



ECG interpretations



Learning Modules

- ECG Basics
- How to Analyze a Rhythm
- Normal Sinus Rhythm
- Heart Arrhythmias

Normal Impulse Conduction

Sinoatrial node



AV node



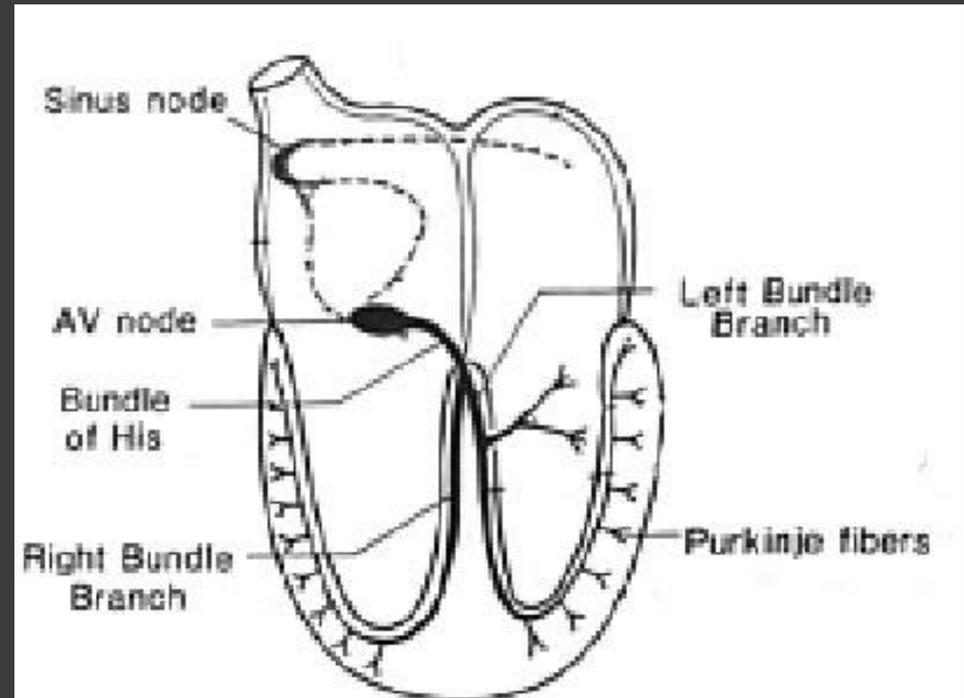
Bundle of His



Bundle Branches



Purkinje fibers



Impulse Conduction & the ECG

Sinoatrial node



AV node



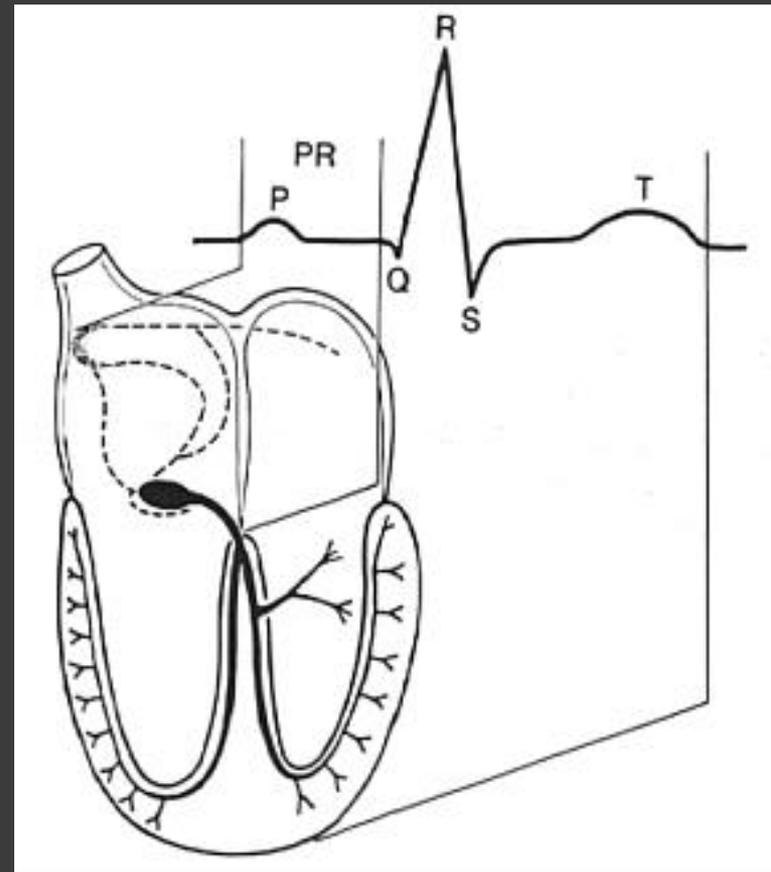
Bundle of His



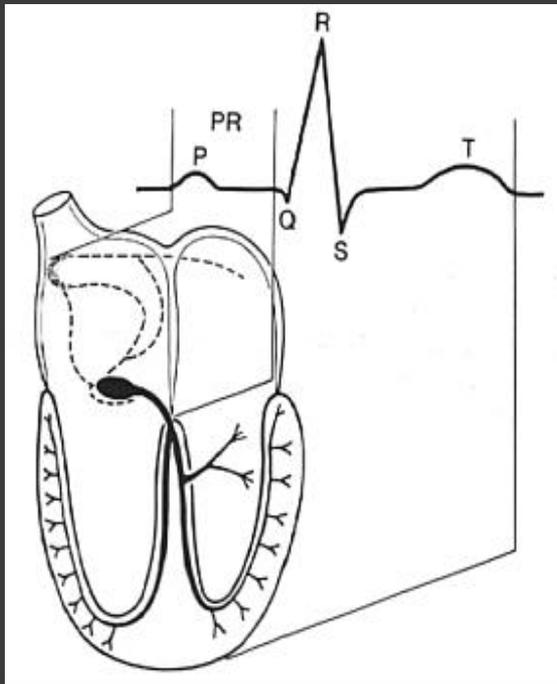
Bundle Branches



Purkinje fibers



The “PQRST”



P wave - Atrial depolarization

- **QRS** - Ventricular depolarization

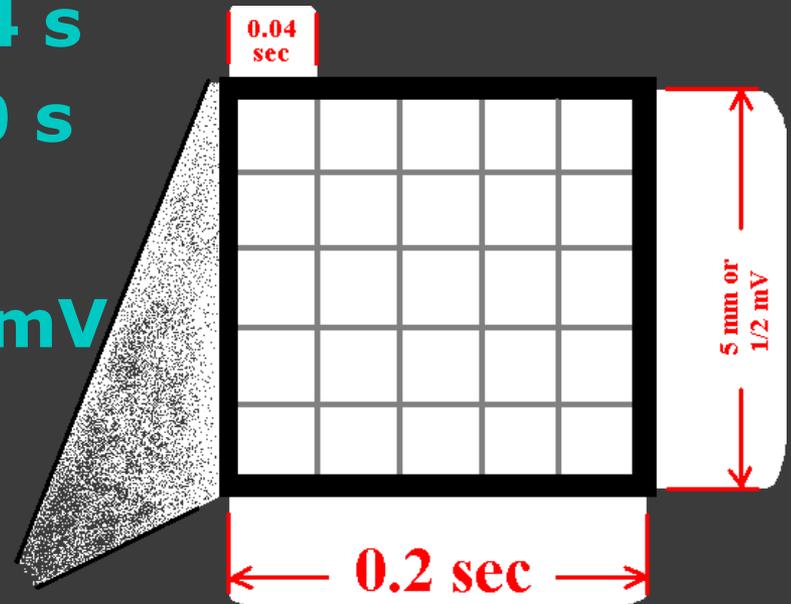
T wave - Ventricular repolarization

Pacemakers of the Heart

- **SA Node** - Dominant pacemaker with an intrinsic rate of 60 - 100 beats/ minute.
- **AV Node** - Back-up pacemaker with an intrinsic rate of 40 - 60 beats/minute.
- **Ventricular cells** - Back-up pacemaker with an intrinsic rate of 20 - 45 bpm.

The ECG Paper

- Horizontally
 - One small box - 0.04 s
 - One large box - 0.20 s
- Vertically
 - One large box - 0.5 mV



The ECG Paper (cont)



- Every 3 seconds (15 large boxes) is marked by a vertical line.
- This helps when calculating the heart rate.

NOTE: the following strips are not marked but all are 6 seconds long.



ECG Rhythm Interpretation

Really Very Easy

How to Analyze a Rhythm

Rhythm Analysis



- Step 1: Calculate rate.
- Step 2: Determine regularity.
- Step 3: Assess the P waves.
- Step 4: Determine PR interval.
- Step 5: Determine QRS duration.

