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Bryan Heart Cardiology Nurse’s Conference
October 13, 2018

**EKG’s..... the Good... the Bad.... and the Ugly.....**

**Objectives**
- To gain basic interpretation skills of 12-lead EKGs
- To gain basic interpretation skills of various heart rhythms
- To be able to recognize potential lethal heart rhythms and treatment of these rhythms

**Cardiac Cycle**
- Consists of one P-QRS-T sequence
- Atrial contraction (P-wave) and relaxation followed by ventricular contraction (QRS) and relaxation then repolarization (T-wave)
- Upright deflections are positive and downward deflections are negative with flat line isoelectric
- Deflections having both positive and negative are biphasic

**Back to the basics....**

Cardiac Cycle
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- Deflections having both positive and negative are biphasic
EKG Measurements

Back to the basics....

KEEP CALM AND FOCUS ON THE BASICS

P-waves

- P wave duration and amplitude — The P wave is normally less than 0.12 seconds in duration and under 0.15 or 0.20 mV (2 little boxes) in height in standard lead II
- Upright in leads I, II and usually aVF
- Inverted in aVR
- Upright, biphasic or inverted in III and aVL
Biphasic P-wave

- QRS complex: Duration less than or equal to 0.12 second
- Positive deflection with upright “R” in leads I, II, V4-V6
- Negative deflection with deep “S” in aVR, V1 and V2
- As V1 proceeds to V6, the R waves get taller and the S waves get smaller. In V3-V4, the waves are usually equal. This is the “transitional zone”
ST Segments

- ST segment: isoelectric, slanting upwards to the T wave in the normal ECG can be slightly elevated (up to 2.0 mm in some precordial leads) never normally depressed greater than 0.5 mm in any lead

Normal ST Segments on EKG
**Abnormal ST Segments (depression)**

- T wave: T wave deflection should be in the same direction as the QRS complex in at least 5 of the 6 limb leads.
- It is normally rounded and asymmetrical.
- Upright in leads V2 - V6.
- Isolated T wave inversion in aVR in an asymptomatic adult is generally a normal variant.

**Abnormal ST Segments (elevation)**

**T-waves**

- T wave: T wave deflection should be in the same direction as the QRS complex in at least 5 of the 6 limb leads.
- It is normally rounded and asymmetrical.
- Upright in leads V2 - V6.
- Isolated T wave inversion in aVR in an asymptomatic adult is generally a normal variant.
Normal T-waves

Abnormal T-waves

Normal Sinus Rhythm
- The QT interval is within normal limits
  - 0.36 to 0.44 seconds
12 Lead EKG

- Utilizes multiple leads:
  - Three bipolar limb leads consisting of Lead I, Lead II, and Lead III
  - Three unipolar limb leads—aVR, aVL, and aVF
  - Six precordial leads—V1 thru V6
  - Six limb leads record electrical activity from the heart's frontal plane
  - Six precordial leads record electrical activity from the horizontal plane

Coronary circulation

- Right Coronary Artery (RCA)
  - Posterior descending, Posterior Lateral
- Left Anterior Descending (LAD)
  - Diagonals
- Circumflex
  - Obtuse marginals
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**Inferior Wall MI (RCA)**

Inferior wall ischemia, injury, or infarct — II, III, aVF

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*There may be an overlap in blood supply by the RCA and/or artery depending on which artery is dominant.*
ST elevation in inferior leads II, III and aVF.
- Reciprocal ST depression in leads I and aVL.

**Lateral Wall changes (Circumflex)**

- Leads 1, avL, V5, V6

**Lateral Wall Infarct**

- Diagram of heart showing lateral wall changes
**Septal wall changes (LAD)**

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**Septal Wall MI**

**Anteroseptal MI (LAD)**

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Quiz time!

A 35-year-old man who was complaining of crushing substernal chest pain which radiated down his left arm for the last ten minutes. He was diaphoretic, and described his pain as a “10” on the 1-10 scale. He got only modest relief from IV fentanyl.
So what was stented??

