Cardiac System

PHYSIOLOGY OF THE CARDIAC SYSTEM

A. The heart is located in the mediastinal space of the thoracic cavity.

B. The apex of the heart points downward and to the left; the apex contacts the chest wall at about the fifth to sixth intercostal space; in the normal individual, the point of maximum impulse (PMI) may be palpated here; this is also the area to auscultate and evaluate the apical heart rate.

C. Myocardial wall.
   1. Epicardium: the outer surface.
   2. Myocardium: the middle layer of cardiac muscle.
   3. Endocardium: the lining of the inner surface of the cardiac chambers.

D. Cardiac chambers (Figure 12-1).
   1. Four chambers are located within the heart; these chambers represent two pumps.
      a. Right-side pump: the right atrium and right ventricle, separated by the tricuspid valve.
      b. Primary function of the right side of the heart is to receive venous blood return from the vascular system and to pump blood through the lungs.
      c. Left-side pump: left atrium and left ventricle, separated by the mitral valve.

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      c. Left-side pump: left atrium and left ventricle, separated by the mitral valve.

2. Both atria are the receiving chambers; both ventricles are the ejecting chambers.

3. The atrioventricular septum separates the respective chambers.

4. The right side of the heart has a thinner myocardium than the left side and is a lower pressure system.

5. The left ventricle is composed of thicker muscle, is a high-pressure system, and is capable of generating enough force to eject blood through the aortic valve and through the systemic circulation.

6. Pericardium: a fibroserous sac that surrounds the heart.

E. Cardiac valves: maintain the directional flow of blood through the heart chambers.

F. Direction of blood flow through the heart structure (see Figure 12-1).
   1. From the venous system, the blood enters the right atrium via the superior vena cava and inferior vena cava; it then flows through the tricuspid valve into the right ventricle; blood is ejected from the right ventricle through the pulmonary valve into the pulmonary artery; then it goes to the lungs for oxygenation.

2. Oxygenated blood returns to the left atrium via the pulmonary veins; it flows through the mitral valve into the left ventricle; blood from the left ventricle is ejected through the aortic valve into the aortic arch, where it enters the systemic circulation.

3. The pulmonary artery is the only artery in the circulatory system to carry unoxygenated blood; the pulmonary vein is the only vein in the circulatory system to carry oxygenated blood.

G. Cardiac function.
   1. One complete cardiac cycle consists of contraction of the myocardium (systole) and subsequent relaxation of the myocardium (diastole).
   2. The amount of blood ejected from the ventricles is the stroke volume.
   3. The heart pumps approximately 5 L of blood every minute.
   4. The heart rate increases with exercise; therefore cardiac output increases.

FIGURE 12-1 Heart structures and path of oxygenated blood through the heart. (From deWit, S: Medical-surgical nursing: Concepts and practices, ed 7, St Louis, 2009, Saunders.)
5. The cardiac output will vary according to the amount of venous return (preload).

H. Myocardial blood flow.
   1. Coronary arteries supply the heart muscle with oxygenated blood.
   2. Collateral circulation.
      a. There are 3 main coronary arteries that branch from the aorta and supply oxygenated blood to the cardiac muscle.
      b. With a gradual occlusion of the large coronary arteries by atherosclerotic heart disease (ASHD), the smaller vessels increase in size and branch out to provide alternative sources of blood flow (collateral circulation).
      c. Because of the development of the collateral circulation, coronary artery disease (CAD) may be well-advanced before the client experiences symptoms.

I. Conduction System (Appendix 12-4)

System Data Collection

A. Health history.
   1. Identify presence of risk factors for the development of arteriosclerotic disease (Box 12-1).
   2. Respiratory system.
      a. History of difficulty breathing.
      b. Medications taken for respiratory problems.
      c. Determine normal activity level.
   3. Circulatory system.
      a. History of chest discomfort.
      b. History of edema, weight gain.
      c. History of syncope.
      d. Medications taken for the heart or for high blood pressure.

B. Physical assessment.
   1. What is the overall general appearance of the client? Is there any evidence of distress? What is the level of orientation and ability to think clearly?
   2. Evaluate blood pressure.
      a. Pulse pressure: the difference between the systolic and diastolic pressures.
      b. Assess for postural (orthostatic) hypotension: decrease in blood pressure when the client stands.
   3. Evaluate character of pulse.
      a. Rate, base rhythm.
      b. Regularity, presence of irregular or ectopic beats.

   c. Pulse deficit: the difference in the rate of the pulse at the radius and at the apex (or apical rate). If there is a pulse difference, the radial pulse rate will be less than the apical pulse rate.
   d. Pulse quality: the amplitude or quality of the pulse; pulses should be evaluated bilaterally.
      (1) +1: thread, weak, rapid pulse.
      (2) +2: diminished pulse; cannot be obliterated.
      (3) +3: easy to palpate, full; cannot be obliterated.
      (4) +4: strong bounding pulse; may be abnormal.
   e. Palpitations: client describes a feeling or sensation of rapid, bounding, or irregular heartbeat.
   5. Apical heart rate: listen for the apical pulse and count the apical rate at the fifth intercostal space, mid-clavicular line.
   6. Evaluate peripheral pulses and observe for presence of peripheral edema.
   7. Weight gain: 3 or more pounds in 24 hours represents fluid gain.
   8. Evaluate for presence of chest discomfort (Box 12-2).
      a. Location.
      b. Intensity of pain.
      c. Precipitating causes.
   9. Determine client’s activity level; increasing fatigue with mild exercise occurs with clients with cardiac disease.

BOX 12-1 RISK FACTORS IN ARTERIOSCLEROTIC HEART DISEASE

Modifiable Risk Factors
   • Elevated serum cholesterol levels
   • High blood pressure
   • Cigarette smoking
   • Sedentary lifestyle
   • Obesity
   • Type A personality (high-pressure lifestyle, driving, competitive)
   • Poorly controlled diabetes mellitus

Nonmodifiable Risk Factors
   • Genetic predisposition
   • Positive family history of heart disease
   • Increasing age
   • Gender: occurs more often in men; increase in women after menopause

TEST ALERT: Teach health promotion information. Know the risk factors for ASHD and be able to teach the client how to effectively reduce risk factors.
B. Temporary ischemia does not cause permanent damage to the myocardium. Pain frequently subsides when the precipitating factor is removed.

C. Types of angina.
1. Chronic stable angina
2. Unstable angina (acute coronary syndrome).
3. New onset angina — first symptoms of angina that most frequently occur after exertion.

Data Collection
A. Risk factors/etiology.
1. Arteriosclerotic heart disease (see Chapter 11).
2. Cardiac ischemia.
3. Increased cardiac demands.
   a. Exercise.
   b. Emotional stress.
   c. Heavy meals.

B. Clinical manifestations—chronic stable angina.
1. Pain in varying levels of severity (see Box 12-2).
   a. Predictable with level of stress or exertion; consistently responds well to nitroglycerin.
   b. Pain rarely occurs at rest.
2. Pain most often is located behind or just to the left of the sternum.
3. Pain may radiate to neck, jaw, and shoulders.
4. Client may describe pain as squeezing, choking, or constricting or as a vague feeling of pressure and indigestion.
5. Client will frequently deny seriousness of the pain.
6. Most clients correlate pain with activity and increased cardiac demands.
7. Pain is of short duration, generally lasting about 5 minutes.
8. Accompanying symptoms may include diaphoresis, increased anxiety, pallor, and dyspnea.

C. No permanent damage to myocardium.

D. Diagnostics—chronic stable angina (see Appendix 12-1).

Treatment—Chronic Stable Angina
A. Primary goal of treatment is to relieve pain and prevent future attacks.
B. Medication — vasodilators, beta-adrenergic blockers (Appendix 12-2).
C. Procedures/surgical intervention.
   1. Percutaneous transluminal angioplasty (PTA), percutaneous coronary intervention (PCI): A balloon is passed through an artery in the groin into the affected coronary artery to the area of obstruction. The balloon is inflated in an attempt to compress the plaque in the affected area and re-establish blood flow to the cardiac muscle.
   2. Atherectomy: a catheter is threaded into the coronary arteries, there is a rotating shaver on the tip that cuts away the plaque.

Angina Pectoris (Chronic Angina)

* Coronary artery disease (CAD) occurs as a result of the atherosclerotic process (see Chapter 11) in the coronary arteries. Angina pectoris is caused by myocardial ischemia due to narrowed or blocked coronary arteries. The buildup of plaque or fatty material in the coronary artery causes a narrowing of the lumen of the artery and precipitates myocardial ischemia that causes chest pain.

A. Pain (angina) occurs when the oxygen demands of the heart muscle exceed the ability of the coronary arteries to deliver it.
3. An intracoronary stent is an expandable wire mesh that can be inserted during any of the above procedures. A stent serves as a scaffold to support the coronary artery and increase the blood flow to the cardiac muscle.


D. Restricted activity.
E. Supplemental oxygen.
F. Control of the modifiable risk factors (see Box 12-1).

Complications
A. Dysrhythmias.
B. Myocardial infarction.

OLDER ADULT PRIORITY: In the older adult client, dyspnea, not angina, may be the presenting symptom of myocardial ischemia.

