Objectives

1. Discuss the significance of homeostasis.
2. Explain the mechanisms that adapt and maintain homeostasis.
3. Discuss the significance of each of the four vital signs: temperature, respiration, pulse, and blood pressure.
4. Identify the normal range for each of the vital signs.
5. Explain the implication of abnormal vital signs.
6. Describe how vital signs are assessed.
7. Explain the indications for administering oxygen therapy.
9. Explain why caution must be used when performing radiographic procedures on patients receiving oxygen therapy.
10. Describe the uses of, or indications for, the following thoracic tubes and lines to manage compromised patients: endotracheal tubes, thoracostomy tubes, and central venous lines.
11. Describe the radiographic appearance and proper placement of endotracheal tubes, thoracostomy tubes, and central venous lines.
12. Differentiate various types of central venous lines.
13. Recognize the clinical complications associated with use and placement of tubes and lines used in the thorax.
14. Describe the electroconduction system of the heart in correlation with normal and abnormal electrocardiographic findings.
Patient Homeostasis

- The body’s “steady state” maintained by adaptive responses that promote healthy survival
- Monitored by physiologic feedback loops
- Feedback loops may be two types
- The body’s feedback loops are predominantly negative loops

Mechanisms for Homeostasis

- Heartbeat
- Blood pressure
- Body temperature
- Respiratory rate
- Electrolyte balance

Vital Signs

- Body temperature
- Pulse rate
- Blood pressure
- Respiratory rate
- Mental state
Normal Vital Signs

- **Temperature**
  - Adult: 97.7° to 99.5°F
  - Child: 98.6° to 99.5°F

- **Respirations**
  - Adult: 12 to 20 breaths per minute
  - Child: 20 to 30 breaths per minute

- **Pulse**
  - Adult: 60 to 100 BPM
  - Child: 70 to 120 BPM

- **Blood Pressure**
  - Systolic: <120 mm Hg
  - Diastolic: <80 mm Hg

Body Temperature

- Measurement of the degree of heat of the deep tissues in the human body

  98.6°F (37°C) ± 1° to 2°F

- Hypothalamus plays a role in preservation of heat (shivering) and regulation of heat loss (sweating)

Routes of Measurement

- Oral
- Axillary
- Tympanic
- Temporal
- Rectal
Abnormal Temperatures

- Hypothermia
  - Temperature below normal 97.7° F
- Hyperthermia
  - Oral temperature higher than 99.5° F

Pulse

- Assessment of heart as reflected in arterial walls throughout the body
- Cardiovascular system is a closed-loop system of vessels

Physiology of Pulse

- When left ventricle contracts, blood is pumped out of the heart into the aorta and out to the arteries of the body
- Ventricular contraction is transferred to arterial walls and permits pulse measurement
- Common sites of measurement
Pulse Rate

- Count rate for 1 minute
- Pulse rate (adult)
  - 60 to 100 BPM
- Pulse rate (children)
  - 70 to 120 BPM

Pulse Measurement

- During CPR, typically pulse measured at carotid artery
- In critical care settings, pulse rate may be measured with a pulse oximeter
- Listening to heart via stethoscope over left side of chest (apical)

Pulse Oximeter

- For infants, a light-emitting probe is placed on big toe
- Also can have it attached to earlobe, temple, nose, or foot
- Oximeter converts light intensity into oxygen saturation and pulse rate values
**Electrocardiogram**

- 6- or 12-lead ECG
- Uses electrodes to monitor heart rate and rhythm
- Monitors electrical activity of the heart and transforms that activity to pulse rate values and waveforms

**Respiration Assessment**

![Respiration Assessment Image]

**Fig. 15-3** Normal ventilation. A, During normal inspiration, the diaphragm contracts, causing an expansion of the chest cavity. As the diaphragm contracts, the pressure within the lungs decreases below atmospheric pressure, allowing air to rush into the lungs. This expansion of the chest cavity is the result of the pressure gradient created by the difference between atmospheric pressure and the pressure within the lungs. B, During normal expiration, the diaphragm relaxes, returning to its original position at the junction of the chest cavity, and causing a decrease in the volume of the chest cavity. The decrease in volume increases the pressure of air within the lungs, eventually exceeding the pressure of atmospheric pressure, causing air to exit the lungs.