He was transported to a full-service cardiac hospital, where he underwent angioplasty of simultaneous 100% occlusions of his proximal left anterior descending artery and diagonal artery.

Next example

75-year-old man with substernal chest pain and diaphoresis. He has significant nausea and developed some heart block.
• Right Coronary Artery (RCA)  
  — Posterior descending, Posterior Lateral 
• Left Anterior Descending (LAD)  
  — Diagonals  
• Circumflex  
  — Obtuse marginals 

What was stented?

The patient was found to have a 100% occlusion of the right coronary artery, which was opened and stented in the cath lab.

Basic Rhythms

Normal- The Good  
Brady- The Bad  
Tachy- The Ugly
Sinus Tachycardia

Heart Rate | Rhythm | P Wave | PR interval (in seconds) | QRS (in seconds)
--- | --- | --- | --- | ---
> 100 bpm | Regular | Before each QRS, identical | .12 to .20 | <.12

Sinus Bradycardia

Heart Rate | Rhythm | P Wave | PR interval (in seconds) | QRS (in seconds)
--- | --- | --- | --- | ---
< 60 bpm | Regular | Before each QRS, identical | .12 to .20 | <.12

Normal Sinus Rhythm

Heart Rate | Rhythm | P Wave | PR interval (in seconds) | QRS (in seconds)
--- | --- | --- | --- | ---
60-100 bpm | Regular | Before each QRS, identical | .12 to .20 | <.12
Heart rhythms are like relationships

- The good......Think of a newly married couple....
- 1 Husband (P) and 1 Wife (QRS)
- P-wave and QRS are in close proximity.... They are in sync....aka Normal sinus

The old happily married couple

- Think of the old man saying “what did you say?”....a little delay in communication but the bond is still strong....
- P-wave and QRS are a little spread apart but still in sync....aka 1st degree block

That cheating.....

- Second degree Block – Type 1 – Wenkebach
- Your cheating heart.....those P’s and QRS’s slowly drift apart then she’s gone!!!

Prolonged PR interval measures 0.20 seconds or greater

PR interval becomes progressively longer until P wave not followed by a QRS complex
It’s attorney time.....
- Second degree Block- Type 2
- Couple is still together.....but QRS has occasional meetings with her attorney and is gone from time to time....

More than 1 P wave before each QRS usually 2 or 3 but can vary... takes a few stimuli to get the signal through

A complete break....
- Third degree heart block or complete heart block
- P and QRS are doing their own thing now....

P waves are at one rate with QRS at a different rate

Gotta get fit for dating!
- More aerobics..... Gotta get moving!
- Many times when you start working out you are excited but not very consistent..... just like atrial fibrillation..... You may have excitable "P's" and inconsistent "QRS's"
Getting fit is getting easier!

• Your working out is getting a little bit more uniform.....
• Your enthusiasm is more even-keel “Ps” and you may still have some inconsistency “QRS”s

Don’t go overboard!

• Those pre-workout caffeinated drinks aren’t for everyone!
• Not much excitement coming through, just a trembling!!!

Or you will just drop.....

