Course Objectives:
By the end of this presentation, the participant will be able to:
1. Describe the basic cardiac electrophysiology of the ECG complex.
2. Discuss the difference between irritable beats and escape beats as seen in atrial, junctional, and ventricular rhythms.
3. Discuss reasons that patients experience ectopic beats and dysrhythmias.

Electrical Conduction of the Heart

SA node
AV node/Junction
Bundle of His
Bundle Branches
Purkinje Fibers

Review of the ECG Complex

P wave
PR interval
QRS complex
ST segment
T wave
U wave

Systematic Rhythm Strip Analysis

- Rhythm/Regularity
- Rate
- Identify/Examine
  - P waves:
    - Upright? Same?
    - One preceding each QRS?
- Assess intervals
  - PR interval
  - QRS complex
  - QT interval
- Assess ST segment
- Evaluate T wave

ECG Complex Basics

- **PR Interval**: 0.12 – 0.20 sec.
- **QRS complex**: 0.04 – less than 0.12 sec.
- **ST Segment**: Flat, equal to isoelectric line
- **T Wave**: Upright, same direction as QRS complex
- **QT Interval**: Less than half of the R-R interval

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Irritable & Escape Beats

- Irritable
  - When an irritable site in the conduction system speeds up and takes over as pacemaker
  - Comes in earlier than next expected beat

- Escape
  - If the SA node slows down or fails to initiate depolarization, the site with the next highest inherent rate takes over as pacemaker
  - Appears after the next expected beat
  - Protective mechanism

Premature Atrial Contractions (PACs)

- Irritable site in the atria discharges early
  - Can have multiple PACs originating from different sites within the atria

- Characteristics of P wave:
  - Early
  - Differ in shape from the sinus P wave [normal P wave]
  - May be hidden in preceding T wave if it is extremely early

- A small pause may occur after a PAC as the SA node resets itself

Examples of Different PACs

- Atrial Bigeminy
- Atrial Trigeminy

Non-conducted PACs

- Defined as a PAC that is very premature
- Comes in too close to T wave of previous beat
- AV junction is unable to respond to impulse and conduct it through to the ventricles
- Most common cause of unexpected pauses in SR

Time to Test Your Knowledge

Which of the following individuals is at high risk for developing PACs?

A. A 22 year old female studying for finals who smoked 5 cigarettes and has had 2 Red Bulls in the last 2 hours.
B. A 54 year old male with h/o CAD who was admitted for fluid overload related to new onset heart failure.
C. A 32 year old male who just completed his first marathon.
D. A 40 year old female admitted for gastroenteritis and dehydration.
**Time to Test Your Knowledge**

Which of the following patients would you expect to need treatment for PACs?

A. A 42 year old patient monitored on telemetry s/p surgery who is having on average of 2 PACs per minute.
B. A 28 year old who drinks 8 cups of coffee a day and sometimes complains of chest palpations.
C. A 67 year old s/p NSTEMI who is having runs of PACs.
D. A 54 year old patient on telemetry with a HR greater than 100, who is complaining of chest palpations and SOB.

**Junctional Dysrhythmias**

- Impulse originates at the AV junction
- Impulse must travel backwards to depolarize atria (retrograde conduction)
- P wave in junctional rhythm can be:
  - Inverted
  - Not visible
  - Inverted and after the QRS
- QRS complex is usually normal in duration

**Premature Junctional Complexes (PJCs)**

- From ectopic focus within the AV junction
- PR Interval usually 0.10 or less in duration
- QRS complex is normal
- Occurs usually as a single beat
- Common for there to be a pause after PJC

**Causes & Treatment of PJCs**

<table>
<thead>
<tr>
<th>Causes</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digitalis toxicity</td>
<td>Asymptomatic and infrequent – no treatment needed</td>
</tr>
<tr>
<td>Caffeine</td>
<td></td>
</tr>
<tr>
<td>Nicotine</td>
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<td>Electrolyte Imbalances</td>
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<tr>
<td>HF</td>
<td></td>
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<tr>
<td>CAD</td>
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</tbody>
</table>

**Junctional Escape Beats**

- Originates in AV junction but comes in late (after the next expected beat)
- Occurs because the SA node fails to generate an electrical impulse or AV node failed to conduct impulse through

**Time to Test Your Knowledge**

When are Junctional Escape Beats most likely to occur?

A. With a Sinus Tachycardia Rhythm
B. After a non-conducted PAC
C. With a Atrial Fibrillation Rhythm
D. After Patient is given a Beta Blocker

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Junctional Rhythm

- Inherent Rhythm of the AV junction
  - Occurs when SA node fires at a rate less than inherent rate of AV junction
  - Impulses from SA node fail to reach the ventricles
- Rate 40-60 bpm
- Treatment depends on rate/symptoms

Examples of Junctional Rhythms

Time to Test Your Knowledge

Which of the following things could cause a patient to go into a Junctional Rhythm?

