EKG Recognition: When to Worry

Roslinde M. Collins, MD, D,ABSM, FCCP, FAASM
Medical Director, Center for Sleep Disorders at Rutland Regional Medical Center in Vermont
rcollins@rrmc.org
NEPS Conference
September 14, 2012
Goals of this lecture

• To gain basic understanding of the electricity of the heart
• To review patterns of arrhythmias
• To know when a rhythm is life threatening or potentially life threatening
• Review special cases such as artificial pacemakers and AICDs
Case #1: Spike Jonze
Lessons Learned from Case #1:

• Keep an eye on your monitors
• It is helpful to hear your alarms
• No singing and dancing and fooling around in the trauma (control) room
• Don’t shock asystole
AASM Cardiac Scoring Rules

• Score **sinus tachycardia** during sleep for a **sustained** sinus heart rate of greater than **90** beats per minute (bpm) for adults

• Score **wide complex tachycardia** for a rhythm lasting a **minimum of 3 consecutive beats** at a rate of greater than **100** bpm with QRS duration of greater than or equal to **120** msec

• Score **narrow complex tachycardia** for a rhythm lasting a **minimum of 3 consecutive beats** at a rate of greater than **100** bpm with QRS duration of less than **120** msec
• Score **bradycardia** during sleep for a **sustained** heart rate of **less than 40/minute** for ages 6 years through adult

• Score **asystole** for cardiac pauses **greater than 3 seconds** for ages 6 years through adult

• Score **atrial fibrillation** if there is an irregularly irregular ventricular rhythm associated with replacement of consistent P waves by rapid oscillations that vary in size, shape, and timing
EKG Basics
The EKG complex
Cardiac Conduction System Diagram - Marquette-KH
Marquette Electronics Copyright 1996
Depolarization = muscle contraction = Systole

Repolarization = muscle relaxation = Diasystole
12 lead EKG

- Rate
- Rhythm
- Axis
- Ischemia, hypertrophy, etc.

Frontal and Horizontal Plane Lead Diagram-KH
Frank G. Yanowitz, M.D.
Rhythm Strip

- Rate
- Rhythm?
- Holter monitor (3 channels)
- Channel/lead

Courtesy of Dr. Alberto Gitiger, ICSA, Buenos Aires, Argentina
(a) 25 seconds snapshot from sleep study in patient number 2 during wakefulness. White arrows show the beats that were initially reported as non-conducted P-waves. Upper channels (C3-A1) (O1-A1): electroencephalogram; third and fourth channel (L-EOG-A1) (R-EOG-A1): oculogram; fifth channel (EMG1) (EMG2): electromyogram; sixth channel (EKG1) (EKG2): electrocardiogram; seventh channel (SaO2): oxygen saturation; eighth channel (LEG1) (LEG2): leg movement; ninth channel: airflow; tenth channel: chest movement; eleventh channel: abdomen movement. (Panel (b)) Amplification of the area under the highlighted rectangle in panel (a). White arrows show the PVCs followed by a postextrasystolic pause. (Panel (c)) 12-lead ECG shows right bundle branch block. White arrows show PVCs arising probably from the left outflow tract.

Truths and Lies from the Polysomnography ECG Recording: An Electrophysiologist Perspective

Case Report Med. 2009 May 4; 2009:675078
Communication of an abnormal EKG

• There is a ________ (wide or narrow) complex __________ (regular or irregular) rhythm with a heart rate of ___.
• There is a ___ beat run of ___________ (wide or narrow) complex ___________ (regular or irregular) rhythm with a heart rate of ___.
• There is/are ________ second pause(s).
EKG Interpretation

• Here’s what you need to determine/describe
  – Heart rate
  – Morphology of QRS complex (narrow v. wide)
  – Rhythm: regular or irregular

• Identify
  – Premature beats
  – Tachycardia
  – Bradycardia
  – Pause/arrest/asystole
  – Atrial fibrillation
EKG Interpretation

1. Heart rate
2. Morphology of QRS complex (narrow v. wide)
3. Rhythm: regular or irregular
First: Determine Heart Rate (Beats Per Minute)

• Do you believe your PSG software? (it counts QRS complexes)
• Do you believe your pulse oximeter? (it uses plethysmography)
Determine Heart Rate
( Beats Per Minute: there are 60 seconds in a minute!)