Nursing Interventions—see acute angina (coronary artery syndrome)

Unstable Angina Pectoris

Unstable Angina Pectoris (acute coronary syndrome) 
Acute coronary syndrome (ACS) according to the American Heart Association, includes degrees of coronary artery occlusion that can develop with coronary atherosclerosis. This includes unstable angina that occurs when a thrombus partially occludes a coronary artery causing prolonged symptoms of ischemia which can occur at rest.

Assessment
A. Risk factors/etiology.
   1. Family history of coronary artery disease.
   2. Hypertension, hypercholesterolemia.
   3. Diabetes, smoking.
   4. Average age for first MI - men over 64.5 years, women over 70.5 years.
   5. Women are at increased risk after menopause.
B. Clinical manifestations.
   1. Two or more episodes of angina within 24 hours, pain occurs when client is at rest.
   2. Chest pain lasting longer than 20 minutes and unrelied by nitroglycerin.
   3. Presenting symptoms in women: indigestion, pain between the shoulders, shortness of breath, and anxiety.
   4. Hypotension, dysrhythmias.
C. Diagnostics (Appendix 12-1).
D. Treatment (initial).
   1. Bed rest.
   2. Monitor vital signs, including oxygen saturation level.

3. Supplemental oxygen to maintain $O_2$ sat at or above 90%.
4. Reduce coronary reocclusion with antiplatelet medications. (Appendix 12-2)
5. Reduce and control ischemic pain: vasodilators (nitroglycerin, morphine sulfate IV if pain not relieved by the nitroglycerin).

Complications
A. Dysrhythmias (see Appendix 12-4).
B. Myocardial infarction (MI).

Nursing Interventions for Angina and Acute Coronary Syndrome

Goal: To decrease pain and increase myocardial oxygenation.
A. Maintain bed rest; position client in reclining position with head elevated.
B. Begin supplemental $O_2$.
C. Assess characteristics of pain
D. Administer medications.
   1. Nitroglycerin sublingual, IV, or translingual spray (Box 12-3; Appendix 12-2), evaluate client’s response; pain from chronic angina is usually relieved; pain from acute angina may not be relieved.

BOX 12-3 CLIENT EDUCATION FOR NITROGLYCERIN ADMINISTRATION

1. Keep in a tightly closed, dark glass container.
2. Carry supply at all times—either sublingual (SL) tablets or translingual spray; do not swallow sublingual tablets.
3. Fresh tablets (sublingual) should cause a slight burning/tingling under the tongue.
4. Date all opened containers and discard all medication that is 24 months old.
5. Take nitroglycerin prophylactically to avoid pain—before sexual intercourse, exercise, walking, etc.
6. Take nitroglycerin when pain begins; stop all activity.
7. If pain is not relieved in 5 minutes, call 911 and activate EMS.
8. While waiting for EMS response, if chest pain continues, take another SL pill or 1 metered sublingual spray.
9. Remain lying down; orthostatic hypotension can be a problem.
10. Long-acting preparations should not be abruptly discontinued; this may precipitate vasospasm.
11. To decrease development of tolerance in long-acting preparations, schedule an 8-hour nitro-free period each day, preferable at night.
12. Do not take erectile dysfunction drugs with nitroglycerin.

TEST ALERT: Instruct clients about self-administration of medications.
2. Narcotic analgesics (morphine), monitor response to small increments of IV morphine.

E. Immediately report presence of chest pain and or any changes in characteristics of chest pain to the RN.

F. Protect venous access.

G. Maintain calm, reassuring atmosphere.

H. Evaluate vital signs.

I. Do not leave a client alone if they are experiencing chest pain.

TEST ALERT: Check client’s discomfort and pain levels. Evaluate client’s response to interventions.

Goal: To evaluate characteristics of anginal pain and client’s overall response (see Box 12-2).

A. Does pain increase with breathing? (Anginal pain is generally not affected by breathing or changes in position.)

B. Assess activity tolerance or precipitating factor.

C. Assess characteristics of pain (Box 12-2).

D. Evaluate response of pain to treatment and or progression to more severe level.

E. Assess respiratory status and response to pain; presence of dyspnea, or wet breath sounds.

F. Assess for presence of irregular heartbeat and tolerance of dysrhythmias.

G. Assess adequacy of cardiac output – peripheral pulses, urinary output, level of consciousness.

H. Continuous ECG monitoring - assess for presence of dysrhythmia and impact on cardiac output.

I. Assess client’s psychosocial response – denial is common; anger, fear and depression occur in both client and family.

Goal: To provide care after cardiac interventional therapies (e.g., angioplasty, stent placement).

A. Monitor for chest pain and hypotension.

B. Frequent reassessment of status of circulation distal to area of catheter insertion.

C. A sheath may be left in place; monitor area for bleeding. If bleeding occurs, put manual pressure on the area and notify the RN.

D. Prevent flexion of affected extremity and maintain bed rest for 6 to 8 hours.

E. Immediately report any bleeding at site and occurrence of chest pain or syncope.

TEST ALERT: Intervene in response to client’s unexpected response to therapy; document response, promote recovery.

Myocardial Infarction

* A myocardial infarction (MI, coronary occlusion, heart attack) is a total occlusion of a portion of a coronary artery. Immediately following the occlusion, there is myocardial ischemia. In the hours following an MI, the tissue becomes necrotic.

A. Most common site of infarction is the left ventricle.

B. The severity of the event depends on the area of the heart involved, as well as the size of the artery occluded.

C. The presence of preestablished collateral circulation will assist in decreasing the size of the necrotic area.

D. The presence of pre-established collateral circulation will assist in decreasing the size of the necrotic area.

Data Collection

A. Risk factors/etiology – see unstable angina.

B. Clinical manifestations.

1. Typical pain is severe, substernal, crushing, and unrelieved by nitroglycerin (see Box 12-2).

2. Frequently client will deny seriousness of the pain.

3. Pain may radiate down the arm or up to the jaw.

4. Dyspnea, nausea, vomiting and indigestion.

5. Pale, dusky skin, syncope.

6. Onset is usually sudden.

7. Diaphoresis; extreme weakness.

8. Decrease in blood pressure, tachycardia, syncope.


C. Diagnostics (Appendix 12-1).

NURSING PRIORITY: Danger of death from an MI is greatest during the first 2 hours.

D. Complications

1. Dysrhythmias (see Appendix 12-4).

2. Cardiogenic shock.

3. Heart failure, (congestive heart failure).
Treatment

A. Reperfusion (fibrinolytic) therapy: most effective if administered immediately or within the first 3 to 6 hours after the MI.
B. Supplemental oxygen 4 L/min via nasal cannula (maintain O₂ sat above 95%).
C. Bedrest
D. Maintain intravenous (IV) line for medications.
E. Pain control: most often morphine; pain increases cardiac workload.
F. Medications (see Appendix 12-2).
G. Dietary restrictions.
   1. Progress to diet as tolerated: low sodium and low cholesterol.
   2. Decrease intake of stimulants (e.g., coffee, tea).
H. Percutaneous coronary intervention (PCI).
I. Open heart surgery for myocardial revascularization.

Nursing Interventions

Goal: To decrease pain and increase myocardial oxygenation (see previous related goal for angina pectoris).

✔ Nursing Priority: As long as a client is experiencing chest pain myocardial ischemia is present. If client experiences tachycardia, decrease activity whether client has chest pain or not.

Goal: To evaluate characteristics of cardiac pain and client’s overall response (see previous related goal for angina pectoris).

Goal: To maintain homeostasis and decrease effects of MI.

A. Maintain IV access; report infiltration or phlebitis at site.
B. Maintain bed rest initially.
C. Evaluate urinary output and renal response to changes in circulation.
D. Continuous cardiac monitoring, assess cardiac rate and rhythm; dysrhythmias are major cause of death after an MI.
E. Assess respiratory system for increasing dyspnea and pulmonary congestion.
F. Evaluate peripheral circulation; assess for presence of dependent edema.
G. Frequent assessment of vital signs; evaluate urinary output in response to changes in vital signs.
H. Frequent assessment for presence of chest pain.

Test Alert: Meet client’s pain management needs; provide medication for pain relief; monitor for effects of pain medication.

Home Care

A. Participate in organized cardiac rehabilitation program.
   1. Monitored exercise.
   2. Dietary modifications.
   3. Continued education regarding ASHD and methods to decrease personal risk factors.
B. Understand medication regimen (see Box 12-3 and Appendix 12-2).
C. Teach client how to check radial pulse for rate and regularity.
D. Teach client how to evaluate response to increased exercise, such as chest pain, shortness of breath and tachycardia.
   1. When beginning walking program, remain close to home.
   2. Always carry nitroglycerin when walking or exercising.
   3. Check pulse rate before, halfway through and at the end of activity.
   4. Stop activity for pulse increase of more than 20bpm, shortness of breath, chest pain, or dizziness.
OLDER ADULT PRIORITY: Older clients will require a longer warm-up session before exercise, as well as a longer period of low exercise and rest between activities. They may also have less tolerance of warm environment due to ineffective sweating.

