Office ECG Interpretation

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Outline of topics

- High risk ischemia
- T wave inversions
- LBBB / RBBB / RVOT PVC
- Atrial activity detection
- ECGs in the young adult at risk for SCD

Acute Coronary Syndrome

Unstable Angina / NSTEMI

STEMI

Time is Myocardium

Key to ECG Diagnosis:
- ST segment elevation
  (in contiguous leads / in arterial distribution)
- Reciprocal changes

48 y/o with CP

Sinus arrhythmia
Inferior AMI

Note:
- Inferior STE can be subtle
- Look for Reciprocal changes in aVL
• Sinus tach
• Posterior MI, acute or recent

66 y/o male with CP and diaphoresis

Key:
- With ST segment depression in V1-V3, consider posterior STEMI
- R wave in these leads can represent posterior Q waves

66 y/o male with CP and diaphoresis
53 y/o DM presents with CP

- SR
- LAFB
- ST changes suggest ischemia

Key:
- diffuse ST segment Depression with STE in aVR suggests multivessel / LM disease

ST segment elevation

Differential Diagnosis of ST segment elevation
- Myocardial injury / infarction from acute vessel occlusion
- Prinzmetal angina
- Post-myocardial infarction: from ventricular aneurysm
- Acute pericarditis
- Normal Variant such as early repolarization pattern
- Repolarization from LVH and LBBB
- Intracranial hemorrhage (typically with deep TW inversion)
- Takotsubo's cardiomyopathy
- Brugada pattern (RBBB-pattern with STE in precordial leads
- Acute pulmonary embolism (right precordial leads)

Modified from Braunwald’s Heart Disease: A Textbook of Cardiovascular Medicine, Tenth Ed. Pg 145

42 y/o with chest pain

- Sinus Tachycardia
- Acute Pericarditis

Key:
- Diffuse ST segment elevation
- No reciprocal changes
- PR depression (PRE in aVR)

T wave inversion

- Normal ECG

Key:
- Normally T wave is inverted in V1, aVR, and often III
- If upright in V1 can be sign of ischemia
- Juvenile T waves: inverted V1-V3
61 y/o with CP and elevated trop

- SR
- LVH
- ST changes secondary to LVH
- LA abnormality

Key:
- DX based on voltage criteria of QRS
- Supported by other characterizations (LAE, LAD, secondary ST-T wave abnormalities, prolonged intrinsoid defect)

LVH

Key:
- Sensitivity <50%, specificity can be >85%
- Limitations include young age, body habitus

ST-T wave abnormality secondary to...

Left ventricular hypertrophy

Ischemia

LVH

Criteria

| Cornell criteria | S in V3 + R in aVL ≥ 28 mm (men) |
| S in V3 + R in aVL ≥ 20 mm (women) |

| Sokolow-Lyon criteria | S in V1 + R in V5 or V6 > 35 mm |
| R in aVL > 11 mm |

| Romhilt-Estes point system | Any limb lead R wave or S wave > 20 mm (3 points) |
| or S in V1 or S in V2 ≥ 30 mm (3 points) |
| or R in V5 or V6 ≥ 30 mm (3 points) |
| ST-T wave abnormalities (not on dig) (3 points) |
| LA abnormalities (3 points) |
| LAD ≥ 30 degrees (2 points) |
| QRS duration ≥ 90 msec (1 point) |
| Intrinsoid defect in V5 or V6 ≥ 50 msec (1 point) |

Modified from Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine, Tenth Ed. Pg 129
Sinus bradycardia
- LBBB

49 y/o CAD history

- QRS > 120 ms
- Broad, notched or slurred R wave in I, aVL, V6. Deep S wave V1, V2
- Absence of septal q waves in I, V5, V6 prolonged intrinsicoid deflection
- Secondary ST / T wave abnormalities
- Typically LAD

LBBB: additional notes

- ~1% of general population
- Following AMI, myocarditis (sarcoidosis)
- Functional / rate-related (long-short)
- Prognosis:
  - Depends on type / severity of any concurrent underlying heart disease / other conduction disease
  - Independent predictor of all-cause mortality in pts with CAD, after MI, with congestive heart failure