• Ventricular fibrillation- You’ve just crashed.....
Bradycardia

- Clinical trials in adults showed that IV atropine improved heart rate, symptoms, and signs associated with bradycardia. Atropine sulfate reverses cholinergic-mediated decreases in heart rate and should be considered a temporizing measure while awaiting intravenous, transvenous, or permanent pacemaker for patients with symptomatic sinus bradycardia, conduction block at the level of the AV node, or sinus arrest.
- The recommended atropine dose for bradycardia is 0.5 mg IV every 3 to 5 minutes to a maximum total dose of 3 mg. Doses of atropine sulfate of 0.5 mg may paradoxically result in further slowing of the heart rate. Atropine administration should not delay implementation of external pacing for patients with poor perfusion.
- Use atropine cautiously in the presence of acute coronary ischemia or MI. Increased heart rate may worsen ischemia or increase infarct size. Atropine will likely be ineffective in patients who have undergone cardiac transplantation because the transplanted heart lacks vagal innervation.
- Avoid relying on atropine in type II second-degree or third-degree AV block or in patients with third-degree AV block with a new wide-QRS complex where the location of block is likely to be in non-ventricular tissue (such as the bundle of His or more distal conduction system). These bradyarrhythmias are not likely to be responsive to reversal of cholinergic effects by atropine and are preferably treated with TCF or β-adrenergic support (Isoproterenol) as temporizing measures while the patient is prepared for transvenous pacing or permanent pacemaker implant.
Tachycardia...
You know...the fast ones...

- Sinus tachycardia
- SVT
- VT/VF

Tachycardia is defined as an arrhythmia with a rate of >100 beats per minute, although more likely attributable to a physiologic stressor, such as fever, dehydration, or other underlying conditions. When encountering patients with tachycardia, efforts should be made to determine whether the tachycardia is the primary cause of the presenting symptoms or secondary to an underlying condition that is causing both the tachycardia and the symptoms. Many experts suggest that when a heart rate >100 beats per minute, it is unlikely that symptoms of instability are caused primarily by the tachycardia unless there is impaired ventricular function.

Because hypoxemia is a common cause of tachycardia, initial evaluation of any patient with tachycardia should focus on signs of increased work of breathing (tachypnea), increased respiratory rate, tachycardia, and respiratory distress. If oxygenation is adequate or the patient shows signs of increased work of breathing, provide supplementary oxygen.

If signs and symptoms persist despite provision of supplemental oxygen and support of airway and ventilation, the provider should assess the patient's degree of instability and determine if the instability is related to the tachycardia. If the patient demonstrates signs of tachycardia-related cardiovascular compromise with signs and symptoms such as acute altered mental status, ischemic chest discomfort, acute heart failure, hypotension, or other signs of shock, tachycardia is more likely to be a tachycardia than the underlying condition causing the instability.

If not hypotensive, the patient with a regular narrow-complex SVT (likely due to suspected ventricular tachycardia, as described below) may be treated with adenosine while preparations are made for synchronized cardioversion.
General management of atrial fibrillation should focus on control of the rapid ventricular rate (rate control), conversion of hemodynamically unstable atrial fibrillation to sinus rhythm (rhythm control), or both. Patients with an atrial fibrillation duration of up to 48 hours are at increased risk for cardioembolic events, although shorter durations of atrial fibrillation do not exclude the possibility of such events. Electric or pharmacologic cardioversion (conversion to normal sinus rhythm) should not be attempted in these patients unless the patient is unstable. An alternative strategy is to perform cardioversion following anticoagulation with heparin and performance of transesophageal echocardiography to ensure the absence of a left atrial thrombus.

In patients who have drug refractory symptomatic atrial fibrillation, referral on to an electrophysiologist for possible ablation may be warranted.

**Atrial fibrillation/flutter**

**Case Study 1**

- Joey is a 65 year old male with no significant past medical history. He presents to the emergency room with complaints of persistent fatigue and weakness. He does report some occasional dizziness and today had a syncopal episode (passed out).
- VS on arrival: 98.7, 55, 18, 108/68
Case Study 2

• Martha is walking with you to lunch talking about how excited you are to try a new restaurant in town when she suddenly states she feels like her heart is “going crazy”.
• You initially laugh and say “so is mine”….but then you realize she is slightly distressed....

• You check her pulse.....because that is what nurses do.... And you notice that it is rapid and irregular and you have a difficult time calculating her heart rate....
• “I shouldn’t have drank that redbull this morning! I’ve never felt this before” she says....
• You convince her to go to the local ER
• VS in the ER- 98.6, 145, 20, 87/55

Resources

• www.uptodate.com
• www.ceufast.com
• www.practicalclinicalskills.com