Step 1: Calculate Rate



- **Count the # of R waves in a 6 second rhythm strip, then multiply by 10.**
- **Reminder: all rhythm strips in the Modules are 6 seconds in length.**

Interpretation? *9 x 10 = 90 bpm*

Step 2: Determine regularity

R R



- Look at the R-R distances (using a caliper or markings on a pen or paper).
- Regular (are they equidistant apart)?
Occasionally irregular? Regularly irregular? Irregularly irregular?

Interpretation?

Regular

Step 3: Assess the P waves



- Are there P waves?
- Do the P waves all look alike?
- Do the P waves occur at a regular rate?
- Is there one P wave before each QRS?

Interpretation? *Normal P waves with 1 P wave for every QRS*

Step 4: Determine PR interval



- Normal: 0.12 - 0.20 seconds.
(3 - 5 boxes)

Interpretation? *0.12 seconds*

Step 5: QRS duration



- Normal: 0.04 - 0.12 seconds.
(1 - 3 boxes)

Interpretation? *0.08 seconds*

Rhythm Summary



- Rate 90-95 bpm
- Regularity regular
- P waves normal
- PR interval 0.12 s
- QRS duration 0.08 s

Interpretation? *Normal Sinus Rhythm*

NSR Parameters



- Rate 60 - 100 bpm
- Regularity regular
- P waves normal
- PR interval 0.12 - 0.20 s
- QRS duration 0.04 - 0.12 s

Any deviation from above is sinus tachycardia, sinus bradycardia or an arrhythmia

SA Node Problems

The SA Node can:

- fire too slow *Sinus Bradycardia*
- fire too fast *Sinus Tachycardia**



Arrhythmias

- Sinus Rhythms
- Premature Beats
- Ventricular Arrhythmias
- AV Junctional Blocks



Sinus Rhythms

- *Sinus Bradycardia*
- *Sinus Tachycardia*
- *Sinus Arrest*
- *Normal Sinus Rhythm*

Rhythm #1



- Rate? 30 bpm
- Regularity? regular
- P waves? normal
- PR interval? 0.12 s
- QRS duration? 0.10 s

Interpretation? *Sinus Bradycardia*

Sinus Bradycardia



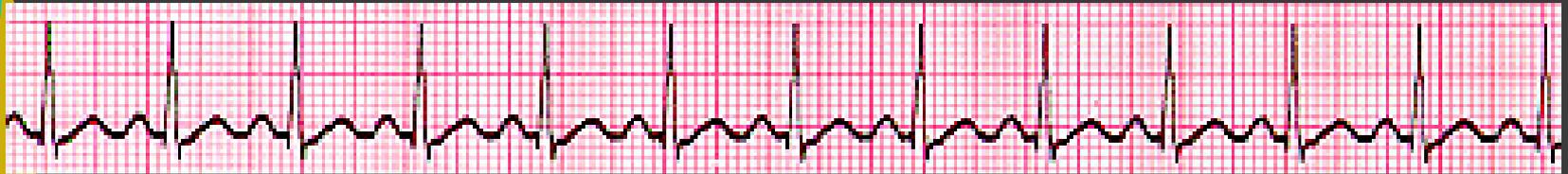
- Deviation from NSR
 - Rate < 60 bpm

Sinus Bradycardia



- **Etiology:** SA node is depolarizing slower than normal, impulse is conducted normally (i.e. normal PR and QRS interval).

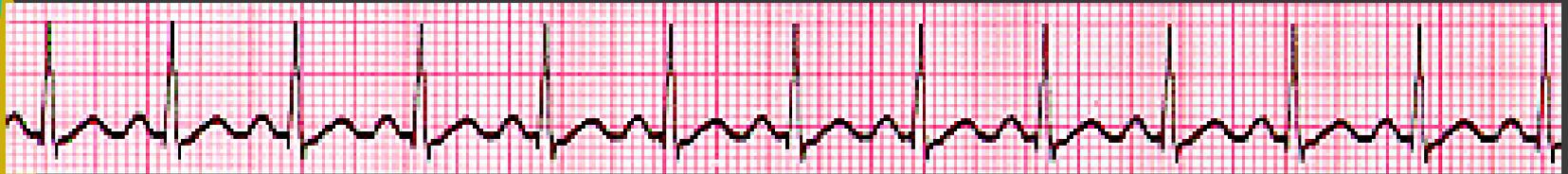
Rhythm #2



- Rate? 130 bpm
- Regularity? regular
- P waves? normal
- PR interval? 0.16 s
- QRS duration? 0.08 s

