sign record.

Vital Sign Record – Blank (pdf)

Date: MM/DD/Year																										
Hour: 24 hour clock	Temp	BP																								
Pulse (Red) Radial ● Apical ✖ **Blood Pressure** (Black) Lying O———O Sitting >———< Standing X———X	40.5	190																								
	40	180																								
	39.5	170																								
	39	160																								
	38.5	150																								
	38	140																								
	37.5	130																								
	37	120																								
	36.5	110																								
	36	100																								
Temp (Celsius) (Blue) Tympanic X Oral ● Axillae □ Rectal O	35.5	90																								
	35	80																								
	34.5	70																								
	34	60																								
	33.5	50																								
	33	40																								
Respirations (BPM)																										
O2 sat																										
Initials																										

Case Study 2: Pediatric Client (continued)

Date: MM/DD/Year			06/12/2018
Hour: 24 hour clock	Temp	BP	1700
Pulse (Red) Radial ● Apical **X** **Blood Pressure** (Black) Lying O——O Sitting ><——< Standing X——X	40.5	190	
	40	180	□
	39.5	170	X
	39	160	
	38.5	150	
	38	140	
	37.5	130	
	37	120	
	36.5	110	
	36	100	
Temp (Celsius) (Blue) Tympanic X Oral ● Axillae □ Rectal O	35.5	90	
	35	80	
	34.5	70	
	34	60	
	33.5	50	
	33	40	
Respirations (BPM)			30
O2 sat			98
Initials			RB

Try to answer the following questions. *Write your answers on a piece of paper.*

1. Which vital sign findings are considered abnormal for this child? What medical terminology is used to define/label these findings?
2. What are the healthcare provider's actions based on this child's findings?

Go to the next page to check your answers.

Case Study 2: Pediatric Client (continued)

1. Which vital sign findings are considered abnormal for this child? What medical terminology is used to define/label these findings?

- The temperature is high: hyperthermia or pyrexia/febrile.
- The heart rate is elevated: tachycardia.
- Sinus arrhythmia is considered normal in the pediatric population.

2. What are the healthcare provider's actions based on these findings?

- Remove external clothing from the client (down to a diaper) to reduce fever.
- Provide cool fluids or popsicles to reduce fever.
- Promote fluid intake to reduce fever and maintain hydration.
- Ensure safety and observe the child due to the risk of febrile seizures that can occur with high body temperatures.
- Report to the most responsible provider if you are not the most responsible provider.

Go to the next page to start Case Study 3.

Case Study 3: Pregnant Adult Client

Initial Assessment Data

- **Biographical data:** Pregnant adult client (age 32)
- **Reason for seeking care:** Shortness of breath at a prenatal visit
- **History of health/illness:** 36 weeks pregnant
- **Past history:** No medications, no illnesses

Vital Sign Measurements

1430 hrs, August 14, 2018

- T 37.1°C axilla
- RR 14 (shallow breathing)
- P 92 (radial), regular rhythm, 2+ force, Sp02 97%
- BP 134/90 mm Hg (right arm, sitting position)

Baseline vital signs (pre-pregnancy)

- T 36.7°C axilla
- RR 14
- P 84, regular rhythm, 2+ force, Sp02 97%
- BP 124/74 mm Hg (right arm)

Think about the client data and try to answer the following questions. *Write your answers on a piece of paper.*

1. What needs to be considered when interpreting the vital signs findings of this pregnant client?
2. Which vital sign findings are considered abnormal for this pregnant client? What medical terminology is

used to define/label these findings?

Go to the next page to check your answers.

Case Study 3: Pregnant Adult Client (continued)

1. What needs to be considered when interpreting the vital signs findings of this pregnant client?

- Even though the client's reason for seeking care is shortness of breath, the Sp02 saturation is within the normal range and the respiratory rate is in the normal range. In the third trimester, it is common for the fetus to push against the diaphragm, causing it to raise and put pressure on the lungs resulting in the pregnant woman feeling short of breath.
- When measuring respiration, the healthcare provider assesses the depth of breathing: breathing is usually shallow in later-term pregnancy.
- Always take a fetal heart rate when taking a pregnant woman's vital signs.

