Disclosures

• None
Clinical Use of the ECG

- Presence or absence of "structural heart disease"
- Chest pain
- Current Arrhythmia
- "Orphans" "Now that’s Interesting"

- Syncope
- Palpitations
- SOB/fatigue
- Ischemia
- Other
- Bradycardia
- Tachycardia
- Palpitations
ECG evaluation in the patient with chest pain

Careful evaluation of symptoms is the most important diagnostic tool

- Characteristic changes with myocardial injury
- “Fake-outs”

**T wave abnormalities**
- New or dynamic
- Q waves
- Localized T wave peaking

**ST segment depression**
- New or dynamic
- Q waves

**ST segment elevation**
- Anatomic distribution
- Reciprocal changes
- Q waves

Left bundle branch block and LVH make the presence of cardiac disease more likely but make the ECG more difficult and sometimes impossible to evaluate.
Case #1: 46 year old policeman with "burning" in the chest when riding a bicycle.
Case #1 (continued): “Burning” has resolved
Case #1 (continued): “Burning” has resolved

**Dynamic ST/T changes with symptoms/resolution of symptoms are important**
Ischemia leads to “localized hyperkalemia”
Case #2: 54 year old woman with 4 hours of chest pain presents in the ER
Regionalization/Localization of ST/T Changes (particularly ST segment elevation)

- Anterior
- Inferior
- Lateral
Case #2: 54 year old woman with 4 hours of chest pain presents in the ER
Case #2 (continued): Cardiac catheterization laboratory
Case #2 (continued): Day #1
Case #2 (continued): Day #2
• Dynamic Changes with symptoms
• Regionalization
• Reciprocal changes
LAD obstruction
“T wave follows the QRS complex”
Electrophysiologic mechanism
“In conduction block, the T wave is opposite the QRS complex”
ST segment elevation

- Characteristic changes with myocardial ischemia/injury
  - Dynamic changes with Sx
  - Localization to a specific region of the heart
  - Always look for ST segment elevation first
  - Reciprocal changes

- "Fake-outs"
ST segment elevation

• Characteristic changes with myocardial ischemia/injury
  • Dynamic changes with Sx
  • Localization to a specific region of the heart
  • Always look for ST segment elevation first
  • Reciprocal changes

• “Fake-outs”
Case #3: 73 year old woman with a prior MI but no chest pain
Pericarditis:
1. Diffuse ST elevation
2. PR segment depression
3. No Q waves
4. aVR: PR segment elevation & ST depression
Early repolarization:
1. Prominent T’s relative to the ST
2. No reciprocal changes
3. No Q waves
Non-infarction causes of ST segment elevation

• Cardiac
  • Bundles (Pacing), early repolarization
  • Aneurysm
  • Coronary artery Spasm (Printzmetal’s angina)
  • Pericarditis
  • Brugada Syndrome
  • LVH

• Noncardiac
  • Metabolic: Hyperkalemia, Hypercalcemia
  • Pneumothorax
Myocardial injury

Pericarditis

Early repolarization

Aneurysm

Kusumoto, ECG Interpretation: From Pathophysiology to Clinical Application 2009
Clinical Use of the ECG

Presence or absence of “structural heart disease”

Chest pain

Current Arrhythmia

“Orphans” “Now that’s Interesting”

Syncope
Palpitations

Ischemia

Bradycardia
Tachycardia

“You are not really having fun until your heart rate is twice normal”

Keith Oken, 2nd Yr Medicine
Resident UCSF
Wide Complex Tachycardia
(Only four kinds of tachycardia)

VT

SVT with aberrancy

Anterograde AP conduction
Causes of WCT

- Ventricular tachycardia
- SVT with aberrant conduction
- Anterograde AP conduction
- Ventricular pacing
- (Metabolic)
Causes of WCT

- Ventricular tachycardia 81%
- SVT with aberrant conduction 14%
- Anterograde AP conduction 5%
- Ventricular pacing 0%
- (Metabolic) 0%

Of the patients with VT:
- VT 32%

Ahktar’s Rule: “Do you have Heart Disease?” or “Have you had a Heart Attack?”

Ahktar et al Ann Int Med 1988
ECG evaluation of WCT

- “Homan’s signs”
- A-V relationship
- QRS morphology
- Algorithms
ECG evaluation of WCT

• “Homan’s signs”
• A-V relationship
• QRS morphology
• Algorithms
ECG evaluation of WCT

- “Homan’s signs”
  - Rate, regularity
  - Axis (“Northwest” Axis)
  - QRS width (“Wider QRS α Disease”)
- A-V relationship
- QRS morphology
- Algorithms
ECG evaluation of WCT

• “Homan’s signs”
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ECG evaluation of WCT

- “Homan’s signs”
- A-V relationship
  - Use a wide angle lens
  - Initiation?
  - Look for AV dissociation, not AV association”
- QRS morphology
- Algorithms
ECG evaluation of WCT

• “Homan’s signs”
• A-V relationship
  • Use a wide angle lens
  • Initiation?
  • Look for AV dissociation, not AV association”
• QRS morphology
• Algorithms
Concordance

- Precordial QRS complexes all in the same “direction.”

Positive concordance  

Negative concordance
“RBBB Morphology”

$V_1$  
$V_6$

$\{ \}$ $VT$

$\{ \}$ $SVT$
“LBBB morphology”

V₁

R > 30 ms

“Notch”

R-S > 70 ms
ECG evaluation of WCT

• “Homan’s signs”
• A-V relationship
• QRS morphology
  • Concordance
  • “plump” initial deflection
  • “Aberrancy looks like aberrancy”
• Algorithms
What to do?
“A practical approach?”

• Pretest probability
• AV Dissociation
• QRS morphology (aberrancy looks like aberrancy):
  • Concordance
  • Positive in aVR
  • “Plump” initial activation
• Acknowledge shortcomings, treat acutely as VT, EPS?
1. Atrial fibrillation with RBBB
2. Multifocal atrial tachycardia with RBBB
3. Ventricular tachycardia
“Wide, irregular, and very very fast”
Wide Complex Tachycardia

Accessory pathway–mediated tachycardias

Orthodromic atrioventricular reentrant tachycardia

Antidromic atrioventricular reentrant tachycardia

Atrial fibrillation with activation of the ventricles via the accessory primary and the AV node

Kusumoto FM, Cardiovascular Pathophysiology Hayes Barton Press 2004
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ECG Interpretation for the Internist: ST changes and Ischemia

• Clinical story first, ECG is adjunctive at best
• Normal Repolarization (T waves)
• Characteristic changes with myocardial ischemia/injury
  • Dynamic changes with Sx
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ECG Interpretation for the Internist: ST changes and Ischemia

- Clinical story first, ECG is adjunctive at best
- Normal Repolarization (T waves)
- Characteristic changes with myocardial ischemia/injury
- “Fake-outs”
  - Aneurysm
  - Pericarditis
  - Early Repolarization
  - Metabolic (Hyperkalemia, Hypercalcemia)
ECG Summary: “A practical approach?”

• Pretest probability/pacemaker?
• AV Dissociation
• QRS morphology (aberrancy looks like aberrancy):
  • Concordance
  • Positive in aVR
  • “Plump” initial activation
• Acknowledge shortcomings (understand the algorithms)
• Treat acutely as VT, EPS?