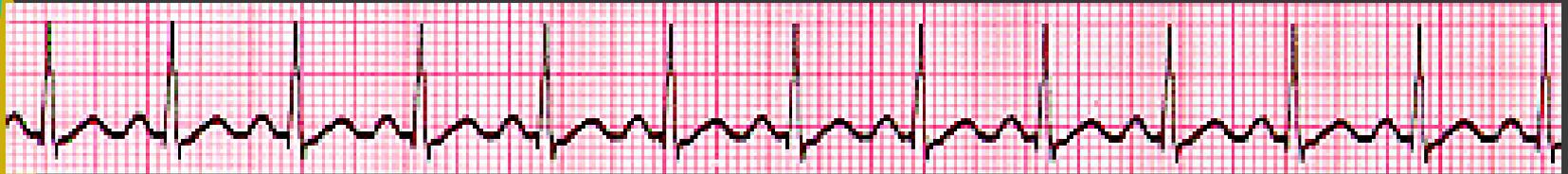
Interpretation? *Sinus Tachycardia*

Sinus Tachycardia



- Deviation from NSR
 - Rate > 100 bpm

Sinus Tachycardia



- **Etiology:** SA node is depolarizing faster than normal, impulse is conducted normally.
- Remember: sinus tachycardia is a response to physical or psychological stress, not a primary arrhythmia.

Sinus Arrest



- **Etiology:** SA node fails to depolarize and no compensatory mechanisms take over
- Sinus arrest is usually a transient pause in sinus node activity

Premature Beats

- *Premature Atrial Contractions (PACs)*
- *Premature Ventricular Contractions (PVCs)*

Rhythm #3



- Rate? 70 bpm
- Regularity? occasionally irreg.
- P waves? 2/7 different contour
- PR interval? 0.14 s (except 2/7)
- QRS duration? 0.08 s

Interpretation? *NSR with Premature Atrial Contractions*

Rhythm #4



- Rate? 60 bpm
 - Regularity? occasionally irreg.
 - P waves? none for 7th QRS
 - PR interval? 0.14 s
 - QRS duration? 0.08 s (7th wide)
- Interpretation? *Sinus Rhythm with 1 PVC*

PVCs



- Deviation from NSR
 - Ectopic beats originate in the ventricles resulting in wide and bizarre QRS complexes.
 - When there are more than 1 premature beats and look alike, they are called "uniform". When they look different, they are called "multiform".



Supraventricular Arrhythmias

- *Atrial Fibrillation*
- *Atrial Flutter*

Rhythm #5



- Rate? 100 bpm
- Regularity? irregularly irregular
- P waves? none
- PR interval? none
- QRS duration? 0.06 s

Interpretation? *Atrial Fibrillation*

Atrial Fibrillation



○ Deviation from NSR

- No organized atrial depolarization, so no normal P waves (impulses are not originating from the sinus node).
- Atrial activity is chaotic (resulting in an irregularly irregular rate).

Rhythm #6



- Rate? 70 bpm
- Regularity? regular
- P waves? flutter waves
- PR interval? none
- QRS duration? 0.06 s

Interpretation? *Atrial Flutter*

Atrial Flutter



- Deviation from NSR
 - No P waves. Instead flutter waves (note "sawtooth" pattern)

AV Nodal Blocks

- *1st Degree AV Block*
- *2nd Degree AV Block, Type I*
- *2nd Degree AV Block, Type II*
- *3rd Degree AV Block*

Rhythm #10



- Rate? 60 bpm
- Regularity? regular
- P waves? normal
- PR interval? 0.36 s
- QRS duration? 0.08 s

Interpretation? *1st Degree AV Block*

1st Degree AV Block



- Deviation from NSR
 - **PR Interval** > 0.20 s

1st Degree AV Block



- **Etiology:** Prolonged conduction delay in the AV node or Bundle of His.

Rhythm #11



- Rate?
- Regularity?
- P waves?
- PR interval?
- QRS duration?

50 bpm

irregular

normal, but 4th no QRS

Lengthens differ one exceed
normal PR interval length
0.08 s

Interpretation? *2nd Degree AV Block, Type I*

2nd Degree AV Block, Type I



- Deviation from NSR
 - PR interval progressively lengthens, then the impulse is completely blocked (P wave not followed by QRS).

2nd Degree AV Block, Type I



- **Etiology:** Each successive atrial impulse encounters a longer and longer delay in the AV node until one impulse (usually the 3rd or 4th) fails to make it through the AV node.