2. Which vital sign findings are considered abnormal for this pregnant client? What medical terminology is used to define/label these findings?

The blood pressure is elevated because the systolic pressure is 134 and the diastolic pressure is 90. Healthcare providers should first repeat the blood pressure reading for accuracy. They should also review the pregnant woman's blood pressure levels pre-pregnancy and during previous pregnancies to determine the significance of these values. These considerations are important because slightly high systolic and diastolic blood pressure levels in later-term pregnant women can require an urgent referral for an obstetrical assessment.

The blood pressure is repeated on both arms after the client is at rest for five minutes to confirm accuracy.

1435 hrs, August 14, 2018

- BP 132/90 mm Hg right arm in sitting position, P 92 (radial)
- BP 128/88 mm Hg left arm in sitting position, P 88 (radial)

Try to answer the following questions. *Write your answers on a piece of paper.*

1. Which blood pressure do you record?
2. Is the variation between the arms of concern?

Go to the next page to check your answers.

Case Study 3: Pregnant Adult Client (continued)

1. Which blood pressure do you record?
The blood pressure readings that were taken after the woman rested for five minutes should be recorded. Record both the right arm and left arm reading in the narrative notes and the highest blood pressure reading on the vital sign record (e.g., the right arm reading of 132/90). Whenever a reading is elevated, consider repeating the measurement for confirmation.

2. Is the variation between the arms of concern?
The difference between the two arms is not significant. A difference below 10 mm Hg between arms is normal.

1430 hrs, August 14, 2018

- T 37.1°C axilla
- RR 14 (shallow breathing)
- P 92 radial in sitting position, regular rhythm, 2+ force, Sp02 97%
- BP 134/90

1435 hrs, August 14, 2018

- BP 132/90 mm Hg right arm, P 92
- BP 128/88 mm Hg left arm, P 88

Print the blank vital sign record and document the woman's vital signs. Then, go to the next page to see accurate documentation of vital signs.

Vital Sign Record – Blank (pdf)

Date: MM/DD/Year																										
Hour: 24 hour clock	Temp	BP																								
Pulse (Red) Radial ● Apical ✖ **Blood Pressure** (Black) Lying O——O Sitting >—— Standing X——X	40.5	190																								
	40	180																								
	39.5	170																								
	39	160																								
	38.5	150																								
	38	140																								
	37.5	130																								
	37	120																								
	36.5	110																								
	36	100																								
Temp (Celsius) (Blue) Tympanic X Oral ● Axillae □ Rectal O	35.5	90																								
	35	80																								
	34.5	70																								
	34	60																								
	33.5	50																								
	33	40																								
Respirations (BPM)																										
O2 sat																										
Initials																										

Case Study 3: Pregnant Adult Client (continued)

Date: MM/DD/Year			08/14/2018	08/14/2018
Hour: 24 hour clock	Temp	BP	1430	1435
Pulse (Red) Radial ● Apical **X** **Blood Pressure** (Black) Lying O——O Sitting > Standing X——X	40.5	190		
	40	180		
	39.5	170		
	39	160		
	38.5	150		
	38	140		
	37.5	130		
	37	120		
	36.5	110		
	36	100		
Temp (Celsius) (Blue) Tympanic X Oral ● Axillae □ Rectal O	35.5	90		
	35	80		
	34.5	70		
	34	60		
	33.5	50		
	33	40		
Respirations (BPM)			14	1
O2 sat			97	1
Initials			DS	DS

Case Study 4: Older Adult Client

Initial Assessment Data

- **Biographical data:** Older adult client
- **Reason for seeking care:** Assess blood pressure at a blood pressure clinic
- **History of health/illness:** Healthy
- **Past history:** No medications, no illnesses

Vital Sign Measurements

1050 hrs, September 7, 2018

- Sitting BP: 160/94 mm Hg right arm
- Pulse: 72 bpm (radial), 2+, regular rhythm

Think about the client data and try to answer the following questions. *Write your answers on a piece of paper.*

1. Which findings are considered abnormal for this adult client? What medical terminology is used to define/label these findings?
2. What factors might cause the blood pressure reading to be higher than normal in this adult client?
3. What is the healthcare provider's next action based on the findings of this adult client?