E. Exercise in climate-controlled areas.
F. Call the physician for pain not controlled by nitroglycerin, significant changes in pulse rate, decrease in activity tolerance, syncope, or increase in dyspnea.
G. Sexual intercourse generally is resumed 4 to 6 weeks following an MI, or when client can climb two flights of stairs, or walk one block without experiencing chest pain.
   1. Do not drink alcohol or eat a large meal before sexual activity.
   2. Take nitroglycerin before sexual activity.
   3. Do not take erectile dysfunction medications (Appendix 17-1) if taking nitrates.
H. Return to physician for regular checkups.

Heart Failure

Heart failure (cardiac insufficiency, ventricular failure) is the inability of the heart to pump adequate amounts of blood into the systemic circulation to meet tissue metabolic demands.

Physiology of Heart Failure

A. Left-sided failure (congestive heart failure [CHF]) (Figure 12-2).
   1. Results from failure of the left ventricle to maintain adequate output.
   2. Blood backs up into the left atrium and into the pulmonary veins.
   3. Increasing pressure in the pulmonary capillary bed causes lungs to become congested, resulting in respiratory distress.
   4. Increasing pulmonary pressure results in increased pressure on right side of heart.
B. Right-sided failure (cor pulmonale).
   1. Results from failure of the right ventricle to maintain adequate output.
   2. Blood backs up into the systemic circulation and causes peripheral edema.
   3. Most common cause is secondary to left-sided failure and chronic pulmonary disease.
C. Each side of the heart is dependent on the other for adequate function.
   1. Left-sided failure results in pulmonary congestion; this causes an increase in pulmonary pressure, which puts increased workload on the right side of the heart and precipitates right-sided failure.
   2. Although the origin of the problem may begin solely on one side, the majority of clinical situations involve failure on both sides.

3. Left-sided failure rapidly causes right-sided failure. However, right-sided failure may occur alone for an extended period of time. Frequently associated with chronic lung problems.

D. The heart will attempt to maintain the body requirements for cardiac output (increasing cardiac rate, vasoconstriction) when these mechanisms become ineffective, cardiac decompensation or failure will occur.
E. In children, HF occurs most often as the result of a congenital defect of the heart.
F. Edema development in heart failure.
   1. Decreased cardiac output leads to decrease in renal perfusion, the kidneys respond by increasing the retention of sodium and water.
   2. Dependent pitting edema occurs with an increase in circulating volume (venous pressure).

Data Collection

A. Risk factors/etiology.
   1. Disease of cardiac valves, most often involves the mitral valve.
   2. History of myocardial disease.
   3. History of congenital heart disease.
   4. Fluid overload; excessive IV fluids.
   5. Chronic pulmonary disease.
B. Clinical manifestations.
   1. Impaired cardiac function.
      a. Tachycardia evaluated according to age group (see Table 3-1).
      b. Enlarged heart from dilatation and hypertrophy.

TEST ALERT: If a test question states that a client is in heart failure, assume that both sides are in failure unless indicated otherwise.
c. Poor perfusion: cool extremities, weak pulses, poor capillary refill.

d. In infants, failure to thrive and gain adequate weight.

2. Pulmonary congestion (left-sided failure).
   a. Dyspnea and cough on exertion.
   b. Orthopnea, tachypnea.
   c. Paroxysmal nocturnal dyspnea (PND) occurs while client is asleep.
   d. Symptoms of respiratory distress and hypoxia (see Table 10-3).
   e. Hemoptysis.
   f. Congested breath sounds.
   g. Feeding difficulties in infants due to dyspnea and decreased tolerance of activity.

   a. Hepatomegaly (enlarged liver): may be an early sign in children.
   b. Peripheral edema and weight gain.
   c. Dependent edema or generalized edema in infants; evaluate by weight gain.
   d. Ascites.
   e. Increase in central venous pressure (CVP).
   f. Jugular vein distention (JVD) with head elevated 30 degrees.

C. Diagnostics – Appendix 12-1

**TEST ALERT: Determine changes in client’s cardiovascular status as related to the client’s CHF; interpret what data need to be reported immediately.**

**Treatment**

A. Treatment of the underlying problem.

B. Prevention.
   1. Early treatment of hypertension.
   2. Early treatment of dysrhythmias.

C. Oxygen.

D. Bed rest: semi-Fowler’s or high-Fowler’s position.

E. Medications (see Appendix 12-2).
   1. Angiotensin-converting enzyme (ACE) inhibitors will decrease systemic vascular resistance; this will decrease cardiac workload (see Appendix 11-4).
   2. Cardiac glycoside (digitalis) will increase contractility of cardiac muscle and increase cardiac output.
   3. Medications to decrease platelet aggregation or clumping.

F. Decrease sodium in diet.

G. Fluid restriction: adults and older children. Infants seldom need fluid restrictions due to feeding difficulty.

**Nursing Interventions**

- **Goal:** To decrease cardiac demands and improve cardiac function.
  
  A. Early identification and treatment of dysrhythmias.
  
  B. Limit physical activity.

C. Maintain normal body temperature; avoid chilling because it will increase oxygen consumption.

D. Provide supplemental oxygen, especially when needed with increased activity.

E. Provide uninterrupted sleep when possible.

F. Monitor urinary output: assess for any correlation of decreased urine output with decreased cardiac output.

G. Minimize crying in children and infants.

H. Decrease stress and anxiety; encourage parents to remain with child.

I. Carefully assess vital signs and compare with other physical assessment data.

**NURSING PRIORITY:** The goals for care of a client with CHF are to:

- Improve cardiac output: digitalis and oxygen.
- Decrease cardiac workload (afterload): decrease activity, administer vasodilator.
- Decrease venous return (preload): diuretics; decrease sodium and fluid intake; place client in semi-Fowler’s position.

- **Goal:** To decrease circulating volume.
  
  A. Diuretics (see Appendix 11-5).
  
  B. Decreased sodium diet and fluid restriction in adults.
  
  C. Calculate fluids carefully; client frequently on fluid restriction.
  
  D. Evaluate fluid retention by obtaining accurate daily weights; teach client to weigh daily (1 kg or 2.2 lb weight gain = 1 L of fluid retention).
  
  E. Accurate intake and output records; assess response to diuretics; notify RN if client gains 2 to 4 pounds over 24-hours.

- **Goal:** To reduce respiratory distress and promote gas exchange.
  
  A. Position client carefully.
  
  1. Position adult client in semi-Fowler’s or in an arm chair; do not elevate client’s legs because this increases venous return.
  
  2. Infants and small children may breathe better side-lying with the knees drawn up to the chest.
  
  3. Infants may be placed in an infant seat.
  
  4. Make sure diapers are loosely pinned and safety restraints do not hinder maximum expansion of the chest.
  
  5. Hold infant upright over the shoulder with knees flexed (knee-chest position).

  B. Administer humidified oxygen to keep saturation levels at or above 90%

  C. Decrease exposure to upper respiratory tract infections.

  D. Evaluate breath sounds; check for distended neck veins and peripheral edema.

  E. Promote gradual activity. Determine client’s respiratory response to increased activity.

  F. Do not allow infants to cry for extended periods.
Goal: To monitor for development of hypoxia (see Chapter 10).

Goal: To maintain nutrition.
A. Due to dyspnea, eating is sometimes difficult.
B. Provide small, frequent feedings; allow client adequate time to eat.
C. Infants may need to be gavaged, due to increased caloric need and increased work of sucking.
D. Infants generally not on fluid restriction, due to decreased intake from dyspnea.
E. Do not prop the bottle, but do burp the infant frequently.

Home Care
A. Client should begin walking short distances, 250 to 300 feet, at least three to four times per week; distance can be increased as tolerated (no shortness of breath, dizziness, chest pain, or tachycardia).
B. Teach client how to count his or her pulse.
C. Client should weigh daily, before breakfast and with similar clothes on (nightgown, pajamas, etc.).
D. Discuss use of and safety factors for home oxygen.
E. Contact health care provider for:
   1. Weight gain of 3-5 pounds over a week, or 1-2 pounds overnight.
   2. Increase in dyspnea or angina, especially with decreased activity or at rest.
   3. Decrease in activity tolerance that exceeds 3 or 4 days.
   4. Increased urination at night, presence or increase in peripheral edema.
   5. Cough or respiratory congestion that lasts longer than 3 or 4 days.
F. Provide written instructions for medications.

Rheumatic Heart Disease
Rheumatic heart disease occurs in about 40% of clients with rheumatic fever; it primarily affects the cardiac valves. Myocardial involvement is characterized by an inflammatory response, causing scarring of the cardiac valves. The mitral valve is the most common area affected.

A. Usually preceded by a group A beta-hemolytic streptococcal infection.
B. Rheumatic carditis is the only symptom that produces permanent damage, most often involves damage to the mitral valve.
C. Rheumatic fever usually occurs during childhood, but manifestations of cardiac damage may not be evident for years.

Data Collection
A. Clinical manifestations of rheumatic fever symptoms vary; no specific symptom or lab test is diagnostic of rheumatic fever. Criteria for the diagnosis require a combination of symptoms to be present.
   1. Polyarthritis.
   2. Carditis and fever.
   3. Chorea: CNS involvement characterized by involuntary purposeless movement; no residual damage occurs.
   4. Possible rash.
   5. Subcutaneous nodules.
B. Clinical manifestations of rheumatic carditis.
   1. Heart murmur, tachycardia.
   2. Pericarditis, pericardial friction rub, and chest pain.

