Chapter 6

Cardiovascular System Assessments
Cardiovascular System Assessments

- Overview of essential components of this chapter are the:
  - Normal electrocardiogram (ECG) patterns
  - Common heart arrhythmias
  - Noninvasive hemodynamic monitoring assessments
  - Invasive hemodynamic monitoring assessments
  - Determinants of cardiac output
The Electrocardiogram (ECG)
Figure 6-1. Electrocardiographic pattern of a normal cardiac cycle.
Normal Heart Rates

- Adult: 60 to 100 bpm
- Infant: 130 to 150 bpm
Methods Used to Calculate Heart Rates

- When the rhythm is regular:
  - Count the number of large boxes on the ECG strip between two QRS complexes and then divide by 300.
  - For example, if an ECG strip consistently shows four large boxes between each QRS complex, the heart rate is 75 bpm.
    - \[ 300 \div 4 = 75 \]
Methods Used to Calculate Heart Rates (Cont’d)

- When the rhythm is irregular:
  - The heart rate can be determined by counting the QRS complexes on a 6-second strip and multiplying by 10.
Common Heart Arrhythmias
Sinus Bradycardia

- In sinus bradycardia the heart rate is less than 60 bpm.
- Bradycardia means “slow heart.”
- Sinus bradycardia has a normal P-QRS-T pattern, and the rhythm is regular.
Figure 6-2. Sinus bradycardia. Rate is about 37 beats per minute.
Sinus Tachycardia

- In sinus tachycardia the heart rate is greater than 100 bpm.
- Tachycardia means “fast heart.”
- Sinus tachycardia has a normal P-QRS-T pattern, and the rhythm is regular.
Figure 6-3. Sinus tachycardia. Rate is about 100 beats per minute.
Sinus Arrhythmia

- In sinus arrhythmia the heart rate varies by more than 10% from beat to beat.
- The P-QRS-T pattern is normal, but the interval between groups of complexes (e.g., R-R intervals) varies.
Figure 6-4. Sinus arrhythmia. Note the varying R-R interval.
Atrial Flutter

- In atrial flutter the normal P wave is absent and replaced by two or more regular sawtooth waves.
- The QRS complex is normal, and the ventricular rate may be regular or irregular.
- The atrial rate is usually constant, 250 to 350 bpm, whereas the ventricular rate is in the normal range.
Figure 6-5. Atrial flutter. Atrial rate is greater than 300 bpm; ventricular rate is about 60 bpm.
Atrial Fibrillation

- In atrial fibrillation the atrial contractions are disorganized and ineffective, and the normal P wave is absent.
- The atrial rate ranges from 350 to 700 bpm.
- The QRS complex is normal, and the ventricular rate ranges from 100 to 200 bpm.
Figure 6-6. Atrial fibrillation.
Premature Ventricular Contractions

- The premature ventricular contraction (PVC) is not preceded by a P wave.
- The QRS complex is wide, bizarre, and unlike the normal QRS complex.
- The regular heart rate is altered by a PVC.
- The heart rhythm may be very irregular when there are many PVCs.
Figure 6-7. Premature ventricular contraction.
Ventricular Tachycardia

- In ventricular tachycardia, the P wave is generally indiscernible and the QRS complex is wide and bizarre in appearance.
- The T wave may not be separated from the QRS complex.
- The ventricular rate ranges from 150 to 250 bpm.
- The rate may be regular or slightly irregular.
- Blood pressure is often decreased during ventricular tachycardia.
Figure 6-8. Ventricular tachycardia.
Ventricular Flutter

- In ventricular flutter the QRS complex has the appearance of a wide sine wave.
  - Regular, smooth, rounded wave
- The rhythm is regular or slightly irregular.
- The rate is 250 to 350 bpm.
- There is usually not discernible peripheral pulse associated with ventricular flutter.
Figure 6-9. Ventricular flutter.
Ventricular Fibrillation

- Ventricular fibrillation is characterized by chaotic electrical activity and cardiac activity.
- The ventricles literally quiver out of control, with no perfusion beat-producing rhythm.
- There is no cardiac output or blood pressure.
  - The patient will die in minutes without treatment.
Figure 6-10. Ventricular fibrillation and asystole.
Asystole (Cardiac Standstill)

- Asystole is the complete absence of electrical and mechanical activity.
- Cardiac output stops, and the blood pressure falls to zero.
- The ECG tracing appears as a flat line.
Figure 6-10. Ventricular fibrillation and asystole.
Noninvasive Hemodynamic Monitoring Assessments