Go to the next page to check your answers.

Case Study 4: Older Adult Client (continued)

Vital Sign Measurements

1050 hrs, September 7, 2018

- Sitting BP: 160/94 mm Hg right arm
- Pulse: 72 bpm (radial), 2+, regular rhythm

1. Which findings are considered abnormal for this adult client? What medical terminology is used to define/label these findings?

- The blood pressure is elevated: hypertension (without diagnosis).

2. What factors might cause the blood pressure reading to be higher than normal in this adult client?

- Operator error
- Anxiety, stress, or pain
- Caffeine, smoking, or nicotine in the preceding 30 minutes
- Recently took adrenergic stimulants such as phenylephrine or pseudoephedrine
- Bladder and bowel discomfort
- Tight clothing on arm or forearm
- Noisy, cold room
- Taken immediately after activity
- Movement during the pressure reading

3. What are the healthcare provider's next actions based on the findings of this older client?

- Retake the blood pressure to ensure accuracy
- Take blood pressure in the other arm

- Have client sit in a room by themselves and then do the following:
    - ensure the room is quiet
    - dim the lights
    - allow the client to sit quietly for five minutes, without talking
    - then take three measurements, a few minutes apart, with the automatic cuff (with an automatic cuff, the blood pressure documented is the average of the three readings).

After the healthcare provider followed the above procedures, the results were:

September 7, 2018

1058 hrs Sitting BP: 156/92 mm Hg right arm P 70 bpm (radial)

1100 hrs Sitting BP: 148/90 mm Hg left arm

Automatic Cuff

5 mins later (1105 hrs)

Sitting BP: 150/86 mm Hg right arm P 66 bpm

2 mins later (1107 hrs)

Sitting BP: 144/84 mm Hg right arm P 68 bpm

2 mins later (1109 hrs)

Sitting BP: 156/82 mm Hg right arm P 62 bpm

Print the blank vital sign record and document the adult client's vital sign readings. Then, go to the next page for a sample vital sign record of these findings.

Vital Sign Record – Blank (pdf)

