EKG “Show and Tell”

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What will I have to know about ECGs?

- ECG-Physiology correlation
  - Recognize what each component of the EKG represents

- ST elevation
  - Distinguish ST elevation MI from other causes of ST segment elevation

- “ Syndromic EKGs”
  - Recognize the classic EKG manifestations of medical conditions

Deflections on ECG and Timing

ECG normal values and pathologic correlates

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Normal range</th>
<th>Pathologic states</th>
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<tbody>
<tr>
<td>Rate</td>
<td>60-100</td>
<td>&lt;60: bradycardia (athletes, elderly, heart block, hypothyroidism) &gt;100: SVT, VT, Sinus tachycardia</td>
</tr>
<tr>
<td>PR interval</td>
<td>0.12-0.2 sec</td>
<td>&gt;0.12 = WPW .2 = 1st degree block or higher</td>
</tr>
<tr>
<td>QRS duration</td>
<td>Up to 0.12 sec</td>
<td>&gt;0.12 = wide complex (bundle branch block, ventricular beats, WPW-delta, severe hyperkalemia)</td>
</tr>
<tr>
<td>QT interval</td>
<td>Correct for underlying rate: QT/√RR interval</td>
<td>&gt;450-470: acquired or congenital Long QT, hypokalemia, hypomagnesemia, ischemia, neurologic catastrophe.</td>
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Action Potential And QRS-T

Hypokalemia
- Wimpy outward flow of positive ions
- Long, broad QT low amplitude
**Action Potential And QRS-T**

Moderate Hyperkalemia
Strong outward flow of positive ions

Peaked T Waves

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44 y/o male who missed 3 dialysis sessions

Hyperkalemia. K=7.8 mmol/L.

Peaked T waves

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Worsening hyperkalemia

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Severe hyperkalemia

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Severe hyperkalemia

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72 y/o male with fatigue and ABD pain

Hypercalcemia - Calcium= 14.2 mg/dL.

Very short Q'interval.
Hypercalcemia:
• QT shortening due to shortening of ST segment (phase II of cardiac action potential)
• Little effect on P, QRS or T

Electrolytes and prolonged QT interval

Electrolyte abnormalities that can prolong the QT interval:
1. Hypokalemia
2. Hypocalcemia
3. Hypomagnesemia

83 y/o female s/p aortic root repair. Had an episode of atrial fibrillation during surgery. We were consulted for management of atrial fibrillation. Post-operative EKG is obtained:

Prolonged QT interval
CNS injury pattern- intracranial hemorrhage!
Deep, inverted T waves

73 y/o female on azithromycin for bronchitis, asymptomatic.

Drug-induced prolonged QT interval.

Torsades de pointes

43 y/o female with long QT syndrome... genetically proven.
**Congenital Long QT Pearls**

<table>
<thead>
<tr>
<th>Type</th>
<th>freq</th>
<th>channel involved</th>
<th>known triggers</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>most common</td>
<td>Potassium Channel (Ks, one active at fast rates)</td>
<td>Exercise</td>
</tr>
<tr>
<td>II</td>
<td>rare</td>
<td>Potassium Channel (Kr, one active at slow rates)</td>
<td>Emotion</td>
</tr>
<tr>
<td>III</td>
<td>very rare</td>
<td>Sodium Channel</td>
<td>Sleep</td>
</tr>
</tbody>
</table>

**Management:**
- Beta blockers
- Restrict exercise
- Send to electrophysiologist to discuss gene testing, ICD, etc.

**Digitalis Effect:**
- ST segment depression with upward concavity
- Shortened QT interval
- PR can be lengthened

**Digitalis Toxicity:**
- Digitalis effect + arrhythmia
- Typical arrhythmias:
  - PAT with block
  - Atrial fibrillation with complete heart block
  - Second or third degree AV block
  - Accelerated junctional or idioventricular rhythm
  - SVT with alternating bundle branch block

**34 y/o female presents with cough and dyspnea.**

S1Q3T3 = McGinn-White Sign
Very specific, not very sensitive!
Most common EKG finding in PE is sinus tachycardia.

**34 y/o male found down in December in Milwaukee.**

Digitalis toxicity.
Different types of ST segment elevation

- Myocardial injury
- Early repolarization
- Pericarditis

42 y/o healthy, asymptomatic male

Early repolarization - benign finding (usually)

42 y/o male with DM, HTN, substernal chest pain

Acute inferior myocardial infarction

Pericarditis - Diffuse ST segment elevation usually indicates that an infarct is NOT present.

53 y/o female with melanoma, SOB

Pericardial effusion - QRS alternans is caused by swinging motion of the heart within the distended pericardium. Tamponade MAY be present. Other common findings are sinus tachycardia, distended neck veins, pericardial rub.

42 y/o male pleuritic chest pain, fevers

“Syndromic ECG’s”

<table>
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<th>Syndrome Type</th>
<th>ECG findings</th>
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<tr>
<td>Hyperkalemia</td>
<td>Peaked, painful T waves, Broad bizarre QRS</td>
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<tr>
<td>Hypokalemia</td>
<td>Long, flat QT, U waves, Low amplitude p waves</td>
</tr>
<tr>
<td>Hypothermia</td>
<td>Bradycardia, tremor artifact, Osborne waves</td>
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<tr>
<td>Acute Pulmonary Embolism</td>
<td>Sinus tachycardia, RV strain, &quot;S1Q3T3&quot; pattern</td>
</tr>
<tr>
<td>Cerebral Hemorrhage</td>
<td>Diffuse symmetric inverted T waves, Long QT</td>
</tr>
<tr>
<td>Hyper/Hypocalcemia</td>
<td>Short/Long QT at expense of ST seg.</td>
</tr>
</tbody>
</table>
Early Repol: usually asymptomatic males

Pericarditis: diffuse ST elevation, some PR depression, ping pong ball would rest in the ST segment

Hypercalcemia: QT is SHORT at the expense of the ST segment.

Hyperkalemia, severe: the QRS duration prolonged, usually K>8.0mM. This is due to very high levels of K causing inactivation of sodium channels (and thus widening the QRS).

Digitalis toxicity: ST segments scooped. Atrial arrhythmias (fast or slow) are common.

Pulmonary embolism: Sinus tachycardia. Rare but specific S1,Q3, T3 pattern.