Cardiovascular Technology

Application and Dysrhythmia Interpretation

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St. Joseph Healthcare 2008
Cardiac Rhythm & Dysrhythmias

I. Anatomy and Physiology of the Heart
II. What is an EKG?
III. Stages of the Heart Beat & How we measure them
IV. Steps to Interpret Rhythms
V. Dysrhythmia Groups

Sinus
1. Normal Sinus Rhythm (NSR)
2. Sinus Tachycardia (ST)
3. Sinus Bradycardia (SB)
4. Sinus Arrhythmia (SA)
5. Sinus Arrest – Asystole
6. Pause
7. Pulseless Electrical Activity (PEA)

Junctional Premature Beats
1. Premature Atrial Contraction (PAC)
2. Premature Junctional Contraction (PJC)
3. Premature Ventricular Contraction (PVC)
   a. PVC
   b. Couplet
   c. Triplet
   d. Bigeminy
   e. Trigeminy

Ventricular
1. Ventricular Tachycardia
2. Sustained V Tach
3. Idioventricular
4. Torsades de Pointes
5. Ventricular Fibrillation

Pacemakers
1. Failure to Capture
2. Failure to Sense
3. Atrial Paced
4. Ventricular Paced
5. AV Paced

Atrial
1. Atrial Fibrillation (A-Fib)
2. Atrial Flutter (A-Fl)
3. Wandering Atrial Pacemaker (WAP)
4. Paroxysmal Atrial Tachycardia (PAT)
5. Paroxysmal Supraventricular Tachycardia (PSVT)

Other Wave Changes
1. ST Elevation
2. ST Depression
3. Tall T Waves
4. Inverted T Waves
5. Tall P Waves
6. Inverted P Waves

Heart Blocks
1. Bundle Branch Block (BBB)
2. AV Blocks (Atrial-Ventricular Block)
   a. First Degree AV Block
   b. Second Degree AV Block – Type 1 – Wenckebach
   c. Second Degree AV Block – Type 2 – Mobitz II
   d. Third Degree – Complete Heart Block

Regions of the Heart

- Sinus
- Atrial
- Junctional
- Ventricular
http://www.smm.org/heart/heart/circ.htm
The heart is made up of four chambers:

- **Right Atrium**
- **Left Atrium**
- **Right Ventricle**
- **Left Ventricle**
The first part of the heartbeat

Oxygen-poor blood from the body fills right atrium

Oxygen-rich blood from lungs fills left atrium
Then both Atria Contract

Pushing all the blood into the left and right Ventricles
They usually contract at the same time
The Second Part of the Heartbeat

The Ventricles Contract, occurs at about the same time:

The Right Ventricle Sends blood through the Pulmonary Artery To the Lungs to pick up Oxygen

The Left side Sends oxygen Rich blood through the Aorta to The body

The combination of the 1st and 2nd part of the heartbeat Creates the Lub-Dub, the first and second sounds of the heart beat
What makes the heart pump?

Natural Electric Impulses

Which stimulate heart muscle to contract

- The heart is made primarily of muscle
- When the muscle contracts, it squeezes the blood through the heart and out to the lungs or to the body
Where does the Electricity Come From?

Pacemakers

The heart has natural power generators that tell the heart to pump.

The primary pacemaker is the SA Node
Located in the top of the Right Atrium

The AV node is located in the junction Of both Atria and both Ventricles

* Secondary pacemakers *
are scattered throughout the heart
They function as a lifesaving backup if the SA node fails, though sometimes they malfunction
How Electricity Travels…

**Electrical Conduction Pathway**

“Power lines” quickly carry electrical impulses from the pacemakers throughout the heart
What Electricity Does…

**Myocardium**—one of three layers of the heart. Muscle cells which make up the bulk of the heart. They are able to generate or pass on electricity.

