Electrocardiographic Interpretation

Basic Rhythm Recognition

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Cardiac Rhythms
Anatomy of a Rhythm Strip
A Review of the Electrical System

Intrinsic conduction system of the heart

- Sinoatrial node
- Right atrium
- Atrioventricular node
- Left atrium
- Left ventricle
- Right ventricle
Intrinsic Pacemakers Cells

These cells have property known as “Automaticity”—means they can spontaneously depolarize.

Sinus Node
- Primary pacemaker
- Fires at a rate of 60-100 bpm

AV Junction
- Fires at a rate of 40-60 bpm

Ventricular (Purkinje Fibers)
- Less than 40 bpm
What’s Normal

P Wave
Atrial Depolarization

PR Interval  (Normal 0.12-0.20)
Beginning of the P to onset of QRS

QRS
Ventricular Depolarization

QRS Interval  (Normal <0.10)
Period (or length of time) it takes for the ventricles to depolarize
The Key to Success...

...A systematic approach!

- Rate
- Rhythm
- P Waves
- PR Interval
- P and QRS Correlation
- QRS Rate
- Pacemaker
A rather ill patient

Very apparent inferolateral STEMI.......with less apparent complete heart block
RATE

Fast vs Slow

QRS Width

Narrow QRS Tachycardia
- Regular
  - Sinus Tach
  - PSVT
  - A-Flutter
  - PAT
- Irregular
  - A-Fib
  - A-Flutter
  - MAT
  - PAT
  - ST PAC / PVC

Wide QRS Tachycardia
- Regular
  - VT
  - SVT aberrant
- Irregular
  - PVT
  - A-Fib

Narrow QRS Bradycardia
- Sinus Brady
- A-Fib / Flutter
- Junctional
  - 1 AVB
  - 2 AVB / I or II
  - 3 AVB

Wide QRS Bradycardia
- Idioventricular
- Bradycardia w/ BBB
- 2 AVB / II
- 3 AVB
Stability

- Hypotension / hypoperfusion
- Altered mental status
- Chest pain
  - Coronary ischemic
- Dyspnea
  - Pulmonary edema
Sinus Rhythm
# Sinus Rhythm

<table>
<thead>
<tr>
<th>P Wave</th>
<th>PR Interval</th>
<th>QRS Rate</th>
<th>Rhythm</th>
<th>Pacemaker</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before each QRS</td>
<td>Constant, regular</td>
<td>Rate 60-100</td>
<td>Regular</td>
<td>SA Node</td>
<td>Upright in leads I, II, &amp; III</td>
</tr>
<tr>
<td>Look alike</td>
<td>Interval .12-.20</td>
<td>Interval =/&lt;= .10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sinus Pause

- A delay of activation within the atria for a period between 1.7 and 3 seconds
- A palpitation is likely to be felt by the patient as the sinus beat following the pause may be a heavy beat. Syncope is also possible.

Sinus Arrest

- a delay of activation in the Atria = or > 3 seconds
- Patient is likely to have a syncopal event
Tachycardia
# Sinus Tachycardia

![Sinus Tachycardia Diagram](image)

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<th>Pacemaker</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before each QRS</td>
<td>Constant, regular Interval .12-.20</td>
<td>Rate &gt; 100 Interval =/&lt; .10</td>
<td>Regular</td>
<td>SA Node</td>
<td>Consider causes</td>
</tr>
<tr>
<td>Look alike</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sinus Tachycardia
## Paroxysmal Supraventricular Tachycardia (PSVT)

<table>
<thead>
<tr>
<th>P Wave</th>
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</table>
| Are not easily seen, because they are buried in the T waves | Difficult to determine due to the rapid rate and poorly distinguished P waves | $>150$; up to 250 | Regular | Originates above the ventricles; typically not driven by the SA Node. | ▶ May be due to increased automaticity or re-entry  
▶ Common provocateurs are: Caffeine, hypoxia, cigarettes, stress, anxiety, sleep deprivation, medications |
PSVT
# Atrial Fibrillation

![Atrial Fibrillation ECG Image](http://www.cardionetics.com/docs/healthcr/ecg/arrhy/0600_bd.htm)

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<tr>
<th>P Wave</th>
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<th>Pacemaker</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>No distinct P waves—chaotic, undulating fibrillation waves</td>
<td>Absent or indiscernible</td>
<td>Varies; may be a slow or rapid ventricular response</td>
<td>Both atrial and ventricular complexes are irregularly irregular</td>
<td>Occurs from multiple reentry sites; resulting in a very rapid atrial rate &gt;300</td>
<td>Lose the “atrial kick” Potential for thrombi</td>
</tr>
</tbody>
</table>