57 y/o with sarcoidosis, presents with near syncope

- SR with 1st degree AV block
- RBBB
- Left posterior fascicular block

RBBB: additional notes

- Can be associated with structural heart disease (cor pulmonale, PE, myocarditis, HTN, CHD)
- Does not interfere with DX of MI b/c the initial 0.04 sec forces are normal
- Can exercise with stress testing

- Challenging in pts with chest pain
- Should lead to evaluation of HTN, CAD, CM
- CRT if EF <35%
- Abnormalities in coronary blood flow
  - Vasodilator stress

- Prognosis tied to underlying heart disease (excellent with structurally normal heart)
- Mimickers such paced rhythm, Brugada

- Can exercise with stress testing
56 y/o with palpitations

- SR
- Frequent monomorphic PVCs

Keys to RVOT tachycardia / PVCs
- PVCs / VT in left bundle morphology, inferior axis, with transition V2-V3
- Typically structurally normal heart
- Can be amenable to ablation

74 y/o with palpitations

- A flutter
- AV block 2:1

Key:
- Suspect atrial flutter when the ventricular rate is ~150 bpm
- Search for P waves (hidden in ST-segment / T waves)
- Flutter waves obscure ST segment

21 y/o women

- SVT (likely AVNRT)

Key:
- Find the P wave (compare to previous ECG for r')
- Assess how close the P wave is to the QRS complex (short RP tach)

72 y/o, NICM, ICD

- Ventricular paced rhythm
- Atrial fibrillation

Key:
- In patients with ventricular paced rhythm, look for atrial activity
- The “computer” often “misses” atrial fibrillation in this setting
34 y/o male; insurance exam

- WPW pattern
- Sinus rhythm

Key:
- Delta wave
- Short PR interval
- Can mimic MI

22 y/o with syncope

- Sinus rhythm
- Brugada Pattern (type I)

Key:
- RBBB with STE in the right precordium
- Can have variable morphologies
- Risk for VF and SCD

Brugada Syndrome (BrS). Expert Consensus Recommendations on BrS Diagnosis

1. BrS is diagnosed in pts with ST segment elevation with type 1 morphology ≥ 2 mm in ≥ 1 lead among the right precordial leads (V1, V2), positioned in the 2nd, 3rd, or 4th intercostal space occurring either spontaneously or after provocative drug test with IV administration of Class I antiarrhythmic drugs.

2. BrS is diagnosed in pts with type 2 or type 3 ST-segment elevation in ≥ 1 lead among the right precordial leads (V1, V2), positioned in the 2nd, 3rd, or 4th intercostal space when a provocative drug test with IV administration of Class I antiarrhythmic drugs induces a type I ECG morphology.

Type 2 Type 3

37 y/o with congenital QT prolongation

- Sinus rhythm
- Prolonged QT

Key:
- Measure longest QT (well seen)
- Assess for secondary causes (medications / electrolytes)
- QTc = QT interval / √ RR interval

2013 HRS / EHRA/APHRS Expert Consensus Statement on the Diagnosis and Management of Patients with Inherited Primary Arrhythmia Syndromes

Brugada syndrome. Orphaned J Rare Dis. 2006 Sep 14;1:35 (CC BY 2.0)


*Courtesy (with permission) of Eric S Williams, MD from University of Indiana
Long QT Syndrome (LQTS) Expert Consensus Recommendations on LQTS Diagnosis

1. LQTS is diagnosed:
   a. In the presence of a LQTS risk score of ≥ 3.5 in the absence of a secondary cause for QT prolongation and/or
   b. In the presence of an unequivocally pathogenic mutation in one of the LQTS genes or
   c. In the presence of a QT interval corrected for HR using Bazett’s formula (QTc) ≥ 500 msec in repeated 12 lead ECGs, and in the absence of a secondary cause for QT prolongation.

2. LQTS can be diagnosed in the presence of a QTc btw 480-499 msec in repeated 12 lead ECGs in a patient with unexplained syncope in the absence of a secondary cause for QT prolongation and in the absence of a pathogenic mutation.