Date: MM/DD/Year																										
Hour: 24 hour clock	Temp	BP																								
Pulse (Red) Radial ● Apical ✖ **Blood Pressure** (Black) Lying O——O Sitting >—— Standing X——X	40.5	190																								
	40	180																								
	39.5	170																								
	39	160																								
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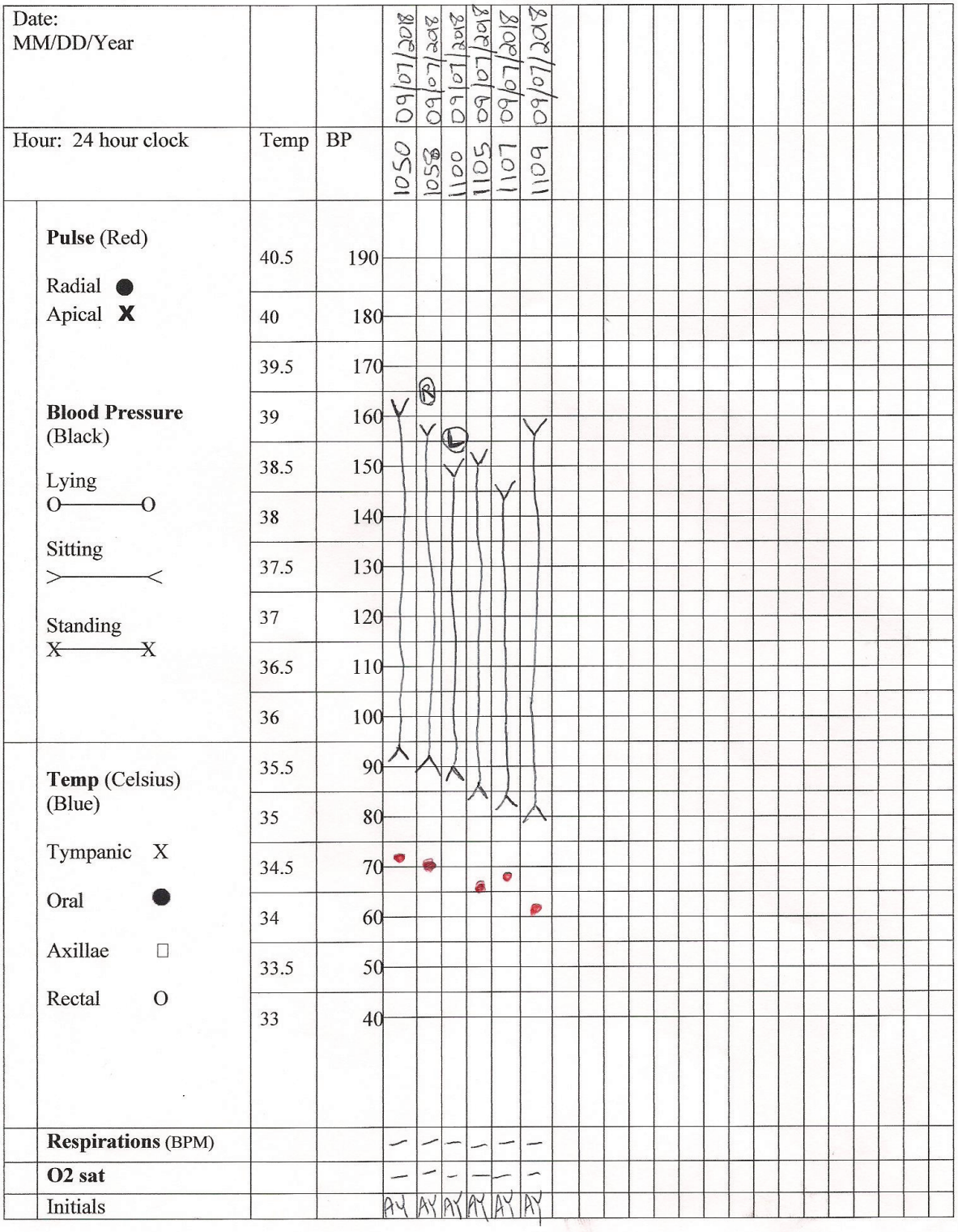
	35	80																								
	34.5	70																								
	34	60																								
	33.5	50																								
	33	40																								
Respirations (BPM)																										
O2 sat																										
Initials																										

Case Study 4: Older Adult Client (continued)

See accurate documentation of findings on vital sign record.

What are the healthcare provider’s actions based on the findings for this adult client?



Case Study 4 – Older Adult Client

Go to the next page to check your answer.

Case Study 4: Older Adult Client (continued)

What are the healthcare provider’s actions based on the findings for this adult client?