Electricity that originated at the pacemaker cells, now waves across the muscle cells, causing them to contract which pumps the blood through the heart.
http://hybridmedicalanimation.com/anim_heart.html
This is the normal pathway for electricity to travel through the heart

SA node

AV node

Bundle of His

• Left bundle branch
• Right bundle branch

= Myocardium contracts
SA Node (inherent rate of 60 – 100)

Atrial foci (inherent rate of 60 – 80)

Junctional foci (inherent rate of 40 – 60)

Ventricular foci (inherent rate of 20 – 40)

When the hospitals in New Orleans lost power after Katrina, they progressed down the different levels of functioning. At first they could still function but not as well as they could with full power. The further down the power source went, they were not as efficient or as effective as the previous level.

Each area can pace, but not as well as the area above it!

The lower the level in the heart, where the foci is located that is doing the pacing, the lower is the “inherent rate” (heart rate) produced by that area. A foci is a potential pacemaker (or cell) that is capable of pacing in emergency situations.
Decoding a Rhythm Strip
Section 2

What Is An EKG?

• A graphic representation of the electrical activity of the heart

As electricity travels across the heart, it causes the cells to shorten, which causes the heart to beat!
This propels the blood through the heart and out to the lungs or to the body!
The Electrical Basis of the EKG

Electrical impulses are present on the skin surface at a very low voltage; The EKG machine picks up these impulses and amplifies them. Electrical activity is sensed by Electrodes are placed on the skin surface to pick up these impulses and give us a picture of how they are traveling in the form of an Electrocardiogram. This is printed on EKG paper and is called a Rhythm strip or an EKG strip.
These lines represent the electricity traveling over specific parts of the heart.
Stages of the Heartbeat:

- **P wave**: Atria contract
- **QRS**: Ventricles contract
- **T wave**: Ventricles relax

P Wave, QRS & T Wave make up one complete CARDIAC CYCLE
Breaking down the QRS complex

There may be 3, 2 or only 1 part of the QRS present. It is still called a QRS!
To know if the heart is healthy, we measure the size of these waves.
How We Measure: EKG Paper

As the paper prints out...... we are measuring time......

Duration (Time) Measured in Seconds

Amplitude

milliVolts
• EKG paper is divided into small squares and larger squares

• **Large squares** are defined by a dark line. They are 5 squares high and 5 squares long *(0.20 seconds)*

• **Small squares** may be lines or may be dots within the dark lines. They are **0.04 seconds**
What We Measure

• Heart rate
• PR interval
• QRS interval
• QT Interval

May be done in ICU’s and if patient is on certain medications (i.e. Tikosyn)
Heart Rate: The Easy Way

Look for marks below EKG grid

Every mark is 3 seconds

(2 marks = 6 seconds)

Count the # of beats by 10’s (10-20-30-40…)

On a 6 second strip

HR for example above = 80 bpm
Intervals We Measure

- PR Interval
- QRS Interval
- QT Interval
Artifact

- EKG waveforms from sources outside the heart
- Interference seen on a monitor or EKG strip
  - 4 causes
    - Patient movement (i.e. pt. with tremors)
    - Loose or defective electrodes (fuzzy baseline)
    - Improper grounding (60 cycle interference)
    - Faulty EKG apparatus
When two cars are traveling a distance at the same miles per hour, the one with the shorter distance will arrive at their destination first. Likewise, it takes a certain amount of time for electricity to travel to a destination in the heart. By measuring these distances and how long it takes to travel, we get a picture of what is going on in the heart.
An easy method to measure the different waveforms is a ruler (If you do not have one, see your clinical educator). Other methods include using calipers, memorizing charts, using tables or even a scrap piece of paper.

The clear spaces are used for measuring

Match up the lines! Don’t place over the rhythm strip.

<table>
<thead>
<tr>
<th>PR</th>
<th>Junctional / PVC</th>
<th>Normal PR / PAC</th>
<th>1st Degree AVB</th>
</tr>
</thead>
<tbody>
<tr>
<td>QRS</td>
<td>Normal QRS</td>
<td>BBB</td>
<td>wide QRS blending into T wave = Ventricular beat / PVC</td>
</tr>
</tbody>
</table>

**Saint Joseph CVTs**

**Measure Up!**

- **CHART QUALITY STRIPS!**
  - Pt label & name match
  - Document if pt off unit
  - Tracing within graph lines
  - No folded strips
  - Don't exceed page width

- **RUN STRIPS for:**
  - Within 1 hr of 8-12-4
  - Admit or transfer
  - Rhythm changes
  - Invasive procedures: (OR, cath lab, endo)

- **STEPS:**
  - Regular?
  - P, QRS, T pattern?
  - HR?
  - PR?
  - QRS?