NURSING PRIORITY: Prevention and adequate treatment of streptococcal infections prevent the development of rheumatic heart disease.

Treatment
A. Prevention: adequate treatment of streptococcal infections.
B. Rest and decreased activity to decrease cardiac work load.
C. Salicylates to control inflammatory response and arthritic pain.
   1. Initiated after acute therapy.
   2. Administration of penicillin over extended period of time. Duration depends on presence and level of cardiac involvement.
   3. Before invasive medical procedures, client will need additional antibiotics due to increased risk of bacterial endocarditis.

Complications
Severe valve damage secondary to infective endocarditis may precipitate the development of congestive heart failure which may require open heart surgery for replacement of diseased valve.

Nursing Interventions
Child is generally cared for in the home environment.

Goal: To assist parents and family to provide home environment conducive to healing and recovery.

A. Decrease activity; maintain bed rest if pulse rate is increased or if febrile.
B. Encourage routine activities within the home.
C. Friends may visit for short periods; child is not contagious.
D. Arrange for school work to be continued at home as appropriate.
E. Maintain adequate nutrition and hydration.
F. Administer analgesics for joint pain.

Goal: To assist parents and client to understand need for long-term prophylactic antibiotic therapy.
A. Discuss the importance of preventing recurring infections.
B. Importance of prophylactic therapy before invasive medical procedures.
C. Continued medical follow-up care for the development of valve problems as child grows.
D. Follow-up required with females; cardiac problems may not be manifested until woman is pregnant.

**Infective Endocarditis (Bacterial)***

**Endocarditis is an infection of the valves and inner lining of the heart.**

A. Organism may enter from any site of localized infection.
B. Organism grows on the endocardium and produces a characteristic lesion consisting of vegetation, fibrin deposits, and collagen; the lesion then progresses to damaged adjacent valves.
C. Lesion is fragile and particles may break off and form emboli.

**Risk Factors**

A. Congenital heart disease.
B. Prosthetic valve replacement.
C. IV drug abuse.
D. History of rheumatic fever with carditis.

**Data Collection**

A. Onset is gradual with nonspecific symptoms.
   1. Intermittent fever, high or low grade.
   2. Anorexia, weight loss.
   4. Petechiae (common) in conjunctiva, lips, buccal mucosa, on the ankle, and in the antecubital and popliteal areas.
   5. Splinter hemorrhages in nail beds.
B. Cardiac murmur, symptoms associated with heart failure.
C. Symptoms secondary to emboli.

**Treatment**

A. Identification of infectious organism and appropriate antibiotic therapy for 4-6 weeks (see Appendix 5-10).
B. Bed rest if high fever or if evidence of heart failure is present.
C. Prophylactic antibiotics for 3 to 5 years, especially in children with history of rheumatic carditis or congenital abnormalities.
D. Prophylactic antibiotics before dental work, invasive diagnostic procedures, or surgery.

**Nursing Interventions**

- **Goal:** To assist parents/client to understand need for long-term prophylactic therapy in high-risk candidates (see related goal for rheumatic heart disease).
- **Goal:** To maintain homeostasis and prevent complications over long-term hospitalization.

A. Maintain pattern of decreased activity; assess activity tolerance.
B. Evaluate for complications of emboli and congestive heart failure.

**Home Care**

A. Explain the purpose of long-term antibiotic therapy.
B. Good oral hygiene
   1. Daily care and regular dental visits.
   2. Inform dentists and PCPs before any invasive procedure (e.g., tooth extraction, cystoscopy). Antibiotics will be ordered prophylactically.
C. Monitor temperature; report fever, chills, malaise, increasing fatigue, weight loss to the PCP.
D. Follow a progressive activity schedule until back to previous level of activity; avoid excessive fatigue; plan rest periods and activity.
E. Advise all health care providers of history of endocarditis.

**Pericarditis**

**Pericarditis is an inflammation of the pericardium.**

The pericardial space is a cavity between the inner and the outer layers of the pericardium.

**Data Collection**

A. Acute form may occur 2 to 3 days after a myocardial infarction.
B. Chronic pericarditis (Dressler's syndrome) may occur 1 to 4 weeks after an MI.
C. Chest pain aggravated by breathing, swallowing, lying supine.
D. Pain increases with deep inspiration and lying supine; sitting may relieve pain; pain may radiate, making it difficult to differentiate from angina.
E. Pericardial friction rub caused by myocardium rubbing against inflamed pericardium.
F. Fever, dyspnea, tachypnea.
G. Restlessness, irritability, anxiousness.

**Treatment**

A. Acute.
   1. Treat underlying problem.
   2. Restricted activity.
   3. Antiinflammatory medications.
Nursing Interventions

**Goal:** To maintain homeostasis and promote comfort.

A. Assess characteristics of pain; administer appropriate analgesics.

B. Position client upright; client leaning forward frequently relieves pain.

C. Decrease anxiety as client often associates problem with an MI; assist client to distinguish the difference.
   1. Pain does not increase with activity.
   2. Pain is not relieved by rest.
   3. Pain is relieved by sitting up and leaning forward.

D. In a client with chronic pericarditis, evaluate for symptoms of CHF and initiate appropriate nursing intervention.

**Cardiovascular Disease in Pregnancy**

* Rheumatic heart disease and congenital heart defects account for the greatest incidence of cardiac disease in pregnancy. Of these, mitral valve stenosis is by far the most common problem.

A. Normal physiological alterations of pregnancy that increase cardiovascular stress.
   1. Increase in oxygen requirements.
   2. Increase in cardiac output.
   3. Weight gain.
   4. Hemodynamic changes during delivery.

B. As normal pregnancy advances, cardiovascular system is unable to maintain adequate output to meet increasing demands.

**Data Collection**

Clinical manifestations indicative of cardiac decompensation are those of impending cardiac failure.

A. Frequent cough.

B. Progressive general edema (face, feet, hands); excessive weight gain.

C. Progressive dyspnea.

D. Excessive fatigue for level of activity.

E. Dysrhythmias: tachycardia greater than 100 beats/min.

F. Congested breath sounds.

G. Cardiac decompensation increases with length of gestation; increased incidence of heart failure at 28- to 32-weeks gestation.

**Treatment**

A. Management of the pregnant client.
   1. Balanced nutritional intake; adequate calories to maintain weight (avoid attempts to lose weight).
   2. Restricted activity, frequent rest periods.
   3. If severe, may be hospitalized and placed on bed rest at 28 to 32 weeks, due to impending cardiac failure.
   4. Prophylactic penicillin to prevent infection: especially important in women with mitral valve disease from rheumatic fever.

B. Management of the client during labor and delivery.
   1. Continuous monitoring of fetus and mother.
   2. Supplemental oxygen.

C. Management of the client during postpartum.
   1. Because of dramatic changes in the hemodynamic system of the mother, the first 24 hours postpartum is a period of increased risk.
   2. Client is treated symptomatically according to status of cardiovascular system; the first 24-48 hours postpartum is period of highest risk for HF in the mother.

**Nursing Interventions**

**Goal:** To assist client to maintain homeostasis during pregnancy.

A. Provide written information regarding nutritional needs.

B. Assess for early symptoms of cardiac failure.

C. Encourage frequent rest periods; stop any activity that increases shortness of breath.

**Goal:** To maintain homeostasis in postpartum period.

A. Assess pulmonary and cardiac adaptation to changes in hemodynamics.

B. Increased blood flow due to decreased abdominal pressure may cause a reflex bradycardia.

C. Maintain semi-Fowler’s position or left lateral position with the head elevated.

D. Promote gradual progression of activities depending on cardiac status as indicated by:
   1. Normal pulse rate.
   2. Good respiratory status.
   3. Activity tolerance.

E. Encourage progressive ambulation as soon as possible to prevent venous stasis and development of DVT.

F. Assist mother and family to prepare for discharge.

**TEST ALERT:** Provide care for client experiencing complications of pregnancy.

**Congenital Heart Disease**

A. Clinical manifestations depend on the severity of the defect and the adequacy of pulmonary blood flow.

B. Normal pressure in the right side of the heart is lower than pressure in the left side; there is an increased blood flow from an area of high pressure to an area of low pressure.
   1. When there is an opening between the right and left side of the heart, oxygenated blood will shunt from the left side of the heart to the right side (right-to-left shunt).
   2. When the pressures on the right side of the heart exceed the pressure on the left side of the heart, unoxygenated blood from the right side will flow into the left side and unoxygenated blood will flow into the systemic circulation (left-to-right shunt).

C. Physical consequences of congenital heart defects.
1. Delayed physical development.
   a. Failure to gain weight, caused by inability to maintain adequate caloric intake to meet increased metabolic demands.
   b. Tachycardia and tachypnea precipitate increase in caloric requirements.
2. Excessive fatigue, especially during feedings.
3. Frequent upper respiratory tract infections.
4. Dyspnea, tachycardia, tachypnea.
5. Hypercyanotic spells (called “blue” spells or “tet” spells): infant suddenly becomes acutely cyanotic and hyperpneic; occur most often in children 2 months to 1 year of age.