Atrial Fibrillation
## Atrial Flutter

<table>
<thead>
<tr>
<th>P Wave</th>
<th>PR Interval</th>
<th>QRS Rate</th>
<th>Rhythm</th>
<th>Pacemaker</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saw tooth</td>
<td>Typically immeasurable; also, may be variable</td>
<td>Varies; may be a slow or rapid ventricular response &lt;.10</td>
<td>Both atrial and ventricular complexes are regular unless there is a variable block</td>
<td>Single reentry circuit; impulse takes a circular course around the atria</td>
<td>Similar to A Fib in symptomology and treatment</td>
</tr>
<tr>
<td>Atrial rate can range from 200-300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lose the &quot;atrial kick&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Potential for thrombi</td>
</tr>
</tbody>
</table>

Atrial Flutter
# Ventricular Tachycardia

**Monomorphic VT**
- **P Wave**: Rare
- **PR Interval**: Absent
- **QRS Rate**: Wide (>0.12) and bizarre
- **Rhythm**: Normally similar (monomorphic)
- **Pacemaker**: Originates in the ventricles
- **Comment**: Typically pulseless; Slower rhythms may have a pulse—typically not tolerated well for long periods.

**Polymorphic VT**
- **P Wave**: If present, dissociated from the QRS
- **PR Interval**: Absent
- **QRS Rate**: >120
- **Rhythm**: Varied appearance termed “polymorphic”
- **Pacemaker**: Originates in the ventricles
- **Comment**: Typically pulseless; Slower rhythms may have a pulse—typically not tolerated well for long periods.

Ventricular Tachycardia
Monomorphic VT

Polymorphic VT – Torsade des Pointes
Polymorphic Ventricular Tachycardia
Torsade des Pointes
Continuously Changing QRS Complex Morphology in a Crescendo-Decrescendo Pattern

Prolonged QT interval noted prior to sudden cardiac death.
### Ventricular Fibrillation

Fine V Fib

<table>
<thead>
<tr>
<th>P Wave</th>
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<th>Rhythm</th>
<th>Pacemaker</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>Absent</td>
<td>Chaotic, unable to quantify, poorly defined</td>
<td>Chaotic</td>
<td>Multiple ectopic foci throughout the ventricles</td>
<td>Cardiac arrest! Very poor prognosis!</td>
</tr>
</tbody>
</table>

Course V Fib

Ventricular Fibrillation

Coarse

Intermediate

Fine
## Sinus Bradycardia

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<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Before each QRS</td>
<td>Constant, regular</td>
<td>Rate &lt; 60</td>
<td>Regular</td>
<td>SA Node</td>
<td></td>
</tr>
<tr>
<td>Look alike</td>
<td>Interval .12-.20</td>
<td>Interval =/&lt; .10</td>
<td></td>
<td></td>
<td></td>
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Sinus Bradycardia
# Junctional Rhythms

<table>
<thead>
<tr>
<th>P Wave</th>
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<th>Rhythm</th>
<th>Pacemaker</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>May be before, during or after the QRS</td>
<td>Normal or prolonged</td>
<td>40-60</td>
<td>Regular</td>
<td>At the level of the AV node</td>
<td>The SA node malfunctions and the AV node initiates escape beats. Normally, the SA node overrides the AV.</td>
</tr>
</tbody>
</table>
Junctional Rhythm
## Idioventricular

<table>
<thead>
<tr>
<th>P Wave</th>
<th>PR Interval</th>
<th>QRS Rate</th>
<th>Rhythm</th>
<th>Pacemaker</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>Absent</td>
<td>Typically 20-40</td>
<td>Regular</td>
<td>Ventricles</td>
<td>Normal SA and AV node fail to generate an impulse; ventricles kick in with a rate of 20-40</td>
</tr>
</tbody>
</table>

May accelerate to 40-100
Idioventricular Rhythm
AV Block
First Degree Block

- Before each QRS
- Actually a delay rather than a block

<table>
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<th>Rhythm</th>
<th>Pacemaker</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before each QRS</td>
<td>&gt;.20</td>
<td>Brady to tachy</td>
<td>Regular</td>
<td>SA...with a delay</td>
<td>Typically Asymptomatic</td>
</tr>
</tbody>
</table>