**Ventilation**

- During inspiration the diaphragmatic muscles:
  - Move downward
  - Push abdominal contents outward
  - Expand chest cavity
  - Allow relaxation, and air rushes into lungs because of slightly lower pressure within the lungs compared with atmospheric pressure
  - Expiration occurs when lung pressure is greater than outside pressure
Respiratory Assessment

- Tidal volume is amount of air exchanged under normal conditions
- Measured as number of breaths per minute
- Accurate measurement

Blood Pressure Measurement

- Measurement of the force exerted on the walls of arteries during cardiac contraction and relaxation
- Consists of two values
- Requires two pieces of equipment

Blood Pressure Measurement

- Typically measured over brachial artery
- Inflate cuff to exceed systolic pressure in artery
- Release air in cuff until pressure in cuff matches systolic pressure
- When no sounds are heard anymore, diastolic pressure value has been reached
Blood Pressure Measurement

• Blood pressure may also be measured and displayed through a cardiac or vital signs monitor.

• The cuff is placed around the patient’s arm and may be inflated manually by a health care professional or through an automatic, timed sequence controlled through the monitor.

• Once the cuff inflates and deflates, blood pressure values electronically display on the monitor.

Blood Pressure Measurement

• Systolic pressure
  – Caused by pressure no longer exceeding internal pressure (contracting)
    • less than 120 mm Hg (normal)

• Diastolic pressure
  – Occurs when sound of blood flowing through arm can no longer be heard (relaxing)
    • less than 80 mm Hg (normal)

• Measured in millimeters of mercury (mm Hg)

Blood Pressure

• Systolic/Diastolic 120/80 (normal in a healthy person)

• Hypotension—Below normal

• Hypertension—Above normal
Oxygen is a Drug

- Absolutely essential for life processes
- Oxygen is a colorless, tasteless, and odorless gas that plays a critical role in efficient cellular metabolism
- Makes up 21% of atmospheric gas
- Not flammable, but supports combustion
- Oxygen is considered a drug and must be ordered as such
- The primary clinical indications for oxygen administration are to correct hypoxemia and possible tissue hypoxia

Oxygen Devices

- Fig. 15A: Large stationary liquid oxygen tank. B: Small portable liquid oxygen canister.

Oxygen Delivery

- Oxygen devices may be continuous flow or conserving device systems.
- Oxygen delivery devices are designed to operate at a certain number of liters per minute (LPM).
- The oxygen flowmeter is green in color (or has green labeling) and has the word OXYGEN on it.
Portable Oxygen Delivery

- Portable systems include a regulator consisting of a flowmeter and pressure manometer.
- It is important to check the portable oxygen system before transporting a patient to ensure that an adequate oxygen supply is available throughout the patient transport period and duration of the radiographic procedure.
- The portable oxygen system must be secured during transport.

Oxygen Delivery Devices

- Two classifications
- Nasal cannula
- Masks
- Tents and oxyhood
- Ventilators

Oxygen Delivery Devices

- Nasal cannula
- Masks
  - Aerosol masks
  - Nonrebreathing masks
O₂ Delivery

• Tent and oxyhood
• Ventilators

Technologist Considerations

• Under no circumstances should an oxygen device be completely removed from the patient for the purpose of taking a radiograph without the consent or supervision of a physician, respiratory care practitioner, or attending nurse.

Chest Tubes and Lines

• Endotracheal (ET) tubes
• Chest tubes (thoracostomy)
• Central venous pressure (CVP) lines
Endotracheal Tubes

- Indications:
  - Need mechanical ventilation or O₂ delivery
  - Inadequate arterial oxygenation
  - Parenchymal diseases that impair gas exchange
  - Upper-airway obstruction
  - Impending gastric acid reflux or aspiration
  - Tracheobronchial toilet (lavage)

Radiograph needed for placement and thereafter

Thoracostomy Tubes

- Also known as chest tubes
  - Drain the intrapleural space and mediastinum
  - Fluid or air
  - Creates negative pressure
  - Atelectasis
  - Pneumothorax
  - Hemothorax
  - Pleural effusion
  - Empyema

Common Insertion Site

- Insertion sites for thoracostomy vary with the intrapleural substances to be removed
- Usually inserted in 5th to 6th intercostal space
- Laterally and midaxillary line
- Can be as high as 4th intercostal space and as low as 8th
Central Venous Pressure Line