- Hemodynamics are defined as forces that influence the circulation of blood.
- The general hemodynamic status of the patient can be monitored noninvasively at the bedside by assessing the:
  - Heart rate
  - Blood pressure
  - Perfusion state
Invasive Hemodynamic Monitoring Assessments

- Invasive hemodynamic monitoring is used in the assessment and treatment of critically ill patients. Invasive hemodynamic monitoring includes:
  - Intracardiac pressures and flows via a pulmonary artery catheter
  - Arterial pressure via arterial catheter
  - Central venous pressure via a venous catheter
Pulmonary Artery Catheter

- The pulmonary artery catheter (Swan-Ganz) is a balloon-tipped, flow-directed catheter that is inserted at the patient bedside.
- Directly measures the:
  - Right atrial pressure
  - Pulmonary artery pressure
  - Left atrial pressure
  - Cardiac output
Figure 6-11. Insertion of the pulmonary catheter. The insertion site of the pulmonary catheter may be the basilic, brachial, femoral, subclavian, or internal insertion sites. As the catheter advances, pressure readings and waveforms are monitored to determine the catheter's position as it moves through the right atrium (RA), right ventricle (RV), pulmonary artery (PA), and finally into a pulmonary capillary wedge pressure (PCWP) position. Immediately after a PCWP reading, the balloon is deflated to allow blood to flow past the tip of the catheter. When the balloon is deflated, the catheter continuously monitors the pulmonary artery pressure.
Arterial Catheter

- The most commonly used mode of invasive hemodynamic monitoring

- Measures:
  - Continuous systolic, diastolic, and mean arterial blood pressure
  - Fluctuations in blood pressure
  - Data for guidance of therapy decisions for hypotension or hypertension
Central Venous Pressure Catheter

- The central venous pressure catheter measures the central venous pressure (CVP) and right ventricular filling pressure.
<table>
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<tr>
<th>Hemodynamic Value</th>
<th>Abbreviation</th>
<th>Normal Range</th>
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<tr>
<td>Central venous pressure</td>
<td>CVP</td>
<td>0-8 mm Hg</td>
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<tr>
<td>Right atrial pressure</td>
<td>RAP</td>
<td>0-8 mm Hg</td>
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<td>Mean pulmonary artery pressure</td>
<td>PA</td>
<td>10-20 mm Hg</td>
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<td>Pulmonary capillary wedge pressure</td>
<td>PCWP</td>
<td>4-12 mm Hg</td>
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<td>(also called pulmonary artery wedge; pulmonary artery occlusion)</td>
<td>PAW</td>
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<td>Cardiac output</td>
<td>CO</td>
<td>4-6 L/min</td>
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Table 6-1. Hemodynamic Values Measured Directly
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<th>Hemodynamic Value</th>
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<th>Normal Range</th>
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<tr>
<td>Stroke volume</td>
<td>SV</td>
<td>40-80 ml</td>
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<td>Stroke volume index</td>
<td>SVI</td>
<td>40 ± ml/beat/m²</td>
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<td>Cardiac index</td>
<td>CI</td>
<td>3.0 ± 0.5 L/min/m²</td>
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<td>Right ventricular stroke work index</td>
<td>RVSWI</td>
<td>7-12 g/m²</td>
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<td>Left ventricular stroke work index</td>
<td>LVSWI</td>
<td>40-60 g/m²</td>
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<td>Pulmonary vascular resistance</td>
<td>PVR</td>
<td>50-150 dynes × sec × cm⁻⁵</td>
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<td>Systemic vascular resistance</td>
<td>SVR</td>
<td>800-1500 dynes × sec × cm⁻⁵</td>
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Table 6-2. Hemodynamic Values Calculated from Direct Hemodynamic Measurements
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<tr>
<th>Disorder</th>
<th>CVP</th>
<th>RAP</th>
<th>PA</th>
<th>PCWP</th>
<th>CO</th>
<th>SV</th>
<th>SVI</th>
<th>CI</th>
<th>RVSWI</th>
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<td>Cystic fibrosis</td>
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<td>Lung collapse</td>
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<td>Hypervolemia (burns)</td>
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<td>Right heart failure (cor pulmonale)</td>
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* — Unchanged.

Table 6-3. Hemodynamic Changes Commonly Seen in Respiratory Diseases

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