- **Wenkebach**
  - .12-.20-.28-B-.12-.20-.28-B

- **Mobitz II**
  - .20-B-.20-.20-B-.20-B-B

- **3rd Degree AVB**
  - .32-B-.24-.16-B-.44-B-.20-B
Normal PR / PAC

BBB
QRS

Normal QRS

Junctional / PJ

PR

.04 .06 .08 .10

QRS

Normal QRS
Steps to Interpret Rhythms

Normal Values

Heart Rate: 60-100 beats per minute

PR Interval: .12-.20 seconds

QRS Interval: < .11 seconds

1. Are the beats at regular or irregular intervals apart?

2. Do you see P, QRS, T pattern?

3. What is the HEART RATE?

4. What is the PR INTERVAL?

5. What is the QRS INTERVAL?
Origin of Rhythms

They are named for the structure of the heart where the foci (a cell sending off an electrical impulse) is located that is producing the abnormal rhythm.

- **Sinus** (Sinus node)
- **Junctional** (Area between the atria & ventricles)
- **Ventricular** (any cell in the ventricles)
- **Atrial** (any cell in the atria)
- **AV Blocks** (AV node blocking some or all of the passage of electricity through it)
Regions of the Heart

- Sinus
- Atrial
- Junctional
- Ventricular
Normal Sinus Rhythm (NSR)

The SA node has generated an impulse that followed the normal pathway of the electrical conduction system

- Rate normal 60-100
- PR normal .12-.20
- QRS normal ≤ .11
Sinus Bradycardia (SB)

- Everything measures normal except the HR is less than 60
Sinus Tachycardia (ST)

- Normal except HR >100 bpm
Sinus Arrhythmia (SA)

Normal except irregular

The difference between the fastest two heart beats (from 1 QRS to the next QRS) and the slowest two heart beats is greater than .12 sec
Asystole

No electrical activity

Code Blue
Pause

Period of no electrical activity, then electrical activity resumes
Pulseless Electrical Activity (PEA)

Normal rhythm, but...No Pulse*

Electrical activity is present but there is no pulse, so the heart is not beating! Something has happened to prevent the muscular tissue from responding to the electrical activity

(i.e. ↓↑ K+, hypothermia, Pneumothorax, cardiac tamponade, hypovolemia, drug overdose, pulmonary or coronary thrombosis)

Code BLUE!
Rhythms arising from the SA Node

- Sinus Rhythm
- Sinus Tachycardia
- Sinus Bradycardia
- Sinus Arrhythmia
- Asystole
- Pulseless Electrical Activity
Regions of the Heart

- Sinus
- Atrial
- Junctional
- Ventricular
**Sinus**

PR Interval will be normal

---

**Junctional**

PR Interval will be Less than normal

Or...

There will Be no P Wave
Junctional Rhythm

No P

or

PR < .12
Regions of the Heart

- Sinus
- Atrial
- Junctional
- Ventricular
Sinus
Atrial

Junctional

Ventricular
Sinus Rhythm

Junctional Rhythm

Ventricular Rhythm
Sinus
Atrial
PR = .12-.20

Junctional
PR < .12

Ventricular
Wide QRS
Premature Beats

• Not a rhythm, just a single early beat

Three Options:

• If it arises from the Atria, it will have a normal PR Interval
  This is a Premature Atrial Contraction or PAC

• If it arises from the Junctional area, it will have a PR Interval
  which is less than normal or no P wave at all
  This is a Premature Junctional Contraction or PJ C

• If it arises from the Ventricular area, it will be a QRS which is
  wide and bizarre shaped
  This is a Premature Ventricular Contraction or PVC
No P Wave

P Wave Close to QRS

A wide bizarre QRS

Junctional Rhythm w/ PVC
Sinus Rhythm

SR w/ PAC
Junctional Rhythm

SR w/ PJC
Ventricular Rhythm

SR w/ PVC
Ventricular Arrhythmias
When are PVCs a Problem?