Count the QRS complexes in your EKG:

- # QRS complexes in 60 seconds = BPM
- # QRS complexes in 30 seconds \( \times 2 \) = BPM
- # QRS complexes in 20 seconds \( \times 3 \) = BPM
- # QRS complexes in 15 seconds \( \times 4 \) = BPM
- # QRS complexes in 10 seconds \( \times 6 \) = BPM
- # QRS complexes in 6 seconds \( \times 10 \) = BPM
- # QRS complexes in 5 seconds \( \times 12 \) = BPM
- # QRS complexes in 4 seconds \( \times 15 \) = BPM
- # QRS complexes in 3 seconds \( \times 20 \) = BPM
- # QRS complexes in 2 seconds \( \times 30 \) = BPM
- # QRS complexes in 1 seconds \( \times 60 \) = BPM
Determine Heart Rate: “Eyeballing It”

One complex per second = 60 BPM (1X60)
More than one complex per second is >60 BPM
Less than one complex per second is <60 BPM
Practice heart rate

Heart rate of the whole strip: 6 complexes x 12 = 72
Heart rate of the triplet: 3 complexes x 60 = 180

Triplet PVC's: occur in groups of three

(one second)

(5 seconds)
EKG Interpretation

1. Heart rate
2. Morphology of QRS complex (narrow v. wide)
3. Rhythm: regular or irregular
QRS Morphology

Narrow = Normal

Wide = Abnormal
Narrow (QRS) Complex vs. Wide (QRS) Complex

**Narrow complex**
- QRS interval is < 0.12 sec
- Originating from above or at the AV node

**Wide complex**
- QRS interval is > 0.12 sec
- Intraventricular conduction delay
Wide QRS Complexes Are Abnormal

• Represent
  – Abnormal conduction through the ventricles
    • LBBB, RBBB, fascicular blocks
    • “Intraventricular conduction delay”
  – Primary (pacemaker) of ventricular origin
    • Premature Ventricular Contraction (PVC)
    • Idioventricular rhythm
    • Ventricular tachycardia (VT)
    • Ventricular fibrillation (VF)
    • Artificial pacemaker (ventricular)
Example of wide complex QRS

Aberrant conduction

Right bundle branch block
How can I tell?

Narrow Complex
• EEG spike

Wide Complex
• EEG K complex
EKG Interpretation

1. Heart rate
2. Morphology of QRS complex (narrow v. wide)
3. Rhythm: regular or irregular
Regular rhythm: R-R interval is constant (measure distance or time)
Irregular rhythm
(includes premature beats)
Regular v. Irregular Rhythm

Normal conduction vs. Atrial fibrillation.

- Normal sinus rhythm: Normal electrical signals from the SA node.
- Atrial fibrillation: Disorganized electrical signals from multiple sites.

ECG tracings show the differences in rhythm.
Sinus Rhythm or Not?
Look for the P waves!

### Regular v. Irregular Rhythm

**Normal Sinus Rhythm**

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Rhythm</th>
<th>P Wave</th>
<th>PR interval (in seconds)</th>
<th>QRS (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-100 bpm</td>
<td>Regular</td>
<td>Before each QRS, identical</td>
<td>.12 to .20</td>
<td>&lt;.12</td>
</tr>
</tbody>
</table>

**Sinus Arrhythmia**

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Rhythm</th>
<th>P Wave</th>
<th>PR interval (in seconds)</th>
<th>QRS (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usually 60-100 bpm</td>
<td>Irregular</td>
<td>Before each QRS, identical</td>
<td>.12 to .20</td>
<td>&lt;.12</td>
</tr>
</tbody>
</table>
Identify

– Premature beats
– Tachycardia
– Bradycardia
– Pause/arrest/asystole
– Atrial fibrillation
Premature Beats: occur earlier than your next predicted QRS complex