D. Diagnostics (see Appendix 12-1).

Nursing Interventions

- **Goal:** To evaluate infant’s response to cardiac defect.
  A. Determine infant’s Apgar score at birth.
  B. Evaluate adequacy of weight gain.
  C. Assess for feeding problems.
     1. Poor sucking reflex.
     2. Poor coordination of sucking, swallowing, breathing.
     3. Fatigues easily during feeding; may result in inadequate intake.
  D. Frequency of upper respiratory tract infections.

E. Determine if cyanosis occurs at rest or is precipitated by activity.
F. Presence and quality of pulses in extremities.
G. All fevers should be reported, bacterial endocarditis is a primary concern before and after correction of congenital defect.

PEDIATRIC PRIORITY: Cyanosis that decreases with crying is associated with respiratory function; cyanosis that increases with crying is associated with cardiac function.

- **Goal:** To assist parents in adjusting to diagnosis.
  A. Allow family to grieve over loss of perfect infant.
  B. Evaluate parents’ level of understanding of the infant’s problem.
  C. Foster early parent-infant attachment; encourage touching, holding, and general physical contact.
  D. Assist the family to develop a relationship which fosters optimal growth and development of all family members. (See Chapter 2 for psychosocial aspect of chronically ill children.)

- **Goal:** To detect, prevent, and treat HF – see earlier discussion of heart failure.

- **Goal:** To provide appropriate nursing interventions for the client undergoing open heart surgery for repair of a defect.

Study Questions: Cardiac System

1. The nurse is preparing a client for a cardiac catheterization. What is important for the nurse to explain to the client regarding his care after the test?
   1. It will be important for you to lie flat for several hours.
   2. It will be necessary for you to ambulate soon after the test.
   3. You will be very sleepy; let the nurse know if you are hurting.
   4. There will be a catheter in your bladder because you cannot get up.
2. A cardiac catheterization is scheduled for a client. In considering allergic reactions to the dye used in the procedure, an allergic reaction to what food would cause the nurse the most concern?
   1. Eggs.
   3. Shellfish.
   4. Penicillin.
3. Cardiac isoenzymes are ordered for a client who is admitted with a diagnosis of “rule out myocardial infarction.” What information will this test provide?
   1. Identifies myocardial tissue damage.
   2. Determines the area of myocardial involvement.
   3. Evaluates the ability of heart muscle to contract.
   4. Identifies presence of endocarditis.
4. The nurse is assessing the apical heart rate on a client.
   Where on the chest wall should the nurse place the stethoscope?
   1. Midline and to the left of the mediastinum.
   2. Mid-clavicular line, fifth intercostal space on the left.
   3. Fifth intercostal space, left mid-axillary line.
   4. Right of mediastinum, anterior to the axillary area.
5. A client with bacterial endocarditis is being discharged. What will be important for the nurse to review with the client?
   1. Begin exercise regimen in about 2 weeks.
   2. Increase your fluid intake of fruit juices.
   4. Return weekly for an electrocardiogram.
6. What is the rationale for a low-sodium diet in the client with congestive heart failure?
   1. Fluid retention will decrease, and this will improve cardiac output.
   2. Fluids will be retained to maintain cardiac output.
   3. A decrease in sodium level will cause a decrease in potassium levels.
   4. Myocardial contractility depends on normal serum sodium levels.
7. The nurse is administering nitroglycerin to a client who says he is experiencing midsternum chest pain. What would the nurse identify as a common side effect of this medication?
1. Pulse rate of 120 beats per minute.
2. Increase in systolic blood pressure.
3. Onset of nausea and vomiting.
4. Client says his head is hurting.

8. A client has a diagnosis of left-sided heart failure, and he is tells the nurse he is having difficulty breathing. The nurse determines the client’s pulse rate to be 120 beats per minute; respirations are 32 breaths per minute. What is the immediate nursing action?
   1. Determine when he last had his medications.
   2. Evaluate the adequacy of urinary output.
   3. Put him in supine position with feet elevated.
   4. Place him in high-Fowler’s position with feet dependent.

9. A client with a diagnosis of chronic angina is being discharged. What is important for the nurse to teach the client regarding how to take the sublingual nitroglycerin tablets?
   1. Take the medication with a full glass of water.
   2. Keep the medication in a clear container.
   3. The medication has a rapid onset of action of 2 to 5 minutes.
   4. Take the medication at the first onset of chest pain.

10. Digitalis has been ordered for a client in congestive heart failure. What would the nurse expect to find when evaluating the client for the therapeutic effectiveness of the drug?
    1. Improved respiratory status and increased urinary output.
    2. Increased heart rate and blood pressure.
    3. Diaphoresis with decreased urinary output.
    4. Increased heart rate with increased respirations.

11. When should the nurse determine the client’s pulse rate by checking the apical heart rate? Select all that apply:
    ___ 1. Determining pulse rate before the administration of digitalis.
    ___ 2. Checking the vital signs on a hypertensive client.
    ___ 3. Determining the heart rate in a client with an irregular pulse.
    ___ 4. Evaluating vital signs within the first 24 hours after a myocardial infarction.
    ___ 5. Evaluating a client with orthostatic hypotension.
    ___ 6. Determining vital signs on an infant.

12. As edema decreases in a client with heart failure, what physiological response would the nurse expect to find?
    1. Increase in body weight.
    2. Rales across all lung fields.
    3. Respiratory rate greater than 24 breaths per minute.
    4. Increase in the urinary output.

13. The nurse is caring for a client with a chronic pulmonary condition who has developed a complication of right-sided heart failure. Which nursing observation is associated with this complication?
    1. Decreasing urinary output.
    2. An irregular pulse rate.
    4. Increasing pulmonary congestion.

14. The nurse is assessing a client 2 days after he was diagnosed with a myocardial infarction. What finding would cause the most immediate concern?
    1. Urinary output of 40 mL per hour.
    2. Jugular vein distention in the supine position.
    3. Shooting pain in the left upper thigh.
    4. Irregular pulse rate of 120 beats per minute.

15. An older adult client is admitted in congestive heart failure. What observation by the nurse indicates that the client’s condition is getting worse?
    1. 1+ edema in lower extremities.
    2. Blood pressure of 160/98 mm Hg.
    3. Urinary output of 60 mL/hr.
    4. Increasing irritability and confusion.

16. A client with a history of cardiac problems tells the nurse he is beginning to have chest pain while he is sitting in a bedside chair. What would be the first nursing action?
    1. Assess the characteristics of the chest pain.
    2. Return the client to bed and begin oxygen.
    3. Advise the physician regarding the client’s status.
    4. Determine when the client last ate any food.

17. What is considered a modifiable risk factor for coronary artery disease?
    1. Age.
    2. Race.
    3. Diet.
    4. Heredity.

18. A client is admitted to the hospital due to malfunction of his permanent pacemaker. What would be important to include in the nursing care of this client?
    1. Encourage increased fluid intake.
    2. Maintain fall precautions.
    3. Encourage daily ambulation in the hall.
    4. Assess for development of hypoxia.

19. A client returns to the room after placement of a permanent pacemaker via the right subclavian vein. What is an important nursing action to prevent complications?
    1. Ambulate the client and encourage deep breathing.
    2. Check the radial pulse rate to evaluate the pacemaker function.
    3. Limit movement and abduction of the right arm.
    4. Assess the status of incision and external pacemaker wire.

20. Why is the client placed on a firm surface when CPR is performed?
    1. The heart is compressed between the sternum and the spine.
    2. It is easier to establish and maintain an open airway.
    3. It promotes venous return back to the heart.
    4. It decreases the potential for damage to the xiphoid process.

Answers and rationales to these questions are in the section at the end of the book titled Chapter Study Questions: Answers and Rationales.
SERUM LABORATORY STUDIES

Cardiac Enzymes
Enzymes are drawn to evaluate myocardial muscle and determine if there has been damage to the muscle.

1. **Creatinine kinase (CK-MB).** Increases occur within 4 to 6 hours after an MI, peak in 12 to 24 hours, and return to normal in 24-36 hours. Increases greater than 5% of total creatine kinase are strongly supportive of an MI.²

2. **Cardiac troponin T and cardiac troponin I:** normal levels are less than 0.2 ng/mL (for T) and less than 0.03 ng/dl (for I); levels are elevated within 3 to 6 hours after an MI and peak within 10 to 24 hours. Any elevation is significant because it is not found in healthy clients.

**Nursing Implications**
1. Enzymes must be drawn on admission and obtained at regular intervals. There is a characteristic pattern to the increases and decreases of enzyme levels in a client with an MI.
2. The larger the infarction, the larger the enzyme response.
3. Increased levels of troponin are the most significant and diagnostic of myocardial damage.
4. Cardiac-specific troponin helps discriminate from other tissue injury.

C-Reactive Protein (CRP), Highly Sensitive C-Reactive Protein (hs-CRP)
Highly sensitive CRP (hs-CRP) may be used to identify risk for developing an MI. The response to the test assists in evaluating the severity and course of inflammatory conditions.

Normal: Less than 1 mg/L or 8 mg/dL; increasing level is significant and may indicate some degree of inflammatory response caused by plaque formation.

B-Type Natriuretic Peptide (BNP)
First whole blood marker for identifying and treating heart failure. Serial BNP values may be used to evaluate left ventricular function; assists to identify heart failure versus respiratory failure as cause of dyspnea. Normal is less than 100 pg/mL.