- Increase from the patient’s normal amount
- Multiple PVCs in a row
- PVC falls on the T wave of previous beat
- **Multifocal** (they arise from different cells, therefore they are different shapes)

**Multifocal PVCs**
PVC Troubles

**Bigeminy** = every other beat is a PVC

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**Trigeminy** = every 3rd beat is a PVC
Multiple PVCs

Couplet

Triplet
Ventricular Tachycardia (VT)

- 4 or more ventricular beats in a row
- Rate $\geq 150$ bpm

If you step on A Tack, you will Get off of it fast!

6 beats of VTach
Sustained VTach

Pt stays in VTach & needs our help to switch (defibrillate or cardiovert)

Code BLUE!
Idioventricular Rhythm

- Ventricular beats, but...
- slow rate
Torsades de Pointes

A form of VTach which looks like the rhythm strip is twisting

Code BLUE!
Ventricular Fibrillation (VF)

- Squiggly line
- Code BLUE!
VENTRICULAR BEATS REVIEW

1 Ventricular Beat = PVC
2 Beats = Couplet
3 Beats = Triplet

More than 3 beats at fast rate = V Tach

Ventricular beats at slow rate = Idioventricular
Ventricular beats twisting tall-short-tall = Torsades

No QRS, just shaking = V Fib
Every second beat is ventricular = Bigeminy
Every third beat = Trigeminy
Pacemakers
Pacemaker Changes on EKG

* You must select pacemaker mode on the monitor

  A straight pacemaker “spike” will appear

A spike before the P wave site is “A-paced”
before the QRS is “V-paced”
before both is “AV-paced”

A-paced

V-paced
Pacemaker Troubles

“What Can Go Wrong?”
Failure to Capture

- Pacer spike is fired, but no beat follows

You can have QRS’s without pacer spikes, but you cannot have pacer Spikes without a QRS following it!
Failure to Sense

- Heart is beating just fine, but pacemaker fires anyway. The pacemaker should sense what the heart is doing on its own so it doesn’t send out an electrical stimulus at a time when the heart is more vulnerable.
- Spikes are not in a consistent place before P or QRS --they are seen in many different places.
Regions of the Heart

- Sinus
- Atrial
- Junctional
- Ventricular
**Atrial Flutter**
Can count the # of flutter waves (P waves)

**Atrial Fibrillation (Afib)**
Unable to count the # of waves
Wandering Atrial Pacemaker

Different pacemakers fire in a row.

Since they come from different areas in the atria, they will be shaped differently on the strip.
Wandering Atrial Pacemaker (WAP)

- P waves vary in shape (at least 3 different P waves)
- They are coming from different areas of the Atria so they may have different PR Intervals, also
Sudden rate change ≥ 150 bpm

**Paroxysmal Atrial Tachycardia (PAT)**

**Paroxysmal Supraventricular Tachycardia (PSVT)**

Cannot distinguish a P wave after the HR gets fast
Atrial Rhythms Review

- Atrial Flutter
- Atrial Fibrillation
- Wandering Atrial Pacemaker
- Paroxysmal Atrial Tachycardia
- Paroxysmal Supraventricular Tachycardia
Early **Indications** that a heart is having difficulty!
The QRS should **enter** & **exit** on the baseline.

**ST Depression** (Ischemia)
(QRS exits lower than it starts)
- **enters**
- **exits**

**ST Elevation** (Infarction)
(QRS exits higher than it starts)
- **enters**
- **exits**
I would probably have a heart attack if I had to climb this!

He sure is down and depressed!
Other Wave Changes

- Tall T waves
- Inverted T waves (upside-down)
- Tall P waves
- Inverted P waves

- Only inverted P waves are normal
Only 1 group of arrhythmias to go!

I feel like I am on a treadmill!
Heart Blocks
What’s the Difference Between Heart Blockage & Block?

**Heart Blockage**

Clogged blood vessels = decrease in oxygen to the heart = heart attack

**Electricity blocked from traveling normally = dysrhythmia**

**Plumbing !**

**Electricity !**
Bundle Branch Blocks (BBB)

It takes longer for electricity to travel around the blockade to contract the ventricles.