A. After an Inferior Wall MI
B. After receiving a dose of Heparin
C. Hypokalemia
D. Strenuous physical activity

Accelerated Junctional Rhythm

- Occurs because of enhanced automaticity of the Bundle of His
- Ventricular response is between 60-100
- Criteria is same as for Junctional Rhythm only rate varies
- Very uncommon to see in practice
- Most common cause is Dig Toxicity

Examples of Accelerated Junctional Rhythms

Junctional Tachycardia

- 3 or more PJC's in a row at a rate of >100 bpm
- Common Causes:
  - Digitalis toxicity
  - Inferior Wall MI
  - Heart Failure
- Signs/Symptoms
  - Racing heart, chest pain, anxiety, hypotension, SOB, decreased LOC

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**Time to Test Your Knowledge**

Which of the following is an appropriate treatment for a patient in junctional tachycardia?

A. Oxygen, Vagal Maneuvers, IVP Diltiazem  
B. Oxygen, Vagal Maneuvers, IVP Atropine  
C. Oxygen, Vagal Maneuvers, IVP Digoxin  
D. Oxygen, Vagal Maneuvers, IVP Vasopressin

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**Ventricular Rhythms**

- Impulses originates below the Bundle of His in either the right or left ventricle  
- Does not follow the normal conduction pathway  
  - Ventricles depolarize cell by cell through myocardium  
  - Ventricular repolarization is abnormal resulting in:  
    - ST segment changes  
    - T wave changes  
  - No P waves  
  - Atrial kick is lost!

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**Types of Premature Ventricular Contractions (PVCs)**

- Patterns of PVCs  
  - Couples/Pair  
  - Run (3 or more PVCs in a row)  
  - Uniform or Multiform  
  - Ventricular Bigeminy  
  - Ventricular Trigeminy  
  - Ventricular Quadrigeminy

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**Types of PVCs**

- Run of V-Tach  
- Ventricular Bigeminy

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**Uniform/Unifocal PVCs**

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**Multiform/ Multifocal PVCs**

**R–on–T PVCs**

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**Time to Test Your Knowledge**

Mr. C, a 57-year-old male admitted to your unit with Acute Kidney Injury. The Telemetry technician notifies you that Mr. C is having bigeminy PVCs. You know electrolyte imbalances increase risk of developing PVCs. Which electrolyte imbalance are you most concerned about?

A. Hypokalemia and Hyponatremia
B. Hyperkalemia and Hypernatremia
C. Hypokalemia and Hypomagnesium
D. Hyperkalemia and Hypomagnesium

---

**Fun Facts about PVCs…**

- Pulse may or may not be palpable
- May experience S&S of Decreased Cardiac Output
- Treatment of PVCs:
  - If asymptomatic and infrequent, no treatment required
  - If symptomatic:
    - Oxygen
    - Pain relief
    - Treat underlying cause (check electrolytes!)
    - Antiarrhythmic medication

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**Ventricular Escape Beats/Rhythm**

- Ventricular Escape Beats:
  - Occur when other pacemakers have failed
  - Occur Late
  - Are a Protective mechanism
- Ventricular Escape Rhythm
  - AKA Idioventricular Rhythm (IVR)
  - 3 or more ventricular escape beats at a rate of 30 – 40 bpm

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**Ventricular Escape Beat**

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**Idioventricular Rhythm**
Time to Test Your Knowledge

What are signs and symptoms a patient in IVR may display?

A. Hypertension, SOB, edema, tachycardia.
B. Hypotension, increase urine output, SOB, ALOC.
C. Hypotension, weakness, LOC, SOB.
D. Hypertension, bradycardia, SOB, ALOC.

Time to Test Your Knowledge

Which of the following may be used to treat a patient in IVR?

A. Oxygen, adenosine IVP, pacing.
B. Oxygen, diltiazem IVP, pacing.
C. Oxygen, epipherine IVP, Pacing.
D. Oxygen, atropine IVP, Pacing

Accelerated IVR

- Commonly occurs after:
  - Inferior Wall MIs
  - Post-Infarction Reperfusion Therapy
  - Digoxin toxicity
- Can be transient and benign
- Serves as an escape rhythm
- No treatment necessary and suppression should be avoided

Ventricular Tachycardia (VT)

- 3 or more PVC’s in a row at rate > 140
- Pulse may or may not be palpable
- Wide QRS complexes (> 0.12)
- ST segment and T wave in opposite direction
- Patient may be stable or unstable

Types of V-Tach

**Monomorphic V tach**

**Polymorphic V-tach**

Time to Test Your Knowledge

Which of the following patients are more likely to have an episode of V-tach?

A. A patient who had an anterior wall MI and has myocardial ischemia.
B. A patient who has HTN and Hyperlipidemia.
C. A patient who has DM Type 2 and CAD.
D. A patient with CAD who was just started on a beta blocker.
Time to Test Your Knowledge

Treatment for a patient in stable Ventricular Tachycardia would include:

A. Oxygen, Vagal Maneuvers, IVP Adenosine.
B. Oxygen, IVP Amiodarone, Cardioversion.
C. Oxygen, IVP Metoprolol, Cardioversion.
D. Oxygen, Vagal Maneuvers, Diltiazem.

