Learning Objectives
- Describe myocardial tissue electrical activity
- Trace electrical conduction through the heart.
- Identify electrode locations for common ECG leads.
- Analyze the components of a normal ECG.
- Identify common dysrhythmias on an ECG monitor.

Chemical Basis for Electrical Activity
Resting potential - cell interior negative, in relation to exterior

Electrochemical Basis For ECG
Na+, Ca++ channels open ==> influx of + ==> negative charge external cell ==>
current ==> conduction & contraction

Electrochemical Basis For ECG
Refractory period - K+ enters cell & restores action potential

Conduction Pathway
atrial and interatrial conduction tracts

SA node
AV junction
Conduction Pathway

Conduction Pathway

Pacemaker Cells

△ Automatic rates for different sites
► SA node = 60-100 / min
► AV node = 40-60 / min
► Bundle branches = 30-40 / min

Pacemakers

△ Beats that originate outside the SA node are 'ectopic'
△ Escape beats originate from alternate sites when higher ones are depressed.

ECG Waves

Depolarization of ventricles
Depolarization of atria
Repolarization of ventricles

ECG Wave Intervals

PR (0.12-0.20 sec.)
ECG Wave Intervals

- QRS (< 0.12 sec.)

ECG Leads and Waves

- Direction of depolarization
- Upward deflection of P, QRS, T

ECG Electrode Placement

- Lead 1
  + under L clavicle
  - under R clavicle

- Lead 2
  + under L pectoral
  - under R clavicle
ECG Electrode Placement

- Lead 3
  + under L pectoral
  - under L clavicle

- MCL
  + R sternum, 4th intercostal
  - under L clavicle

Rhythm Analysis

ECG Analysis Steps

- Lead
  - usually lead II or III
- Rate- five large boxes = 1.0 sec
  - six second tracing & multiply R waves by ten
  - count large squares between R waves and divide into 300
- Regularity- compare distances between QRS complexes

ECG Analysis Steps

- P wave
  - absent ==> beats are ectopic or rate is excessive
  - tall or wide ==> atrial enlargement

- PR interval
  - short (<0.12 sec) ==> Wolf-Parkinson White (WPW) syndrome
  - prolonged (>0.2 sec) ==> AV block
ECG Analysis Steps

Δ PR relationship
◆ more P than QRS =>
  ➤ AV block
  ➤ atrial flutter with block
◆ absent P wave =>
  ➤ hidden by QRS complex
  ➤ ectopic rhythm

ECG Analysis Steps

Δ QRS complex
◆ interval >0.12 =>
  ➤ bundle branch block
  ➤ ectopic beat
  ➤ electrolyte imbalance

Δ ST segment- should be flat
◆ elevation => ischemia
◆ depression => ischemia

Δ T wave- should be same direction as QRS
◆ inversion => evolving infarction
◆ tall => electrolyte imbalance

Interpret, with consideration to:
◆ medical history
◆ general clinical status
◆ electrolyte balance
◆ artifacts
◆ equipment calibration and adjustment

Dysrhythmias
Sinus Dysrhythmias
- Sinus bradycardia
  - beats originate in SA node
  - normal wave configurations
  - rate < 60/min

Sinus Dysrhythmias
- Sinus tachycardia
  - beats originate in SA node
  - normal wave configurations
  - rate > 100/min

Sinus Dysrhythmias
- Sinus dysrhythmia
  - beats originate in SA node
  - normal wave configurations
  - irregular rhythm

Atrial Dysrhythmias
- Paroxysmal atrial tachycardia (PAT)
  - ectopic atrial focus initiates beats
  - type of paroxysmal supraventricular tachycardia (PSVT)
  - sudden onset
  - spontaneous termination
  - rate > 150/min

Atrial Dysrhythmias
- Atrial flutter
  - sawtooth atrial waves
  - associated with pulmonary disease
  - promotes thrombus formation
  - atrial rate 180-300/min
  - usually four atrial waves per QRS