Takes longer for ventricles to contract

This shows as a wide QRS \( \geq .12 \)

Left BBB
You are trying to get to Lexington from Berea. There is a Wreck on the Clays Ferry Bridge and the bridge will be Shut down indefinitely. You can still get to Lexington, you Will just have to go a different route, which will take longer.
Atrial Ventricular Heart Blocks

The AV Node acts as the gatekeeper for the ventricles, holding the electrical impulse a brief interval to make sure the Atria have finished contracting thus expelling all the blood into the ventricles before allowing the ventricles to contract.

- Electricity contracts atria first, then travels down to contract the ventricles.
- If the electricity is blocked between the atria & ventricles, the travel time (PR) is abnormal.
- Hence, AV blocks have an abnormal PR interval.
Types of AV Blocks

- **First Degree**
- **Second Degree**
  - Wenckebach/Mobitz I
  - Mobitz II
- **Third Degree**

*lightest* 1°AVB

*worst* 3°AVB
First Degree AV Block
(1º AVB)

• PR interval > .20

Example PR intervals: .28 - .28 - .28 - .28 - .28 - .28
Mobitz I: Wenkebach

- PR interval gradually longer until a QRS is dropped
  - “B” indicates a Blocked Beat
- Pattern is repeated
- Typically not harmful

Example PR intervals: 0.14 - 0.20 - 0.32 – B - 0.14 - 0.20 – 32 - B
**Mobitz II**

- PR interval consistent except some QRS missing
- **Harmful**—may indicate serious heart disease or progress to 3rd degree block

Example PR intervals: \(0.16 - B\) - \(0.16 - B\) - \(0.16\) - \(0.16 - B\)
3rd Degree AV Block (3º AVB)

Atria & ventricles act independently
- Regular P waves
- Regular QRS complexes

But…P waves and QRS not working together
- PR interval varies (but not in Wenkebach pattern)
- Harmful -- patient needs a pacemaker soon!

Example PR intervals: .14 – B - .20 – B – B - .12 – B - .44 - .32 - B
Wenckebach Theme Song

http://www.youtube.com/watch?v=GVxJ2DBPiQ
Block Review

Bundle Branch Blocks

QRS > .11

1º AVB

.24 - .24 - .24 - .24 - .24

- PR interval > .20

Wenkebach

.12 - .18 - .24 - B - .12 - .18 - .24 - B

- PR gradually longer until QRS dropped

Mobitz II

.12 - B - .12 - .12 - B - .12 - B

- PR regular except some QRS are dropped

3º AVB

.12 - B - .20 - B - B - .16 - .44 - B - .32

- PR interval varies, but not in Wenkebach pattern
# Heart Block Review

<table>
<thead>
<tr>
<th></th>
<th>Other Name</th>
<th>PR Interval</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st °AV Block</td>
<td></td>
<td>Same</td>
<td>PR Interval &gt; .20</td>
</tr>
<tr>
<td>2nd °AV Block</td>
<td>Wenkebach or Mobitz I</td>
<td>Different</td>
<td>PR Interval gets longer until 1 is dropped</td>
</tr>
<tr>
<td>2nd °AV Block</td>
<td>Mobitz II</td>
<td>Same</td>
<td>PR Interval is the same when you can measure it, some p waves do not have a QRS after it so you can’t measure a PR Interval for all</td>
</tr>
<tr>
<td>3rd °AV Block</td>
<td></td>
<td>Different</td>
<td>PR Interval varies but not in any pattern, P waves and QRS waves are not in any relationship to each other</td>
</tr>
</tbody>
</table>

**Bundle Branch Block = QRS is > .11**

**PR Interval**

PR Interval’s are the same - it will either be 1st Degree AVB (QRS for every P) or Mobitz II (May or may not have QRS for every P)

PR Interval’s vary – it will either be Wenkebach (pattern) or 3rd Degree AVB (no pattern)
Which rhythms are a CODE Blue?