NONINVASIVE

**Electrocardiogram (ECG)**
A graphic representation of the electrical activity of the heart, generally conducted using a 12-lead format. Test to identify conduction in rhythm disorders as well as specific electrical changes that correlate with cardiac ischemia and injury.

**Holter Monitor**
Client is connected to a small portable ECG unit with a recorder that records the client’s heart activity for approximately 24 hours. The client is directed to keep a log of activity, pain, or palpitations. The client should not shower or bathe while the monitor is in place. The recording is then analyzed, comparing the heart rate and rhythm to the client’s activity log.

**Event Monitor**
Client is connected to an ECG portable unit with a recorder. The client can activate the recorder at any time he feels any dizziness or palpitations. Monitor may be worn for extended periods of time. Monitor leads and battery unit may be removed for showering, but should be reconnected immediately after bathing. Recordings are transmitted over the phone.

**Exercise Stress Test**
This test involves the client exercising. This may be done on a treadmill or a stationary bicycle that increases in speed and degree of incline to increase the heart rate and blood pressure. ECG leads are attached to the client, and the response of the heart to exercise is evaluated.

**Nursing Implications**
1. Appropriate pretest client education; establish baseline vital signs and cardiac rhythm.
2. Client should:
   a. Avoid smoking, or drinking alcohol immediately before test, a light meal may be give 2 hours prior to the test.
   b. Avoid stimulants (caffeine), and extreme temperature changes immediately after test.
3. Cardiac rhythm and vital signs are monitored constantly during test.
4. Reasons for terminating an exercise stress test: predetermined heart rate is reached, chest pain, excessive fatigue, dyspnea, vertigo, hypotension or ventricular dysrhythmias occur; ECG changes of significant ST segment depression or T-wave inversion occurs.
5. If any of the above changes occur and the test is terminated, it is said to be a positive stress test.

**Thallium 201 Test**
A small dose of thallium is administered, and a camera records the uptake of thallium through the heart. Normal tissue has a rapid uptake of thallium; areas of scarring or damage have slower or no uptake of thallium. Clients should not ingest caffeine or smoke before this test.

**Echocardiogram**
An ultrasound procedure to evaluate valvular function, cardiac chamber size, ventricular muscle, and septal motion. The ultrasound waves are displayed on a graph and interpreted. Provides more specific information that an ECG. Nurse should determine if any medication needs to be given and/or withheld prior to the test. Sedation is not used.

Continued
Transesophageal Echocardiography
This test is an endoscopy ultrasound and provides a higher quality picture and additional diagnostic data than a regular echocardiogram. The throat is anesthetized, and a flexible endoscope is passed into the esophagus to the level of the heart and an echocardiogram is conducted from the esophageal view.
Sedation is used during the procedure.

Nursing Implications
1. NPO for 4 to 6 hours before test.
2. After the test, check for gag reflex before resuming PO fluids.

Magnetic Resonance Imaging
This is a noninvasive diagnostic scan. A magnetic field and radio waves are used to detect and define the differences between healthy tissue and diseased tissue. Provides images in three dimensions.

Nursing Implications
1. The client cannot have any metal on his/her body; remove all jewelry, hair clips, etc.
2. Clients with permanent metal implanted in the body (pacemakers, implanted clips and wires, insulin pumps) are not candidates for MRI.
3. Client must be cooperative and remain very still during the procedure.
4. No specific care required after the procedure.

Positron Emission Tomography (PET)
Very sensitive in identifying viable and nonviable cardiac tissue. The procedure takes about 2 to 3 hours, and a radioactive dye is injected intravenously, followed by glucose. A client’s glucose must be between 60-140 mg/dL prior to the test.

INVASIVE DIAGNOSTICS
Cardiac Catheterization
An invasive procedure in which a catheter is passed through an artery or vein into the heart. Cardiac catheterization will provide data regarding status of the coronary arteries, as well as cardiac muscle function, valvular function, and left ventricular function (ejection fraction).

Right-side catheterization: Provides information regarding the function and structure of the right atrium, right ventricle, pulmonic valve, and tricuspid valve.

Left-side catheterization: Provides information regarding the function and structure of the left atrium, left ventricle, aortic valve, and mitral valve. The catheter is manipulated through the aorta and dye is injected into the coronary arteries (coronary angiogram).

Nursing Implications
   a. NPO 4 to 8 hours before test.
   b. Record quality of distal pulses for comparison post-test.
   c. Check for dye allergy, especially iodine and contrast media.
   d. Determine whether any medications need to be withheld.
   e. Client education: report any chest pain or discomfort or difficulty breathing. Client will need to lie still on hard table; a flushed feeling may occur when dye is injected.
   f. Client is awake during procedure; sedative may be given.

2. Post-test.
   a. Evaluate catheterization entry site (most often femoral) for hematoma formation. Notify the RN or the physician immediately for excessive bleeding at the site, and for significant changes in blood pressure.
   b. Evaluate pulses distal to catheterization site, color, sensation of the extremity. Notify the RN or the physician immediately for a decrease in peripheral circulation or neurovascular changes in affected extremity.
   c. Assess for dysrhythmias, if identified, notify RN immediately.
   d. Maintain bed rest for 4 to 8 hours; avoid flexion, keep the extremity straight.
   e. Keep head of bed elevated at 30 degrees or less.
   f. Fluids will be encouraged to flush the dye out of the body.

TEST ALERT: Monitor peripheral pulses; identify and intervene to prevent circulatory complications.
NITRATES: Increase blood supply to the heart by dilating the coronary arteries; cardiac workload is reduced due to decrease in venous return because of peripheral vasodilation.

<table>
<thead>
<tr>
<th>Medications</th>
<th>Side Effects</th>
<th>Nursing Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitroglycerin (NTG, Nitrostat):</td>
<td>Headaches (will diminish with therapy),</td>
<td>1. Advise client that alcohol will potentiate postural hypotension.</td>
</tr>
<tr>
<td>sublingual</td>
<td>postural hypotension, syncope, blurred vision,</td>
<td></td>
</tr>
<tr>
<td>Nitroglycerin (Nitro-BID, Nitrol):</td>
<td>dry mouth, reflex tachycardia</td>
<td>2. Educate client regarding self-medication (see Box 12-3).</td>
</tr>
<tr>
<td>topical (patch)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitroglycerin ointment (Nitropaste):</td>
<td>topical, by the inch</td>
<td>3. Do not take with erectile dysfunction drugs.</td>
</tr>
<tr>
<td>Nitroglycerin translingual spray</td>
<td></td>
<td>4. Topical or transdermal application is used for sustained</td>
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<tr>
<td></td>
<td></td>
<td>protection against anginal attacks.</td>
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<td></td>
<td></td>
<td>5. Avoid skin contact with topical form; remove all previous</td>
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<tr>
<td></td>
<td></td>
<td>applications on client’s skin.</td>
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<tr>
<td></td>
<td></td>
<td>6. Sublingual tablets and translingual spray given for an</td>
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<td>immediate response.</td>
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</tbody>
</table>

Calcium Channel Blockers: Blockade of calcium channel receptors in the heart causes decreased contractility and dilation of arteries for treatment of hypertension and angina; some medications have cardiac specific properties.

<table>
<thead>
<tr>
<th>Medications</th>
<th>Side Effects</th>
<th>Nursing Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diltiazem (Cardizem): PO, IV</td>
<td>Constipation, exacerbation of CHF, hypotension,</td>
<td>1. Nifedipine is less likely to exacerbate preexisting cardiac</td>
</tr>
<tr>
<td>Nifedipine (Procardia): PO</td>
<td>bradycardia, peripheral edema</td>
<td>conditions; is not effective in treating dysrhythmias.</td>
</tr>
<tr>
<td>Verapamil (Calan, Isoptin): IV, PO</td>
<td></td>
<td>2. Intensifies cardiosuppressant effects of beta-blocker medications.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Assess for bradycardia.</td>
</tr>
</tbody>
</table>

Beta-Adrenergic Blocking Agents (adrenergic antagonists): Blockade of beta receptors in the heart causes decreased heart rate, and decreased rate of AV conduction. Used to treat hypertension as well as angina. Beta blockers should be administered to all clients experiencing unstable angina or having an MI unless contraindicated.

<table>
<thead>
<tr>
<th>Medications</th>
<th>Side Effects</th>
<th>Nursing Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labetalol (Trandate): PO, IV</td>
<td>Bradycardia, hypotension, depression, lethargy</td>
<td>1. Closely monitor cardiac client—may precipitate heart failure,</td>
</tr>
<tr>
<td>Metoprolol (Lopressor, Toprol XL):</td>
<td>and fatigue</td>
<td>but is also used to treat heart failure.</td>
</tr>
<tr>
<td>Propranolol (Inderal): PO, IV</td>
<td></td>
<td>2. Teach client how to decrease effects of postural hypotension.</td>
</tr>
<tr>
<td>Atenolol (Tenormin): PO, IV</td>
<td></td>
<td>3. Teach client to continue medication regardless of feeling better.</td>
</tr>
<tr>
<td>Carvedilol (Coreg): PO</td>
<td></td>
<td>4. Check pulse for bradycardia before administering.</td>
</tr>
<tr>
<td>Note: Carvedilol, bisoprolol, and</td>
<td></td>
<td>5. If client has diabetes, blood glucose control may be impaired.</td>
</tr>
<tr>
<td>metoprolol sustained release are</td>
<td></td>
<td>6. Give with caution to clients with history of bronchospasm.</td>
</tr>
<tr>
<td>used to treat HF</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Antidysrhythmic Medications: Decrease cardiac excitability; delay cardiac conduction in either the atrium or ventricle. Atropine is cardiac stimulant for bradycardia.