<table>
<thead>
<tr>
<th>Premature Atrial Contractions (PACs)</th>
<th>Premature Ventricular Contractions (PVCs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Narrow (usually)</td>
<td>• Wide complex</td>
</tr>
<tr>
<td>• Look like EEG spikes</td>
<td>• Look like K complexes</td>
</tr>
</tbody>
</table>
Premature Atrial Contraction (PACs)

**Premature Atrial Contraction • Isolated PAC's: Occur Single**

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Rhythm</th>
<th>P Wave</th>
<th>PR interval (in seconds)</th>
<th>QRS (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Irregular</td>
<td>Premature &amp; abnormal or hidden</td>
<td>&lt;.20</td>
<td>&lt;.12</td>
</tr>
</tbody>
</table>

**Premature Atrial Contraction • Atrial Bigeminy: Every Other Beat is a PAC**

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Rhythm</th>
<th>P Wave</th>
<th>PR interval (in seconds)</th>
<th>QRS (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Irregular</td>
<td>Premature &amp; abnormal or hidden</td>
<td>&lt;.20</td>
<td>&lt;.12</td>
</tr>
</tbody>
</table>
Premature Ventricular Contractions (PVCs)

Unifocal PVC's: identical shapes
Note: A single PVC is labeled isolated

Multifocal PVC's: more than one shape
PVC patterns are important to recognize: abnormal PVC rhythms increase the risk of having deadly ventricular rhythms such as Venticular Tachycardia (VT) and Ventricular Fibrillation (VF)
Bigeminy (every other beat is a PVC)

Trigeminy (every third beat is a PVC)

Quadrigeminal PVC's: every fourth beat is a PVC
More than 3 PVCs = Ventricular tachycardia (VT)
Identify

– Premature beats
– Tachycardia (heart rate greater than 100)
– Bradycardia
– Pause/arrest/asystole
– Atrial fibrillation
Wide complex tachycardias are **VERY BAD**
Sustained Ventricular Tachycardia (VT)
Non-Sustained Ventricular Tachycardia (NSVT)

6 second strip

- Heart rate of whole strip: 120 (12 x 10)
- Heart rate of burst of NSVT: 160 (8 x 20)
Ventricular Fibrillation (VF or Vfib) (often looks like sawtooth waves!)
VF: Torsades de Pointe
(think of CSR)
Holter monitor recording showing ventricular tachycardia degenerating to ventricular fibrillation. HR, heart rate. Cleveland Clinic
Ventricular Tachycardia (VT) and Ventricular Fibrillation (VF)
Vfib Shocked
AICD: Automatic Implantable Cardioverter Defibrillator

- Indicated in patients with previous VT, VF, sudden cardiac death or increased risk of ventricular arrhythmias
- Often has pacemaker ability
- Safe for health care providers to perform CPR, etc.
- Send the patient to the ED if the device discharges
Narrow Complex Tachycardia
Sinus Tachycardia v. SVT
(Supraventricular Tachycardia)

Heart rate is 25 x 6 = 150
Burst of SVT: often seen in association with arousals following respiratory events

Heart rate of whole strip: 78 (13 x 6)
Heart rate of SVT: 200 (10 x 20)
Identify

– Premature beats
– Tachycardia
– Bradycardia (heart rate less than 60)
– Pause/arrest/asystole
– Atrial fibrillation
Bradycardia: wide or narrow? P waves or not?

Sinus Bradycardia

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Rhythm</th>
<th>P Wave</th>
<th>PR interval (in seconds)</th>
<th>QRS (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 60 bpm</td>
<td>Regular</td>
<td>Before each QRS, identical</td>
<td>.12 to .20</td>
<td>&lt;.12</td>
</tr>
</tbody>
</table>

(6 second strip)

4 QRS complexes X 10 = 40 BPM
Identify

– Premature beats
– Tachycardia
– Bradycardia
– Pause/arrest/asystole
– Atrial fibrillation
One Second Pause

