Arrhythmias Detected on ECG

- Arrhythmias are abnormal heart rhythms
- Heart rate <60/min is bradycardia; >100/min is tachycardia

Bradyarrhythmias

- What is the rhythm?

Sinus Bradycardia

Sinus tachycardia (lead I)

Sinus Bradycardia (lead III)
Sinus Arrhythmia

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

Atrial Rhythms
- Originate in the atria
- Atrial fibrillation (A Fib)
- Atrial flutter
- Wandering pacemaker
- Multifocal atrial tachycardia (MAT)
- Supraventricular tachycardia (SVT)
- PAC's
- Wolff-Parkinson–White syndrome (WPW)

Atrial Fibrillation

Heart rate: 350-650 bpm
Rhythm: Irregular
P wave: Fibrillatory
PR interval: N/A
QRS: <.12

A - Fib

Atrial Flutter

Heart rate: 220-430 bpm
Rhythm: Regular
P wave: Sawtoothed appearance
PR interval: N/A
QRS: <.12
Multifocal Atrial Tachycardia (MAT)
(Rapid Wandering Pacemaker)
- Similar to wandering pacemaker (< 100)
- MAT rate is >100
- Usually due to pulmonary issue
  - COPD
  - Hypoxia, acidic, intoxicated, etc.
- Often referred to as SVT by EMS
  - Recognize it is a tachycardia and QRS is narrow

Tachyarrhythmias
- What is the rhythm?

The "Re-Entry" Mechanism of Ectopic Beats & Rhythms

Tissues with these type of circuits may exist:
- in microscopic size in the SA node, AV node, or any type of heart tissue
- in a "macroscopic" structure such as an accessory pathway in WPW
The "Re-Entry" Mechanism of Ectopic Beats & Rhythms

1. An arrhythmia is triggered by a premature beat
2. The beat cannot gain entry into the fast conducting pathway because of its long refractory period and therefore travels down the slow conducting pathway only.

Repolarizing Tissue (long refractory period)

Fast Conduction Path
Slow Recovery

Slow Conduction Path
Fast Recovery

3. The wave of excitation from the premature beat arrives at the distal end of the fast conducting pathway, which has now recovered and therefore travels retrogradely (backwards) up the fast pathway.

4. On arriving at the top of the fast pathway it finds the slow pathway has recovered and therefore the wave of excitation "re-enters" the pathway and continues in a "circular" movement. This creates the re-entry circuit.

Re-entry Circuits as Ectopic Foci and Arrhythmia Generators

Atrial Re-entry
- atrial tachycardia
- atrial fibrillation
- atrial flutter

Atrio-Ventricular Nodal Re-entry
- supraventricular tachycardia

Atrio-Ventricular Re-entry
- Wolf Parkinson White
- supraventricular tachycardia

Tachyarrhythmias

- What is the rhythm?

SVT

Atrial Tachycardia

<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>140-250 bpm</td>
<td>Regular</td>
<td>Abnormal P before each QRS (difficult to see)</td>
<td>&lt;0.20</td>
<td>&lt;0.12</td>
</tr>
</tbody>
</table>
Tachyarrhythmias

- What is the rhythm?

PAC’s

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Rhythm</th>
<th>P Wave</th>
<th>PR interval</th>
<th>QRS duration</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>

Wolff–Parkinson–White - WPW

- Caused by an abnormal accessory pathway (bridge) in the conductive tissue
- Mainly non-symptomatic with normal heart rates
- If rate becomes tachycardic (200-300) can be lethal
- May be brought on by stress and/or exertion

Tachycardia circuits in Wolff-Parkinson-White syndrome

Wolff–Parkinson–White (AKA - Preexcitation Syndrome)
**Short PR Interval**
- WPW (Wolff-Parkinson-White) Syndrome
- Accessory pathway (Bundle of Kent) allows early activation of the ventricle (delta wave and short PR interval)

**Ventricular preexcitation (WPW)**

**AV/Junctional Rhythms**
- Originate in the AV node
- Junctional rhythm rate 40-60
- Accelerated junctional rhythm rate 60-100
- Junctional tachycardia rate over 100
- PJC's
- Inherent rate of 40 - 60

**Junctional Rhythm**

**ECGs, Normal and Abnormal**
- (a) Sinus rhythm (normal)
- (b) Nodal rhythm – no SA node activity
Accelerated Junctional

**Accelerated Junctional Rhythm**

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Rhythm</th>
<th>P Wave</th>
<th>PR interval (in seconds)</th>
<th>QRS duration (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-100 bpm</td>
<td>Regular</td>
<td>Inverted, absent or after QRS</td>
<td>&lt;.12</td>
<td>&lt;.12</td>
</tr>
</tbody>
</table>

Junctional Tachycardia

Often difficult to pick out so often identified as “SVT”

**Paroxysmal Junctional Tachycardia**

150 - 250/min.