1993-2011 LQTS Diagnostic Criteria

<table>
<thead>
<tr>
<th>Findings Points</th>
<th>Points</th>
</tr>
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<tbody>
<tr>
<td>A. QTc (in the absence of medications known to affect these ECG features)</td>
<td></td>
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<tr>
<td>≥ 480 msec</td>
<td>3</td>
</tr>
<tr>
<td>460-479 msec</td>
<td>2</td>
</tr>
<tr>
<td>450-459 msec (in males)</td>
<td>1</td>
</tr>
<tr>
<td>B. QTc 4th min of recovery from exercise</td>
<td>2</td>
</tr>
<tr>
<td>C. Torsades de pointes</td>
<td>1</td>
</tr>
<tr>
<td>D. T wave alternans</td>
<td>1</td>
</tr>
<tr>
<td>E. Notched T wave in 3 leads</td>
<td></td>
</tr>
<tr>
<td>F. Low HR for age</td>
<td>0.5</td>
</tr>
<tr>
<td>Clinical History</td>
<td></td>
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<tr>
<td>A. Syncope</td>
<td>2</td>
</tr>
<tr>
<td>With stress</td>
<td>1</td>
</tr>
<tr>
<td>Without stress</td>
<td></td>
</tr>
<tr>
<td>B. Congenital Deafness</td>
<td>0.5</td>
</tr>
<tr>
<td>Family History</td>
<td></td>
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<tr>
<td>A. Family members with definite LQTS</td>
<td>1</td>
</tr>
<tr>
<td>B. Unexplained SCD below the age of 30 in immediate family member</td>
<td>0.5</td>
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Key:
- Sinus rhythm
- Short QT

18 y/o

Short QT Syndrome (SQTS). Expert Consensus Recommendation on SCQS

1. SQTS is diagnosed in the presence of a QTc ≤ 330 msec

2. SQTS can be diagnosed in the presence of a QTc < 360 msec and one or more of the following: a pathogenic mutation, family h/o SCD at ≤ 40, survival of a VT / VF episode in the absence of heart disease.

2013 HRS / EHRA/APHRS Expert Consensus Statement on the Diagnosis and Management of Patients with Inherited Primary Arrhythmia Syndromes
Concern for ARVC

Key for Arrhythmogenic RV cardiomyopathy
-Task Force on DX of ARVC (combination of echo, MRI, arrhythmias, conduction abnormalities, BX data, Family HX)
-Epsilon waves (poor sensitivity)
-TW inversion anteroseptal leads
-Late potential on SAECG
-PVCs, VT with left bundle morphology

-Sinus rhythm
-Anterior TW inversion
-PVC in left bundle morphology

21 y/o with exercise induced syncope. MRI, echo, and ECG c/w ARVC

Key for HCM
-ECG is rarely normal, but findings are not often specific
-Can have prominent voltages with repolarization
-Prominent Q waves (inferior and lateral leads)
-LAD
-Deeply inverted T waves with apical variant HCM

51 y/o with syncope. FHX of SCD. Evidence of apical HCM on cardiac MRI

Key for apical HCM
-Deep, symmetrical, inverted T waves anterolateral leads

20 y/o with HOCM. Septal hypertrophy. Peak LVOT gradient 144 mm Hg
**Classification of Heart Block**

<table>
<thead>
<tr>
<th>Classification of Heart block</th>
<th>Notes</th>
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<tbody>
<tr>
<td>First Degree AV Block</td>
<td>PR interval &gt; 200 msec. All P waves followed by QRS complexes</td>
</tr>
<tr>
<td>2nd Degree, Mobitz type I (Wenckebach)</td>
<td>Progressive PR prolongation until a P wave is not conducted</td>
</tr>
<tr>
<td></td>
<td>Note: compare the post non-conducted beat PR interval to the PR interval immediately before</td>
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<tr>
<td></td>
<td>Typically at the level of the AV node</td>
</tr>
<tr>
<td>2nd Degree, Mobitz type II</td>
<td>Intermittent or repetitive non-conducted / dropped beats without prior PR lengthening (fixed PR interval)</td>
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<td>Site of pathology is distal to the AV node</td>
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<tr>
<td>Complete Heart Block</td>
<td>Failure of all P wave to conduct</td>
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**Thank you!**

- jason.evanchan@osumc.edu
- Special thanks to:
  - Dr. Rick (Stephen) Schaal
  - Dr. Eric S. Williams