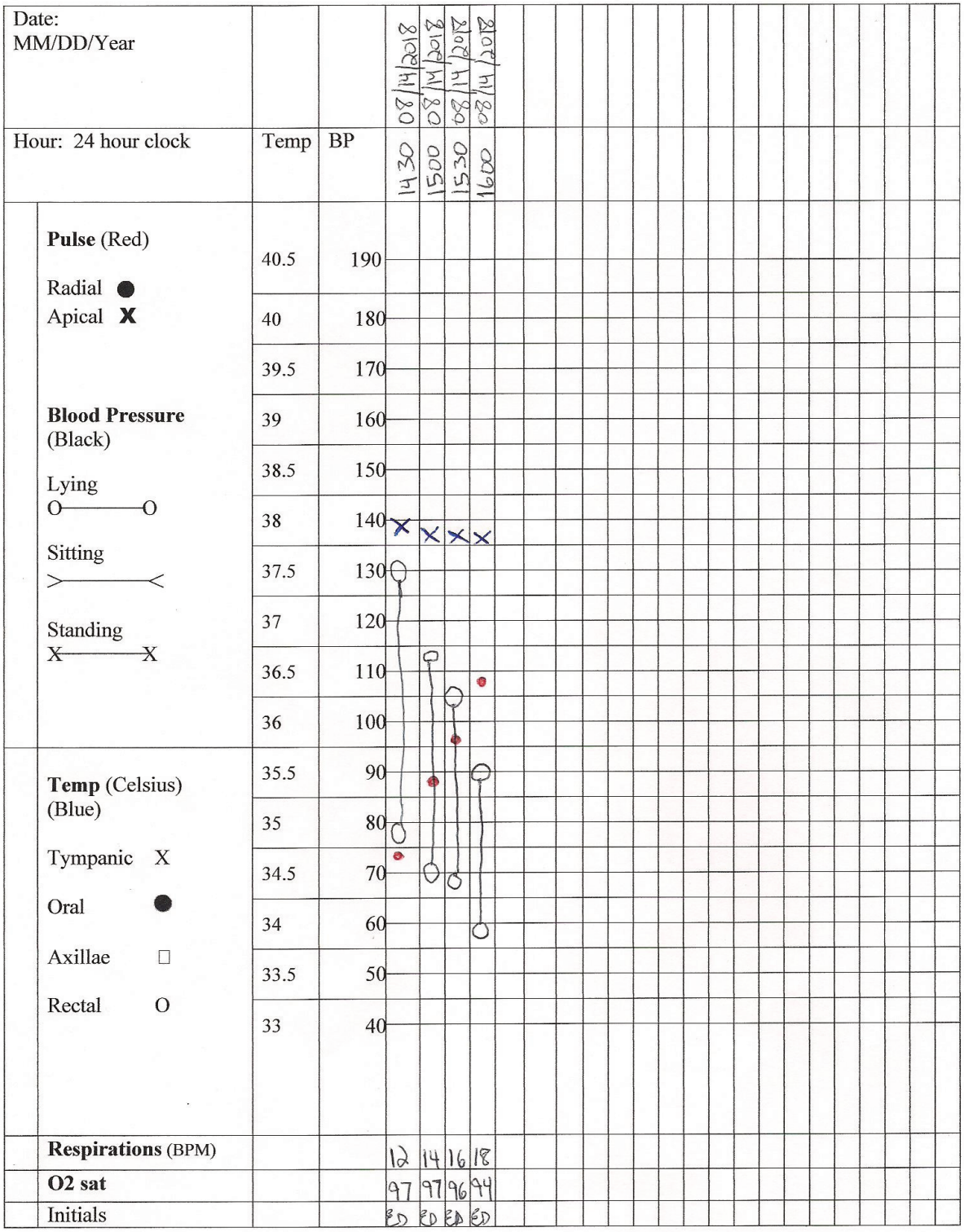
- Notify primary care provider.
- If you are the primary care provider, anticipate two visits for blood pressure readings within one month of this visit, or home blood pressure monitoring.

Case Study 5: Adolescent Client

Initial Assessment Data

- **Biographical data:** Adolescent client (age 17)
- **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. Awakes 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



Case Study 5 – Adolescent Client

Think about the client data documented on the vital sign record and try to answer the following questions. *Write your answers on a piece of paper.*

1. Review the vital sign record and identify the trends that you see.
2. What should the healthcare provider’s next action be?

Go to the next page to check your answers.

Case Study 5: Adolescent Client (continued)

1. After reviewing the vital sign record, identify the trends that you see.

The trends include a significant decrease in blood pressure, increase in pulse, and decrease in pulse force over 90 minutes. There is an increase in respiratory rate and a decrease in oxygen saturation. The temperature is slightly elevated, which is a common finding post-surgery. The temperature remained stable over the 90-minute period.

The changes in the above vital signs suggest hypovolemic shock, particularly in the context of recent abdominal surgery. Hypovolemic shock is a life-threatening condition that occurs with significant fluid loss such as blood. As part of diagnostic reasoning, healthcare providers recognize the indicators of hypovolemic shock as a decrease in blood pressure and an increase in pulse. The change in the respiratory rate is a compensating mechanism for blood loss and decreasing oxygen saturation: physiological factors stimulate increased respiratory rate to meet the oxygen demands of tissues as a result of decreasing blood pressure.

2. What should the healthcare provider's next actions be?

This condition is a medical emergency that requires immediate intervention.

- Notify the most responsible provider (if you are not the most responsible provider).
- Anticipate fluid rehydration and continue to monitor the client closely.

Chapter 7: Conclusion

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 oximter

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 mmHg 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).

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