Atrial Dysrhythmias
- Atrial fibrillation
  - non-discernible P waves
  - promotes thrombus formation
Atrial Dysrhythmias
- Premature atrial complex (PAC)
  - normal beat inserted between other beats
  - normal waves and configurations

Junctional (Nodal) Dysrhythmias
- Junctional rhythms
  - slow rhythm - due to suppression of SA node
  - junctional tachycardia - type of PSVT

Premature junctional complexes
- beat originates in AV node
- P wave may be inverted
- P wave may appear after QRS

Ventricular Dysrhythmias
- Premature ventricular complexes (PVC)
  - beat originates in ventricle
  - P wave is absent
  - wide QRS complex
  - compensatory pause before next regular beat

Premature ventricular complexes (PVC)
- unifocal - similar configurations ==> one damaged area
- multifocal - variable configurations ==> more than one damaged area

Premature ventricular complexes (PVC)
- frequency
  - isolated
  - every third - trigeminy
  - every other - bigeminy
  - couplet = two, triplet = three
  - every - ventricular tachycardia
### Ventricular Dysrhythmias

<table>
<thead>
<tr>
<th>Premature ventricular complexes (PVC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>increased frequency ==&gt; increased risk for R on T and ventricular tachycardia (VT)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ventricular tachycardia</th>
</tr>
</thead>
<tbody>
<tr>
<td>all beats originate in ventricle</td>
</tr>
<tr>
<td>wide QRS complexes</td>
</tr>
<tr>
<td>P waves are absent</td>
</tr>
<tr>
<td>torsades des pointes- type of VT caused by hypomagnesemia</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ventricular fibrillation (VF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>rapid, irregular rhythm</td>
</tr>
<tr>
<td>coarse to fine complexes</td>
</tr>
</tbody>
</table>

### Heart Block

<table>
<thead>
<tr>
<th>First degree block</th>
</tr>
</thead>
<tbody>
<tr>
<td>benign</td>
</tr>
<tr>
<td>PR interval &gt; 0.20 sec.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second degree block- Mobitz type one</th>
</tr>
</thead>
<tbody>
<tr>
<td>progressive lengthening of PR, then dropped beat</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Blockage of conduction between atria and ventricles at:</th>
</tr>
</thead>
<tbody>
<tr>
<td>lower atrial tissue</td>
</tr>
<tr>
<td>AV node</td>
</tr>
<tr>
<td>Bundle of His</td>
</tr>
<tr>
<td>Bundle branches</td>
</tr>
</tbody>
</table>
### Heart Block
- **Second degree block - Mobitz type two**
  - constant PR intervals
  - beats dropped at fixed ratio
  - often occurs with bundle branch block

- **Third degree (complete) block**
  - slow ventricular rate
  - no consistent association between P wave and QRS complex
  - associated with bundle branch block

### Heart Block
- **Bundle branch block**
  - slow ventricular rate
  - wide, notched QRS complex

### Artificial Pacemakers
- **Pacemaker create spikes in waves**
  - atrial pacemaker
  - ventricular pacemaker
  - failure to pace

### Artifact
- **Patient movement causes abnormal waves**

### Review & Summary
- **ECG trace is result of electrical conduction through heart.**
- **ECG comprised of waves and intervals between waves.**
- **Sinus dysrhythmias**
  - bradycardia
  - tachycardia
  - dysrhythmia
**Review & Summary**

**Atrial dysrhythmias**
- PAT, PSVT
- atrial flutter
- atrial fibrillation
- premature atrial contractions

**Junctional (nodal) dysrhythmias**
- premature junctional complex
- junctional rhythms

**Ventricular dysrhythmias**
- premature ventricular contractions
- ventricular tachycardia
- ventricular fibrillation

**Heart block**
- first degree
- second degree, Mobitz I
- second degree, Mobitz II
- third degree (complete)
- bundle branch

**Pacemaker beats**
- atrial
- ventricular

**Artifact**

**References**

- Elstun LR. Electrocardiography and cardiac monitoring, Chap 7 in Chang DW, Elstun LR, Jones AP. The multiskilled respiratory therapist: A competency-based approach 2000: FA Davis; Phila.