EKG Recognition: 
When to Worry

Roslinde M. Collins, MD, D,ABSM, FCCP, FAASM
Dartmouth-Hitchcock Sleep Disorders Center
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Disclosures

• I have no financial affiliations to disclose.

• Permission has been received to use EKG examples from:
  i. [http://library.med.utah.edu/kw/ecg/index.html](http://library.med.utah.edu/kw/ecg/index.html) “The Alan E. Lindsay ECG Learning Center in Cyberspace”
Learning Objectives

• Review common patterns of arrhythmias during sleep studies
• Identify potentially life threatening arrhythmias and how to describe them
Overview of this lecture

• Gain basic understanding of the electricity of the heart
• Review patterns of arrhythmias
• 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
AASM Cardiac Scoring Rules (cont.)

• 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
OSA is arrhythmogenic!
EKG Basics
EKG =

Electrocardiogram =

ECG
The EKG complex
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)
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
(a) 25 seconds snap shot 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 post-extrasystolic pause. (Panel (c)) 12-lead ECG shows right bundle branch block. White arrows show PVCs arising probably from the left outflow tract.
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
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

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 X2 = BPM
- # QRS complexes in 20 seconds X3 = BPM
- # QRS complexes in 15 seconds X4 = BPM
- # QRS complexes in 10 seconds X6 = BPM
- # QRS complexes in 6 seconds X10 = BPM
- # QRS complexes in 5 seconds X12 = BPM
- # QRS complexes in 4 seconds X15 = BPM
- # QRS complexes in 3 seconds X20 = BPM
- # QRS complexes in 2 seconds X30 = BPM
- # QRS complexes in 1 seconds X60 = BPM

Best for Irregular Rhythms
Easy to calculate
Short bursts of tachycardia
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

(5 seconds)

Heart rate of the whole strip: 6 complexes x 12 = 72

Heart rate of the triplet: 3 complexes x 60 = 180
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.
Regular v. Irregular Rhythm

Sinus Rhythm or Not? Look for the P waves!
(Cherchez le P)
Identify

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

Premature Atrial Contractions (PACs)
- Narrow (usually)
- Look like EEG spikes

Premature Ventricular Contractions (PVCs)
- Wide complex
- Look like K complexes
Premature Atrial Contractions (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

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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 (usually) VERY BAD
Sustained Ventricular Tachycardia (VT)

(this is not called SVT)
Non-Sustained Ventricular Tachycardia (NSVT)

- 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.
- Contact physician on call if the device discharges
Narrow Complex Tachycardia
Sinus Tachycardia v. SVT (Supraventricular Tachycardia)

Heart rate is 25 x 6 = 150
Burst of SVT: look for them 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?

(6 second strip)

4 QRS complexes X 10 = 40 BPM
Identify

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

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

<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)
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
Artificially induces electronic stimulus that paces the patient's rhythm causing a blip or spike on the ECG waveform.
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.)
“Polysomnography and Implantable Cardiac Devices: Identifying Normal and Abnormal Paced Beats”
JCSM Volume 8, No. 3, 2012
When to Worry:

The Threatening Threes

• Heart rate in the triple digits (≥ 100)
• Wide complex 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?

1. Confirm that the arrhythmia is real
2. Check on the patient (ABCs)
3. Call a code (or 911) if unstable
4. If stable and asymptomatic, call physician coverage if unsure about severity or transfer to ED
5. Know your emergency policies and procedures
6. 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.utah.edu/kw/ecg/index.html
  “The Alan E. Lindsay ECG Learning Center in Cyberspace”

• http://en.ecgpedia.org/wiki/Main_Page  “ECGPedia”

• http://learntheheart.com/  “LearnTheHeart.com”
• Narrow or wide complex?
• Regular or irregular?
• Heart rate?
• What is it?

(6 seconds)

• 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

(6 seconds)
• Narrow or wide complex?
• Regular or irregular?
• Heart rate?
• What is it?

(6 seconds)

• 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