A Systematic Approach to the 12 Lead EKG

Emily Caldwell, MSN ACNP-BC
Normal EKG
Overview

- Heart Rate
- Rhythm
- Intervals
- Axis
- Voltage
- R Wave Progression
- Q Wave
- ST Segments
- T waves
- Device Involvement
1 large box = 5mm = 0.2 sec
1 small box = 1mm = 0.04 sec
Heart Rate

- Rule of 300- Divide 300 by the number of boxes between each QRS = rate

<table>
<thead>
<tr>
<th>Number of big boxes</th>
<th>Rate</th>
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<tbody>
<tr>
<td>1</td>
<td>300</td>
</tr>
<tr>
<td>2</td>
<td>150</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
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<tr>
<td>4</td>
<td>75</td>
</tr>
<tr>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td>6</td>
<td>50</td>
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</table>
Rhythm

- P:QRS relationship
  - P:QRS = 1
  - P:QRS < 1
  - No P waves (or many)
- Heart Rate
- RR regularity
- P wave morphology
- PR interval
- QRS width
P wave morphology

• Normal P wave duration 80-110 msec
• Upright in I, II, and aVF; upright or biphasic in III, aVL, V1, V2. Small notching may be present.
• Normal amplitude: Limb leads < 2.5mm and V1 positive deflection < 1.5mm and negative deflection < 1mm
• Atrial enlargement- look at leads II, V1 and V2
  – RAE- tall, upright P waves > normal (p-pulmonale)
  – LAE- terminal negative portion of the P wave in V1 >/= 1 mm deep and 40 msec wide and notched P wave with a duration >/= 120msec in II, III, aVF (p-mitrale)
Electrical System of the Heart

- Sinoatrial (SA) Node
- Bachmann's Bundle
- Anterior Internodal Tract
- Left Bundle Branch
- Middle Internodal Tract
- Conduction Pathways
- Posterior Internodal Tract
- Right Bundle Branch
- Atrioventricular (AV) Node
Intervals

- PR: 0.12-0.20 seconds
- QRS: < 0.10 seconds
  - Distinguish between moderate prolongation 0.10-0.12 and marked prolongation 0.12 secs when establishing a differential diagnosis
- Only report QTc- corrects for heart rate
  - Bazett’s Formula
    \[ QT_B = \frac{QT}{\sqrt{RR}} \]
- QTc: 0.35-0.43 seconds for heart rates of 60-100 BPM
QRS Axis

- Represents the major vector of ventricular activation - overall direction of the heart’s activity
- Axis of −30 to +90 degrees is normal
- Consider the differential- early clues - once axis is identified
The Quadrant Approach

- QRS up in I and up in aVF = Normal
QRS Voltage

• Measurement: from baseline to the peak of the R wave or S wave
  – Normal voltage
  – Low voltage: Total QRS (R +S) < 5 mm in all limb leads and < 10 mm in all precordial leads
  – Increased voltage
    • LVH
    • RVH
LVH

• **Precordial Leads** (one or more)
  – R wave in V5 or V6 + S wave in V1
    • > 35mm if age >40
    • > 40mm if age 30-40
    • > 60mm if age 16-30
  – Max R wave + S wave in precordial leads > 45 mm
  – R wave in V5 > 26mm
  – R wave in V6 >20mm
• Also **Limb Lead** criteria
Left Ventricular Hypertrophy
RVH

- Right axis deviation with mean QRS axis ≥ 100°
- Dominant R wave:
  - R wave in V1 ≥ 7 mm
  - rSR’ in V1 with R’ >10mm
  - qR complex in V1
- Secondary ST-T changes in right precordial leads
- RAE is common
RVH
R Wave Progression

- Determine the **precordial transition zone** (R/S = 1)
  - Normal: transition zone = V2-V4
  - Poor RWP: transition zone = V5-V6
  - Early/Reverse RWP: Decreasing R wave amplitude across the precordial leads
Normal EKG
Implanted Cardiac Devices

- Final step if not already identified with rhythm - Is Pacing Present?
- Identify pacing spikes
- EKG rarely identifies a defibrillator
  - Patient history
  - Device interrogation
Implanted Cardiac Devices

- Pacemakers
- Implanted Cardioverter Defibrillators-ICDs
- BiVentricular (BiV) Pacemakers and ICDs
- Implanted Loop Recorders
  *cannot be detected on EKG*
Concepts in Pacing

- 4 Major Functions of a Pacemaker
  - Stimulate cardiac depolarization
  - Sense intrinsic cardiac function
  - Respond to increased metabolic demand by providing rate responsive pacing
  - Provide diagnostic information stored by the pacemaker
Concepts in Pacing

• Types
  – Single Chamber +/- ICD
  – Dual Chamber +/- ICD
  – Dual Chamber Biventricular (3 chambers) +/- ICD

• Problems
  – Loss of Capture
  – Non-sensing
  – Loss of Pacing Artifact
Concepts in Pacing

- Pacemaker “spike”
  - Configuration of the lead
    - Unipolar = Large spike
    - bipolar = Small spike
AV SEQUENTIAL OR DUAL CHAMBER ELECTRONIC PACEMAKER