- VT
- VFib
- Asystole
- Torsades
- PEA
Performing a 12 Lead EKG
12 Lead (views) of the Heart

Anterior leads:
V1, V2, V3, V4, V5, V6

Lateral leads:
AVR
AVL

Inferior leads:
I, II, III

AVF
Skin Prep:
For quality EKGs

You need good contact between the skin & electrode

- Hair interferes with the EKG reading—shave if needed!
- Rub with alcohol to remove body oil
- Rub with a dry 2×2 gauze to remove old skin cells
V1 & V2 in the 4th rib space (barely above the nipple to each side of the sternum—
not on the sternum!)
V4 in line with mid-collarbone
V6 in line w/ mid-underarm
V3 will go halfway between V2 & V4
V5 in line w/ underarm front, halfway between V4 & V6
Limb Lead Placement

Limb leads can be placed anywhere on the limbs and still get the same reading but, **AVOID BONY AREAS!**
• Verify the EKG is ordered & you have the correct patient
• Explain to the patient what you are doing
• Ask patient to lie down
• Maintain privacy (close door, pull curtain, uncover minimally)
• Prep skin, attach electrodes & wires
• If pacemaker is to be turned off, RN must turn it off and RN must remain in the room until pacemaker is back on.
• Ask the patient not to move
• Wait for tracings to stabilize
• Press “Record EKG”
• Verify patient name, room #, and quality tracing
• Detach electrodes & wires
• Place EKG on chart or give to requesting MD
If ordered stat, do it right away! Rhythms can change in a matter of minutes!
A patient could code at any time...
so be prepared—
100% Quality Monitoring
100% of the Time
Top 3 Absolutes!

#1—Change batteries

#2—Fix loose electrodes (leads)

#3—Ensure all patients are on the monitor
  – Make sure staff call you before removing transmitters
  – Place a location label on patients off the unit
  – Re-attach the transmitters when patients return
  – Re-engage alarms by removing “off unit” label

Patients have died when alarms were off & arrhythmias unnoticed
Transmitters

- Only use a transmitter that is assigned to your specific pt’s room
  - If transmitter is broken or missing, use a spare
  - Do NOT allow staff to use transmitter from another room
  - Call the House Administrator if additional spares needed
- ALWAYS double-check transmitter # before using
- Insist staff return transmitters immediately upon discharge!
- Inventory transmitters & track missing equipment ASAP
- Notify UM of broken or missing equipment (repairs by Bio-med)
- Clean transmitters & wires between patients (wear gloves)

Make sure staff place soiled transmitters in soiled bin—not on your desk!
Patients who are at greater risk of developing Cardiac problems:

- New patients
- Confused patients (often pull off their monitor)
- Recent or current procedure
- Recent EKG change or risky rhythm
Troubleshooting

If the heart rhythm is not transmitting correctly:

- **Check the electrodes & change if necessary**
- **Change the battery**
- **Try a different transmitter box**
- **Try a different set of lead wires**

If still no success:

- **Use a spare transmitter & notify Bio-Med**
Documentation

• Run strips every 4 hours (8-12-4)
  * Strips must be run within 1 hour of above times
• Measure & interpret the 8 o’clock strips & have nurse sign
• Also run strips:
  – Upon admission or transfer
  – After invasive procedures (cath lab, OR, endoscopy)
  – New or risky rhythms
• If a patient is off the unit when you run strips,
  – document where the pt is on the strip
  – leave yourself a note to run a strip when they return
Charting Strips

• **No poor quality strips** in the chart—run another strip
• Cut strips so the name, room #, and time are displayed
• Strips must be 6 seconds in length, but not exceed page width
• Do not fold strips. Cut & write “continuous” on the strip
• Place first strip at bottom of the page, and work upward
• **Verify the pt labels match when placing strip on the chart!**
• Make sure rhythm is not outside grid lines (too tall or small)
• Do not write over the rhythm tracing
• Don’t tape over writing or rhythm. Use double-stick tape.
Patient Confidentiality

Protect privacy...Please do not look up rhythms or info on patients you (or others) are not treating

(This includes yourself, family, & friends)

Don’t risk it--People have been terminated for this!
YOU MADE IT!

Congratulations ! ! !
Now......
Study....Study....Study

Dysrhythmia's