Courtesy of W.G. de Voogt, MD, PhD, Amsterdam, The Netherlands
PAUSE/ARREST/ASYSTOLE

Greater than 3 second pause is considered asystole
Sick Sinus Syndrome
Narrow complex irregular rhythm with frequent long pauses and escape beats.
Artificial Pacemakers

**Ventricular Pacing**
The pacing lead is inserted into the ventricle to cause ventricular depolarization.

**Atrial Pacing**
The pacing lead is inserted into the atrium to cause atrial depolarization.

**A-V Sequential Pacing**
The pacing leads are inserted into both the atrium and ventricle stimulating at set intervals.

**Pacemaker Lead Wire Replacement**
Atrial Pacemaker: spike instead of P wave
Electronic Ventricular Pacemaker Rhythm - Marquette-KH

Marquette Electronics Copyright 1996
AV Sequential Pacemaker (dual chamber)

One spike followed by an abnormal P (atrial capture) followed by a second spike producing a wide QRS (ventricular capture).
Identify

– Premature beats
– Tachycardia
– Bradycardia
– Pause/arrest/asystole
– Atrial fibrillation
# Atrial Fibrillation (Afib)

![Atrial Fibrillation](image)

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Rhythm</th>
<th>P Wave</th>
<th>PR interval (in seconds)</th>
<th>QRS (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: 350-650 bpm</td>
<td>Irregular</td>
<td>Fibrillatory (fine to course)</td>
<td>N/A</td>
<td>&lt;.12</td>
</tr>
<tr>
<td>V: Slow to rapid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Atrial Fibrillation with Rapid Ventricular Response (RVR) is a type of Supraventricular Tachycardia (SVT)
Abnormal EKG?
Make sure that it’s real!

• Artifact can look like arrhythmias and even asystole
• Lead on the patient?
• Look in another channel/lead
• Asystole artifact: look for your pleth wave tracing or be happy that you have EKG artifact in your EEG
When to Worry: The Threatening Threes

- Heart rate in the **triple** digits ($\geq 100$)
- Tachycardia of more than **3** beats in a row
- Heart rate in the **30s** (or less!)
- Pause of greater than **3** seconds
- More than **6** PVCs per minute (or more than **3** PVCs per **30** second epoch)
- (Irregularly irregular heart rhythm)
What do I do now?

• Confirm that the arrhythmia is real
• Check on the patient (ABCs)
• Call a code (or 911) if unstable
• If stable and unsymptomatic, call physician coverage if unsure about severity or transfer to ED
• Know your emergency policies and procedures
• Document well and sign out your findings
Communication of an abnormal EKG

• There is a _______ (wide or narrow) complex _________ (regular or irregular) rhythm with a heart rate of ___.
• There is a ___ beat run of _________ (wide or narrow) complex _________ (regular or irregular) rhythm with a heart rate of ___.
• There is/are _________ second pause(s).
(Free!) References

- [http://library.med.med.utah.edu/kw/ecg/index.html](http://library.med.med.utah.edu/kw/ecg/index.html) “The Alan E. Lindsay ECG Learning Center in Cyberspace”
- [http://en.ecgpedia.org/wiki/Main_Page](http://en.ecgpedia.org/wiki/Main_Page) “ECGPedia”
• Narrow or wide complex?
• Regular or irregular?
• Heart rate?
• What is it?

- Narrow
- Irregular
- 80
- NSR with pauses
- Narrow or wide complex?
- Regular or irregular?
- Heart rate?
- What is it?

- Wide complex
- Regular
- 140
- VT until proven otherwise
• Narrow or wide complex?
• Regular or irregular?
• Heart rate?
• What is it?

• Narrow
• Irregular
• 50
• Atrial fibrillation (Afib)
Narrow or wide complex?

Regular or irregular?

Heart rate?

What is it?

- Wide
  - Regular
  - 50
  - Wide complex bradycardia without P waves (likely idioventricular)
- Narrow or wide complex?
- Regular or irregular?
- Heart rate?
- What is it?

- Narrow
- Irregular
- 110
- Sinus tachycardia with two unifocal PVCs