General Nursing Implications

- Assess client for changes in cardiac rhythm and impact on cardiac output.
- Evaluate effect of medication on dysrhythmia and resulting effects on cardiac output.
- Have atropine available for cardiac depression resulting in symptomatic bradycardia.
- All cardiac depressant medications are contraindicated in clients with sinus node or AV node blocks.
- Digitalis will enhance cardiac depressant effects.
- Closely monitor for dysrhythmias that are precipitated by the treatment.
- All of these medications can make existing dysrhythmias worse and also create new ones.
- RN or physician will administer IV medications; LPN may assist in monitoring the client.
### Appendix 12-2 CARDIAC MEDICATIONS—cont’d.

<table>
<thead>
<tr>
<th>Medications</th>
<th>Side Effects</th>
<th>Nursing Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quinidine sulfate</strong> (<strong>Quinidine Sulfate, Quinidex</strong>): PO</td>
<td>Hypotension</td>
<td>1. Administer with food.</td>
</tr>
<tr>
<td></td>
<td>Diarrhea, nausea, vomiting</td>
<td>2. Monitor for ECG changes for toxicity—widened QRS and prolonged QT.</td>
</tr>
<tr>
<td><strong>Atropine</strong>: subQ, IV</td>
<td>Tachycardia</td>
<td>1. <em>Use</em>: symptomatic bradycardia.</td>
</tr>
<tr>
<td></td>
<td>Dry mouth, blurred vision, dilated pupils</td>
<td>2. Assess client’s cardiac output in response to the bradycardic episode.</td>
</tr>
<tr>
<td><strong>Amiodarone hydrochloride</strong> (<strong>Cordarone</strong>): PO, IV</td>
<td>AV heart block, hypotension</td>
<td>1. <em>Use</em>: life-threatening ventricular arrhythmias, atrial fibrillation.</td>
</tr>
<tr>
<td></td>
<td>Toxicity—lung and visual problems</td>
<td>2. Monitor for severe bradycardia.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. <strong>High Alert Medication</strong> - caution with administration and maintain close client observation.</td>
</tr>
<tr>
<td><strong>Lidocaine hydrochloride</strong> (<strong>Xylocaine</strong>): IV</td>
<td>Drowsiness, confusion, seizures, severe depression of cardiac conduction</td>
<td>1. <em>Use</em>: ventricular dysrhythmias.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Must use IV preparation of Lidocaine for IV infusion.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. <strong>High Alert Medication</strong> - use only cardiac preparation for IV.</td>
</tr>
<tr>
<td><strong>Procainamide</strong> (<strong>Pronestyl</strong>): PO, IV</td>
<td>Abdominal pain, cramping, hypotension, prolonged QT interval Blood dyscrasias</td>
<td>1. <em>Use</em>: short- and long-term control of ventricular and supraventricular dysrhythmias.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Closely monitor for bradycardia and hypotension.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Do not take OTC cold preparations.</td>
</tr>
<tr>
<td><strong>Propranolol hydrochloride</strong> (<strong>Inderal</strong>): PO, IV</td>
<td>See previous discussion of beta-adrenergic blockers</td>
<td>1. <em>Use</em>: long- and short-term treatment and prevention of tachycardia.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. <strong>High Alert Medication</strong> - give with caution and closely monitor client response.</td>
</tr>
</tbody>
</table>

**Fibrinolytic (thrombolytic) medications:** Initiate fibrinolysis of a clot. Medications will break up a clot anywhere in the body – in a surgical incision as well as in the heart.

**General Nursing Implications**
- Therapy should begin as soon as the MI is diagnosed or when there is a history of prolonged angina—for best results, from admission in the ED until medication is administered is 30 min (door-to-needle), or within 60 min of onset of symptoms.
- Used to treat: acute coronary thrombosis (MI), deep vein thrombosis (DVT), and massive pulmonary emboli.
- Medication should be administered by an RN or physician; LPN may monitor client after infusion.
- Bleeding precautions (see Table 9-1).

<table>
<thead>
<tr>
<th>Medications</th>
<th>Side Effects</th>
<th>Nursing Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alteplase</strong> (<strong>tPA, Activase</strong>): IV</td>
<td>Bleeding and hypotension</td>
<td>1. Obtain base vital signs, monitor for hypotension.</td>
</tr>
<tr>
<td><strong>Reteplase</strong> (<strong>Retavase</strong>): IV</td>
<td></td>
<td>2. Monitor for allergic reactions with streptokinase.</td>
</tr>
<tr>
<td><strong>Streptokinase</strong> (<strong>Streptase, Kabikinase</strong>): IV</td>
<td></td>
<td>3. Monitor for bleeding.</td>
</tr>
<tr>
<td><strong>Streptokinase</strong> (<strong>Streptase, Kabikinase</strong>): IV</td>
<td></td>
<td>4. Avoid venipunctures during and after infusion.</td>
</tr>
<tr>
<td><strong>Streptokinase</strong> (<strong>Streptase, Kabikinase</strong>): IV</td>
<td></td>
<td>5. <strong>High Alert Medication</strong> - monitor client closely.</td>
</tr>
<tr>
<td><strong>Streptokinase</strong> (<strong>Streptase, Kabikinase</strong>): IV</td>
<td></td>
<td>6. <em>Use</em>: MI, PE, DVT; brain accident, contraindicated in clients with active bleeding.</td>
</tr>
</tbody>
</table>

*Continued*
## Appendix 12-2  CARDIAC MEDICATIONS—cont’d.

### ANTIPLATELETS (PLATELET AGGREGATION INHIBITORS): Inhibit the aggregation and clumping of platelets which reduces the risk of stroke, or MI or peripheral vascular occlusion in clients with peripheral vascular.

<table>
<thead>
<tr>
<th>Medications</th>
<th>Side Effects</th>
<th>Nursing Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin: PO</td>
<td>GI bleeding, dyspepsia, hemorrhagic stroke</td>
<td>1. Aspirin is given in small doses (e.g., 81 mg daily).</td>
</tr>
<tr>
<td>Clopidogrel (Plavix) PO</td>
<td>GI disturbances, skin reactions, blood dyscrasias</td>
<td>2. Take aspirin and Ticlid with food to decrease gastric irritation.</td>
</tr>
<tr>
<td>Ticlopidine (Ticlid): PO</td>
<td></td>
<td>3. Prophylactic therapy for prevention of MI and ischemic stroke (thrombotic) in clients with TIAs.</td>
</tr>
</tbody>
</table>

**Blood Viscosity Reducing Agent:**

- **Pentoxifylline (Trental): PO**
  - Nausea, vomiting, dizziness, headache, diarrhea,
  - 1. Primary use is for relief of intermittent claudication from PVD.
  - 2. Therapeutic effect may not be noted for 2-4 weeks.
  - 3. Do not chew, crush or break tablets.

**Cardiac Glycosides:** Increase myocardial contractility and cardiac output. Decrease heart rate by slowing conduction of impulses through the AV node.

### General Nursing Implications
- Take the apical pulse for a full minute; if the rate is below 60 beats/min in an adult or below 90-110 beats/min in infants and young children, or below 70 in a child, hold the medication and notify the RN or the physician.
- Evaluate for tachycardia, bradycardia, and irregular pulse. *If there is significant change in rate and rhythm, hold the medication and notify the RN or primary care provider.*
- Evaluate serum potassium levels and response to diuretics; hypokalemia potentiates action of digitalis.
- Gastrointestinal symptoms are frequently the first indication of digitalis toxicity.
- Teach client not to increase or double a dose in the case of a missed dose; if client vomits, do not give an additional dose.
- To achieve maximum results rapidly, an initial loading dose is administered; then dose is reduced to a maintenance dose.

<table>
<thead>
<tr>
<th>Medications</th>
<th>Side Effects</th>
<th>Nursing Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digoxin (Lanoxin): PO, IV</td>
<td>Most common: anorexia, nausea, vomiting,</td>
<td>1. Therapeutic plasma levels of digoxin are 0.5-2.0 ng/mL.</td>
</tr>
<tr>
<td></td>
<td>Most serious: drug-induced dysrhythmias</td>
<td>2. First sign of toxicity is usually GI symptoms.</td>
</tr>
<tr>
<td></td>
<td>Visual disturbances, fatigue</td>
<td>3. Uses: supraventricular tachycardia, CHF.</td>
</tr>
<tr>
<td></td>
<td>poor feeding, or slow heart rate may indicate</td>
<td>5. <strong>High Alert Medication</strong> - monitor client closely for side effects and toxicity.</td>
</tr>
<tr>
<td></td>
<td>toxicity.</td>
<td></td>
</tr>
</tbody>
</table>

**OLDER ADULT PRIORITY:** Older adults are more sensitive to digitalis and are more likely to experience toxicity.

**GI,** Gastrointestinal; **MI,** myocardial infarction; **PO,** by mouth (orally); **TIA,** transient ischemic attack; **PVD,** peripheral vascular disease.
Appendix 12-3  CARDIOPULMONARY RESUSCITATION (CPR) FOR HEALTH CARE PROVIDERS

The American Heart Association (AHA) has established standards for cardiopulmonary resuscitation for the health care provider. For further delineation of the procedure, consult the American Heart Association Cardiopulmonary Resuscitation Guidelines. For health care providers, the American Heart Association uses the term infant to refer to individuals between birth and 1 year of age; child is used to refer to those who are between 1 year of age and the onset of puberty.