- Catheter that is inserted into a large vein
  - Central venous catheters
  - Venous access devices
- Wide variety of clinical applications
  - Administer a variety of drugs
  - Manage fluid volume
  - Serve as a conduit for blood analysis and transfusions
  - Monitor cardiac pressures

CVP Lines

- Mainly used for chemotherapy and parenteral nutrition
- Also used to:
  - Administer drugs
  - Manage fluid volume
  - Perform blood transfusions
  - Monitor cardiac pressures

CVP Lines

- First developed by Broviac
- Then later by Hickman, hence the names of the CVP lines
- CVP lines
  - Port-A-Cath (chemotherapy)
  - PICC (peripherally inserted central catheter)
  - Swan-Ganz catheter
CVP Lines

- May be single-, double-, or multi-lumen
- Most common insertion site is subclavian vein; also can be internal jugular and femoral veins
- Position should be superior vena cava, approximately 2 to 3 cm above the opening of the right atrium

PICC Line Placement

- Tunneled catheter.
- Posteroanterior projection of the chest shows double-lumen tunnel catheter in the subclavian vein with the tip in the superior vena cava and apex of right atrium.

Pulmonary Arterial (PA) Catheter

- Swan-Ganz catheters
- Incorporates a small electrode at distal end, used to monitor pulmonary arterial pressure
- Access to left ventricle requires arterial approach
- Catheter placement in the left ventricle has major physiologic consequences
- Safest way to assess left-sided heart pressure is to extrapolate its value by monitoring right-sided heart and pulmonary pressures.
- Distal tip will be in one of the two pulmonary arteries
**Pulmonary Arterial (PA) Catheter**

- Catheter placement in left ventricle has major physiologic consequences.
- Has balloon on distal end; during pressure monitoring inflates balloon and allows tip to float and wedge in pulmonary artery.
- Measures pressure, and then balloon deflates.

**Technologist Responsibilities**

- Radiographic confirmation of line placement is essential at the time of insertion and thereafter as needed.
- Recognition of catheter malposition requires thorough knowledge of CV structures and their branches.
- Without any expectation of the radiographer to interpret the image from a pathologic diagnostic standpoint, when malpositioning is thought to occur, alerting the appropriate authority (e.g., radiologist, attending physician) is both appropriate and beneficial to the patient.

**Electrocardiography**

- Assessment of the heart’s ability to perform its vital function is possible using a device called an electrocardiograph (ECG).
- Cardiac cycle refers to events that occur from the beginning of one ventricular contraction (systole) until the beginning of another.
- ECG technology measures small voltages traveling through the heart and body and graphically displays them on paper or a monitor.
ECG Strip

Fig. 15-44 A, Normal electrocardiogram (ECG) pattern.

Cardiac Conduction System

- SA Node
- AV Node
- Bundle of His
- Purkinje Fibers

Fig. 15-41 Electroconduction tissues of the heart.

ECG Tracing

- The baseline of an ECG tracing is called the isoelectric line and signifies resting membrane potentials.
- The first deflection is the P-wave and represents depolarization of atrial muscle cells.
- The QRS-complex represents depolarization of ventricular muscle cells.
- The PR-interval is measured from the beginning of the P-wave to the beginning of the R-portion of the QRS-complex.
- The T-wave represents repolarization of ventricular muscle.
- The U-wave is theorized to represent repolarization of the papillary muscles and Purkinje fibers and often is not visible.
ECG Analysis

- ECG readers all have their own style or sequence for interpretation
- Five-step analysis

![ECG Tracing](image)

Conclusion

- Vital sign assessment is a critical part of emergency patient care and within the scope of radiologic sciences professionals.
- Assessment of vital signs is an objective, noninvasive evaluation of the patient’s immediate condition or response to therapy.
- Accuracy of data collection and recording is critical.
- The need for oxygen becomes critical to patients when the internal environment of the body is not consistent.
- Patients on ventilators require special care in handling, and the radiographic technologist must never alter ventilator alarms and settings. In addition, oxygen flow should never be interrupted in order to perform radiography.
- Radiographers must understand the use and radiographic appearance of common chest tubes and lines, including endotracheal tubes, thoracostomy tubes, and central venous lines.