PJC’s

Flat or inverted P Wave or P wave after the QRS

Ventricular Rhythms

- Originate in the ventricles / Purkinje fibers
- Ventricular escape rhythm (idioventricular) rate 20-40
- Accelerated idioventricular rate 42 - 100
- Ventricular tachycardia (VT) rate over 102
  - Monomorphic – regular, similar shaped wide QRS complexes
  - Polymorphic (i.e. Torsades de Pointes) – life threatening if sustained for more than a few seconds due to poor cardiac output from the tachycardia
- Ventricular fibrillation (VF)
  - Fine & coarse
- PVC’s

Idioventricular

**Idioventricular Rhythm**

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Rhythm</th>
<th>P Wave</th>
<th>PR interval (in seconds)</th>
<th>QRS duration (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-40</td>
<td>Regular</td>
<td>absent or not related</td>
<td>N/A</td>
<td>≥ .12</td>
</tr>
</tbody>
</table>

Accelerated Idioventricular

**Accelerated Idioventricular Rhythm (AIR)**

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Rhythm</th>
<th>P wave</th>
<th>PR interval (in seconds)</th>
<th>QRS duration (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-100</td>
<td>Regular</td>
<td>absent or not related</td>
<td>N/A</td>
<td>≥ .12</td>
</tr>
</tbody>
</table>
Arrhythmias Detected on ECG

- In flutter, contraction rates can be 200-300/min.
- In fibrillation, contraction of myocardial cells is uncoordinated & pumping ineffective.
- Ventricular fibrillation is life-threatening.
  - Electrical defibrillation resynchronizes heart by depolarizing all cells at same time.

VT (Monomorphic)

Ventricular Tachycardia (3 or more consecutive beats)

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Rhythm</th>
<th>P Wave</th>
<th>PR interval</th>
<th>QRS width</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100</td>
<td>Regular</td>
<td>Absent</td>
<td>not related</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Monomorphic VT

VT (Polymorphic)

Polymorphic VT

Note the "twisting of the points"
“Torsade de Pointes” (Polymorphic VT Associated with Prolonged Repolarization)

Ventricular Flutter
- VT > 250 beats/min, without clear isoelectric line
- Note “sine wave”-like appearance

Ventricular Fibrillation (VF)
- Totally chaotic rapid ventricular rhythm
- Often precipitated by VT
- Fatal unless promptly terminated (DC shock)

Sustained VT: Degeneration to VF

Atrial Fibrillation with Rapid Conduction Via Accessory Pathway: Degeneration to VF
ECGs, Abnormal

(a) Ventricular fibrillation

No pumping action occurs

(b) Premature ventricular contraction

Extrasystole: note inverted QRS complex, misshapen QRS and T and absence of a P wave preceding this contraction.

PVC’s

(c) Ventricular fibrillation

No L staging, PWC, full-figured rhythm

(d) Multifocal PVC’s

R on T PVC’s

R on T: occur on the peak of the T wave of the preceding beat

Synchronized Cardioversion

Cardioversion is synchronized to avoid the refractory period of the T wave

The monitor “plots” out the next refractory period in order to shock at the right moment – the safer R wave

With a QRS complex & T wave present, the R wave can be predicted (cannot work in VF – no wave forms present)

R on T PVC’s cont.

- Why is R on T so bad?
  - Downslope of T wave is the relative refractory period
  - Some cells have repolarized and can be stimulated again to depolarize/discharge
  - Relatively strong impulse can stimulate cells to conduct electrical impulses but usually in a slower, abnormal manner
  - Can result in ventricular fibrillation
  - Absolute refractory period is from the beginning of the QRS complex through approximately the first half of the T wave
  - Cells not repolarized and therefore cannot be stimulated