1. AIRWAY.
1. Identify that the victim is unconscious.
2. Activate the emergency medical services (EMS) system.
3. Repeat and/or obtain an automated external defibrillator (AED). Use AED as soon as it is available for all adults and children for sudden, witnessed collapse and for in-hospital clients.
4. Place client in position to open airway.
5. Open the airway: head-tilt/chin-lift maneuver.
6. Check for adequate breathing (look, listen, and feel for breaths).
7. If victim is breathing, place in recovery position.
8. If victim is not breathing, give 2 rescue breaths using mouth to mouth, or a pocket mask or bag mask.

2. Breathing.
1. Maintain the open airway.
2. Pinch nostrils closed.
3. Give two breaths that make the chest rise, at 1 sec per breath, using mouth-to-mouth technique (mouth–to–nose and mouth technique may be used for small children and infants).
4. Do not give “extra” breaths; do not give large, forceful breaths.
5. When an advanced airway is present, ventilate at the rate of 8-10/min; do not pause for cardiac compressions.

3. Check the pulse for no more than 10 sec.
1. Adult and child: Check the carotid pulse.
2. Infant: Check the brachial or femoral pulse.
3. If the pulse is absent, begin chest compressions—cycles of 30 compressions and 2 breaths until ACLS or PALS standards are initiated.
4. If the pulse is present, continue rescue breathing, and recheck pulse every 2 min. If despite adequate ventilation, the heart rate of an infant or child remains under 60 bpm, chest compressions should be started.
5. Adult: 1 breath every 5-6 sec, 10-12 per min.
6. Child and infant: 1 breath every 3-5 sec, 12-20 breaths per min.
7. Advanced airway present (laryngeal mask airway, endotracheal tube): 1 breath every 6-8 sec without trying to synchronize breaths with compressions.

✔ PEDIATRIC PRIORITY: Be careful not to hyperextend the infant’s head; this may block the airway. Don’t pinch the infant’s nose shut—cover the nose with your mouth instead. Breathe slowly, just enough to make the chest rise.

4. External cardiac compression.
1. Place the victim on a firm surface. If the client is in a bed, put a cardiac board behind him or her. DO NOT attempt to remove the client from the bed.
2. Locate the lower half of the sternum in the adult. For the adult, place one hand over the lower sternum; place the other hand on top of the previous hand. For a child (age 1 year to puberty), use the heel of one hand, or two hands based on the size of the child, and press on the center of the chest at the nipple line. For an infant, locate the nipple line; the area for compression is one finger’s width below the line.
3. Depress the sternum 1½ to 2 inches in the adult; in children and infants depress approximately one-third to one-half of depth of chest.
4. Push hard and fast; allow the chest to recoil completely between compressions and as few interruptions as possible.

Adult and child:
One rescuer and two rescuers: 30 compressions (rate of 100 per min) to 2 ventilations.

Infant:
One rescuer: 30 compressions (rate of 100 per min) to 2 ventilations.
Two rescuers: 15 compressions to 2 ventilations.

Continued
Defibrillation: Use automatic electronic defibrillator (AED) as soon as available for sudden collapse and for in-hospital clients.

Steps for using an automated external defibrillator (AED):
1. Provide CPR until the AED arrives.
2. On arrival, open the case and turn the power on.
3. Select the correct pads for the size and age of the victim (only use the child pads/system for children less than 8 years old).
4. Attach the adhesive electrodes—one on the upper-right side of the chest directly below the clavicle, the other below the left nipple below the left armpit.
5. Attach the connecting cable to the AED.
6. Compressions will need to be discontinued while the rhythm is analyzed.
7. If shock is indicated, loudly state “Clear!” and visually check to ensure that no one is touching the client.
8. Press the SHOCK button.
9. Resume CPR immediately with cycles of 30 compressions to 2 breaths.
10. After 2 min, the AED will prompt you to repeat steps 6 through 9.

5. Termination of CPR. A rescuer who is not a physician should continue resuscitation efforts until one of the following occurs:
1. Spontaneous circulation and ventilation have been restored.
2. Resuscitation efforts are transferred to another equally responsible person who continues the resuscitation procedure.
3. A physician or physician-directed person assumes responsibility for resuscitation procedure.
4. The victim is transferred to an emergency medical service (e.g., paramedics and ambulance).
5. The rescuer is exhausted and unable to continue resuscitation.

Life Threatening Dysrhythmias

**Ventricular tachycardia**
Wide, bizarre, erratic or regular ORS complexes occurring at a very rapid rate of 125 to 200 beats/min

**Ventricular fibrillation**
Very rapid, erratic conduction with undetermined rate; cannot identify QRS complexes;

Severe decrease in cardiac output; potentially life-threatening situation.
May have a pulse or be pulseless. If unconscious and pulseless initiate CPR.
**Treatment:** lidocaine, amiodarone, procainamide, cardioversion.

Client is unresponsive, with no pulse; initiate a code and begin CPR.
**Treatment:** defibrillation, lidocaine.

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**CHARACTERISTICS OF NORMAL SINUS RHYTHM**

**Pulse Characteristics:**
Rate: 60 to 100 beats/min
Rhythm: regular

**Electrocardiograph Characteristics** (Figure 12-3):
1. P wave: indicative of the impulse generated from the sinoatrial node. A P-wave is present and precedes each QRS complex.
2. PR interval: delay of the impulse at the atrioventricular node to promote ventricular filling, normal interval is 0.12 to 0.20 second.
3. QRS complex: passage of the impulse through the bundle of His, down the bundle branches, through the Purkinje fibers; depolarization of the ventricle occurs. A QRS is present for each P-wave, QRS interval is less than 0.10 second.
4. T wave: ventricular repolarization and return to the resting state.
5. S-T segment: above the baseline in cardiac injury and below the baseline with ischemia.

Dysrhythmias:
Dysrhythmias may be classified according to:
**Rate**—either bradycardia or tachycardia.
**Origin**—atrial or ventricular. Ventricular dysrhythmias are more life-threatening than atrial dysrhythmias.

**Nursing Implications**
1. Evaluate client’s tolerance of the dysrhythmia.
   - Level of consciousness, increased lethargy
   - Hypotension or postural hypotension
   - Pulse rate: tachycardic/bradycardic
   - Urinary output
2. Maintain adequate cardiac output: keep client on bed rest until client’s response to the dysrhythmia is determined.
3. Provide supplemental oxygen immediately with any client who complains of chest pain or shortness of breath.
An internal generator is inserted into soft tissue of upper chest or abdomen, and electrodes are positioned in the heart according to the pacing mode; procedure planned and conducted under highly controlled environment. Most often done in same-day surgery (Figure 12-5).

**Demand Pacing Mode**

The heart is stimulated to beat when the client’s pulse rate falls below a set value or rate. The majority of pacemakers have a set rate between 60 and 72 beats per minute; if client’s pulse rate falls below the set value, the pacemaker will be initiated. The pacemaker “senses” the initiation of a beat and the following conduction. If a normal cardiac impulse or beat is initiated and conducted, the pacemaker does not initiate an impulse.

**NURSING PRIORITY:** Pacemaker failure - An ECG must be available to validate pacemaker failure. If a client with a pacemaker experiences syncope or a bradycardia below the rate set on the pacemaker, it needs to be investigated immediately.

**Nursing Implications**

1. Assess insertion site for signs of bleeding or hematoma formation.
2. If pulse rate falls below preset level, keep client in bed and report it immediately.
3. Assess client’s tolerance of activity: syncope or orthostatic hypotension should not occur.
4. After initial insertion, avoid moving affected arm above the head.

**Client Education**

1. Wear a medical alert identification, and advise all health care professionals regarding the pacemaker.
2. Avoid irritating or tight clothing that puts pressure on or irritates the site; report any signs of infection over site.
3. Safe environment: avoid close contact with areas of high voltage, magnetic force fields, large running motors; microwaves are not a problem.
4. Avoid activity that requires vigorous movement of arms and shoulders or any direct blows to PM site.
5. Advise the client of the set rate of pacemaker; teach client how to count their radial pulse. Notify the cardiac center or primary care provider immediately if the pulse rate is lower than the set rate.
6. Advise client to immediately report episodes of syncope.
7. Follow-up care and monitoring of the pacemaker are very important. Follow-up is usually done on a monthly basis via a trans-telephonic device; it does not require client to come into office.
8. Client may travel without restrictions.

**TEST ALERT:** Determine pacemaker malfunction.