Torsades de Pointes

- Form of Polymorphic Ventricular Tachycardia
- Associated with prolonged QT interval
- Rate is usually greater than 250 bpm
- Alteration in amplitude and direction of QRS complexes
- Seen between V-Tach and V-Fib rhythms

Ventricular Fibrillation

- Known as the “chaotic rhythm”
- Ventricles quiver, there is no myocardial contraction
- Two kinds: Coarse V-fib and Fine V-fib
- Patient will be unresponsive, apneic and pulseless
- Treatment: CPR and defibrillation - progress down ACLS protocol with meds

Case Study: Mr. J

Mr. J is a 71 year old s/p anterior wall MI who underwent two coronary stents 2 days ago to his LAD for blockages. He has been stable and his troponins have been trending down in the ICU. Due to a lack of critical care beds, his physician has decided to transfer him from the ICU to the med-surg telemetry unit for continued monitoring. He arrives to your unit alert and oriented and in stable condition. Two hours after he arrives, the telemetry monitor alarms and you see the following rhythm:

Case Study: Mr. J

What is this Rhythm?

A. Accelerated Junctional Rhythm
B. Accelerated Idioventricular Rhythm
C. A Run of PVCs
D. Atrial Fibrillation

Case Study: Mr. J

Treatment for this rhythm would include:

A. Call a code blue and prepare to defibrillate patient
B. Call a code blue and prepare to push IV Adenosine
C. Assess the patient, notify the provider and if stable do nothing. If unstable call a RRT.
D. Call a RRT, place pacing pads on patient and prepare to transfer patient back to ICU

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**Case Study: Mr. W**

Mr. W is a 38 year old healthy male who was admitted to your unit for a cardiac work-up after an abnormal 12 lead ECG. Mr. W tells you he has been under a great amount of stress lately after losing his job as a financial advisor. He confides that he has begun smoking again after quitting 15 years ago and is also having a couple of drinks of whiskey to take the edge off. He initially went to his Physician because he began having some pains in his chest and was worried because his 60 year old uncle just died of a heart attack. When you connect him to the monitor, you see the following rhythm:

**What is this Rhythm?**

A. SR with bigeminy PVCs  
B. SR with trigeminy PVCs  
C. SR with bigeminy PACs  
D. SR with bigeminy PJCs

**Case Study: Mr. W**

What are Mr. W risk factors for developing this rhythm?

A. Smoking  
B. Alcohol  
C. Stress  
D. All of the above

**Case Study: Mrs. P**

Mrs. P is a 84 year old admitted to your unit for pain control and potential palliative care following a 3 year battle with Colon Cancer. Although, Mrs. P is a DNR, the ED physician has ordered telemetry monitoring until she is seen by her oncologist tomorrow. Mrs. P has been in Sinus Bradycardia since arriving. Around 4 am, the telemetry monitor alarms and you see the following rhythm:

**What is this Rhythm?**

A. Idioventricular Rhythm  
B. Junctional Escape beats with non-conducted PACs  
C. Ventricular Escape beats with ventricular standstill  
D. Fine Ventricular Fibrillation

**Case Study: Mrs. P**

As the RN caring for this patient, your next action would be to:

A. Call a code blue and begin CPR  
B. Call a code blue and prepare to pace the patient  
C. Call a code blue and prepare to give Atropine  
D. Assess the patient and notify the provider

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Case Study: Mr. K

- Mr. K is a 45 year old admitted to your unit last night with a diagnosis of unstable angina R/O NSTEMI. The night RN stated Mr. K has been resting comfortably all night in SR 80s with occasional PVCs. He is scheduled for an AMIBI stress test this AM. When assessing Mr. K he complains of chest tightness and states it feels like his heart is racing. Just then, the telemetry technician calls you and tells you that your patient is in the following rhythm:

What is this Rhythm?
A. Accelerated Idioventricular
B. Coarse Ventricular Fibrillation
C. Monomorphic Ventricular Tachycardia
D. Polymorphic Ventricular Tachycardia

Case Study: Mr. K

As the RN caring for Mr. K, what is your next action?
A. Assess patient, apply Oxygen, call RRT/Code blue
B. Apply Oxygen, Call Code Blue, begin CPR
C. Call Code Blue, begin CPR, prepare to defibrillate patient
D. Begin CPR, Call Code blue, prepare to give Amiodarone

Additional Resources

Websites:
http://www.practicalclinicalskills.com
http://skillstat.com
http://highered.mheducation.com
http://quizlet.com

Apps for Smart Phones/Tablets
ECG Guide by QxMD ($0.99)
Instant ECG by iAnesthesia ($0.99)
Easy ECG by Cody Blend ($1.99)
ECG I Pocketcards ($3.99)