WHEN COMPARED WITH ECG OF 20-JUN-2013 19:55,

SIGNIFICANT CHANGES HAVE OCCURRED

Confirmed by... on 6/22/2013 11:08:00 AM
03-May-2009 17:23:10

IB-1947 (62 yr)
Caucasion
0b
w423

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Vent. rate</td>
<td>75 BPM</td>
</tr>
<tr>
<td>PR interval</td>
<td>* ms</td>
</tr>
<tr>
<td>QRS duration</td>
<td>192 ms</td>
</tr>
<tr>
<td>QT/QTC</td>
<td>478/533 ms</td>
</tr>
<tr>
<td>F-R-T axes</td>
<td>* 167 79</td>
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</table>

ELECTRONIC VENTRICULAR PACEMAKER
WHEN COMPARED WITH ECG OF 15-APR-2009 06:22,
VENT. RATE HAS INCREASED BY 4 BPM
Confirmed by (Signature-106) on 5/4/2009 7:11:29 PM
Heart Blocks on EKG
Classification of AV Blocks

- **First Degree**
  - PR interval fixed, >0.2 sec
- **Second Degree**
  - Type I (Wenckebach/Mobitz I)
    - PR gradually lengthened, then drop QRS
  - Type II (Mobitz II)
    - PR fixed, QRS drops randomly
- **High degree AV Block**
  - Momentary absence of conduction for several seconds
- **Third Degree, Complete Heart Block**
  - PR and QRS dissociated
82 yo woman presents with fatigue
QRS duration

- Right Bundle Branch Block
- Left Bundle Branch Block
- If QRS duration is 120msec but waveform is not typical of RBBB or LBBB, diagnosis is intraventricular conduction delay
Cardiac Conduction System

- Sinotriual Node (SAN)
- Right Atrium
- Atrioventricular Node (AVN)
- Right Ventricle
- Right Bundle Branch (RBB)
- Left Bundle Branch (LBB)
- Purkinje Fibers (PF)
- Left Atrium
- HIS bundle
- Left Ventricle

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Bundle Branch Blocks

• An obstruction in the transmission of impulses through one of the branches, either the left or the right, of the bundle of His

• A bundle branch block alone is not significant and requires no treatment
  – Understanding causes: MI, many types of heart disease. *Is it new?*
Bundle Branch Blocks - When is it Significant?

• A bundle branch block complicated by a 1\textsuperscript{st}, 2\textsuperscript{nd}, or 3\textsuperscript{rd} degree AV block or by a fascicular block, especially when associated with an acute MI.
Fascicular Blocks (Hemiblocks)

- A fascicle is a bundle of Purkinje fibers – any main division of the ventricular conduction system is a fascicle.
- There are 3 fascicles in the ventricular conduction system:
  - the Right Bundle Branch
  - the Anterior Division of the Left Bundle Branch
  - the Posterior Division of the Left Bundle Branch.
Right Bundle Branch Block

- QRS $\geq$ 120 msec
- Secondary R wave (R’) in V1 and V2 (rsR’ or rSR’)
- Delayed onset of intrinsicoid deflection in V1 and V2
- Secondary ST and T wave changes in V1 and V2
- Wide slurred S wave in I, V5, V6
75 year old man
LAFB- Left Anterior Fascicular Block

- Left axis deviation
  - With no other responsible factors to explain it
- qR complex (or an R wave) in leads I and aVL
- rS complex in lead III
- Normal or slightly prolonged QRS duration
LA FB

Rate 93
PR 178
QRS 112
QT 381
QTC 474

---Axis---
P 233
QRS -52
T 129

- ABNORMAL ECG -

Unconfirmed diagnosis.
LPFB- Left Posterior Fascicular Block

- Right axis deviation
  - With no other responsible factors to explain it
- Normal or slightly prolonged QRS duration
- rS complex in I and aVL
- Tall R wave II, III and aVF
LPFB
Left Bundle Branch Block

• Prolonged QRS duration $\geq 120$ msec
• Delayed onset of intrinsicoid deflection in V5 and V6
• Broad monophasic R waves in I, V5 and V6 that are usually notched or slurred
• Secondary ST and T wave changes opposite in direction to the major QRS deflection
• rS or QS complex in right precordial leads
LBBB
Nonspecific intraventricular conduction delay/disturbance

- QRS $\geq 110$ msec but morphology does not meet criteria for RBBB/LBBB
- Seen with:
  - Antiarrhythmic drug toxicity (esp. IA and IC agents)
  - Hyperkalemia
  - LVH
  - WPW
  - Hypothermia
  - Severe metabolic disturbances
Trifascicular Block

- 1st Degree AV Block
- RBBB
- LAFB or LPFB
- Cardiology referral
  - Is the prolonged PRi due to AV node disease or diffuse distal conduction system disease? only an EP study can differentiate
  - Treatment = Pacemaker, especially if symptomatic
Trifascicular Block
Where is the Block?
Mobitz II

PR intervals constant
60 yo man with lightheadedness
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