First-degree AV Block
## Second Degree Block: Type I
(aka Wenckebach)

<table>
<thead>
<tr>
<th>P Wave</th>
<th>PR Interval</th>
<th>QRS Rate</th>
<th>Rhythm</th>
<th>Pacemaker</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size and shape normal; occasional P wave not followed by a QRS</td>
<td>Progressive lengthening of the PR until a QRS is dropped</td>
<td>&lt;.10 interval approximate 50-80</td>
<td>Atrial rate usually faster than ventricular due to the dropped beat</td>
<td>Problem at the AV Node level with increasing slowing</td>
<td>Causes may include drugs, ischemia, increased parasympathetic tone</td>
</tr>
</tbody>
</table>

Second-degree AV Block / Type I
## Second Degree Block: Type II

<table>
<thead>
<tr>
<th>P Wave</th>
<th>PR Interval</th>
<th>QRS Rate</th>
<th>Rhythm</th>
<th>Pacemaker</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Normal configuration</td>
<td>Intervals will remain constant</td>
<td>Slowed</td>
<td>• Atrial rate unaffected;</td>
<td>• Interval—in relation to</td>
<td>• Cause organic lesions</td>
</tr>
<tr>
<td>• May not have corresponding</td>
<td></td>
<td></td>
<td>ventricular rate slowed</td>
<td>AV Node &lt;.10 implies high</td>
<td>• May progress to 3\textsuperscript{rd} degree!</td>
</tr>
<tr>
<td>QRS</td>
<td></td>
<td></td>
<td>Ventricular irregular</td>
<td>level block; &gt;.12 implies</td>
<td>• Prepare to pace!</td>
</tr>
<tr>
<td>• May be a varied block</td>
<td></td>
<td></td>
<td>due to blocked beats</td>
<td>low level block</td>
<td></td>
</tr>
</tbody>
</table>

Second-degree AV Block / Type II
# Third Degree Block (complete)

<table>
<thead>
<tr>
<th>P Wave</th>
<th>PR Interval</th>
<th>QRS Rate</th>
<th>Rhythm</th>
<th>Pacemaker</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal configuration</td>
<td>No relationship</td>
<td>Atrial rate 60-100</td>
<td>Atrial and ventricular complexes are regular…but <strong>dissociated</strong></td>
<td>Damage to the conduction system results in NO passage of impulse; therefore, ventricle escape beats arise</td>
<td>Prepare to pace!!</td>
</tr>
<tr>
<td></td>
<td>between the P and R</td>
<td>Ventricular rate 20-40</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Third-degree AV Block
Premature Beats
PAC (Premature Atrial Contraction)

- Caused by a premature contraction
- Patient may or may not sense a “skipped” beat

PVC (Premature Ventricular Contraction)

- PVC
- Bigeminy
- Multi-focal or Polymorphic PVC’s
- Trigeminy
Pulseless Electrical Activity
What is PEA?

Definition:

“PEA is a rhythmic display of some type of electrical activity other than VT/VF, but without an accompanying pulse that can be palpated by any artery.”
PEA is a Survivable Rhythm

Key to Survival: Rapidly determining underlying causes

<table>
<thead>
<tr>
<th>6 H’s</th>
<th>6 T’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypovolemia</td>
<td>Tablets, toxins</td>
</tr>
<tr>
<td>Hypoxia</td>
<td>Tamponade, Cardiac</td>
</tr>
<tr>
<td>Hydrogen Ion (acidosis)</td>
<td>Tension Pneumothorax</td>
</tr>
<tr>
<td>Hyper/hypo-kalemia</td>
<td>Thrombosis, Cardiac</td>
</tr>
<tr>
<td>Hypothermia</td>
<td>Thrombosis, Pulmonary</td>
</tr>
<tr>
<td>Hypoglycemia</td>
<td>Trauma</td>
</tr>
</tbody>
</table>

- PEA: Pointless Electrical Activity
Rhythm Characteristics in PEA Relative to Resuscitation Outcome

Figure 2A

Rhythm Prevalence                  Successful Resuscitation

Normal QRS with P Wave
Wide QRS with P Wave
Wide QRS without P Wave
Very Wide QRS without P Wave

Rhythm Prevalence
Successful Resuscitation
Asystole
Asystole

- Absent
- Absent
- None
- None
- No electrical activity!
- Cardiac arrest!
- Very poor prognosis!

Asystole
Present in 3 leads