Rhythm #12



- Rate? 40 bpm
- Regularity? regular
- P waves? nl, 2 of 3 no QRS
- PR interval? 0.14 s
- QRS duration? 0.08 s

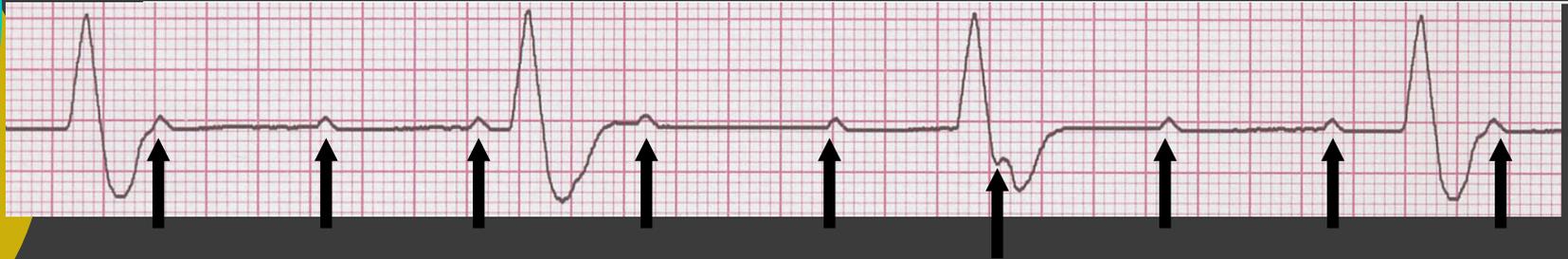
Interpretation? *2nd Degree AV Block, Type II*

2nd Degree AV Block, Type II



- Deviation from NSR
 - Occasional P waves are completely blocked (P wave not followed by QRS).

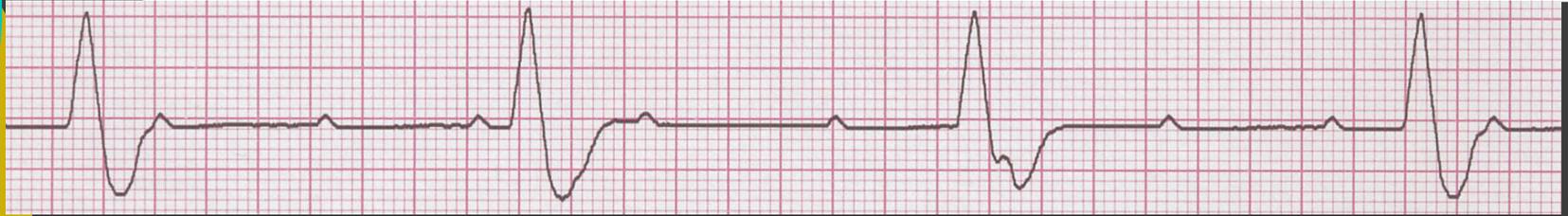
Rhythm #13



- Rate? 40 bpm
- Regularity? regular
- P waves? no relation to QRS
- PR interval? none
- QRS duration? wide (> 0.12 s)

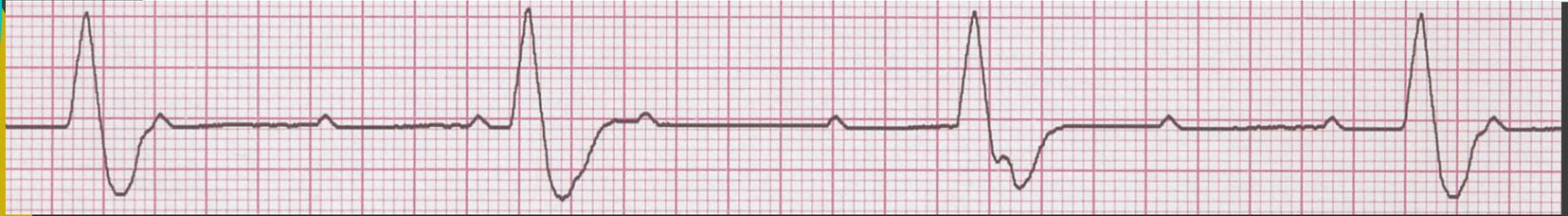
Interpretation? *3rd Degree AV Block*

3rd Degree AV Block



- Deviation from NSR
 - The P waves are completely blocked in the AV junction; QRS complexes originate independently from below the junction.

3rd Degree AV Block



- **Etiology:** There is complete block of conduction in the AV junction, so the atria and ventricles form impulses independently of each other.
- Without impulses from the atria, the ventricles own intrinsic pacemaker kicks in at around 30 - 45 beats/minute.

Remember

- When an impulse originates in a ventricle, conduction through the ventricles will be inefficient and the QRS will be wide and bizarre.



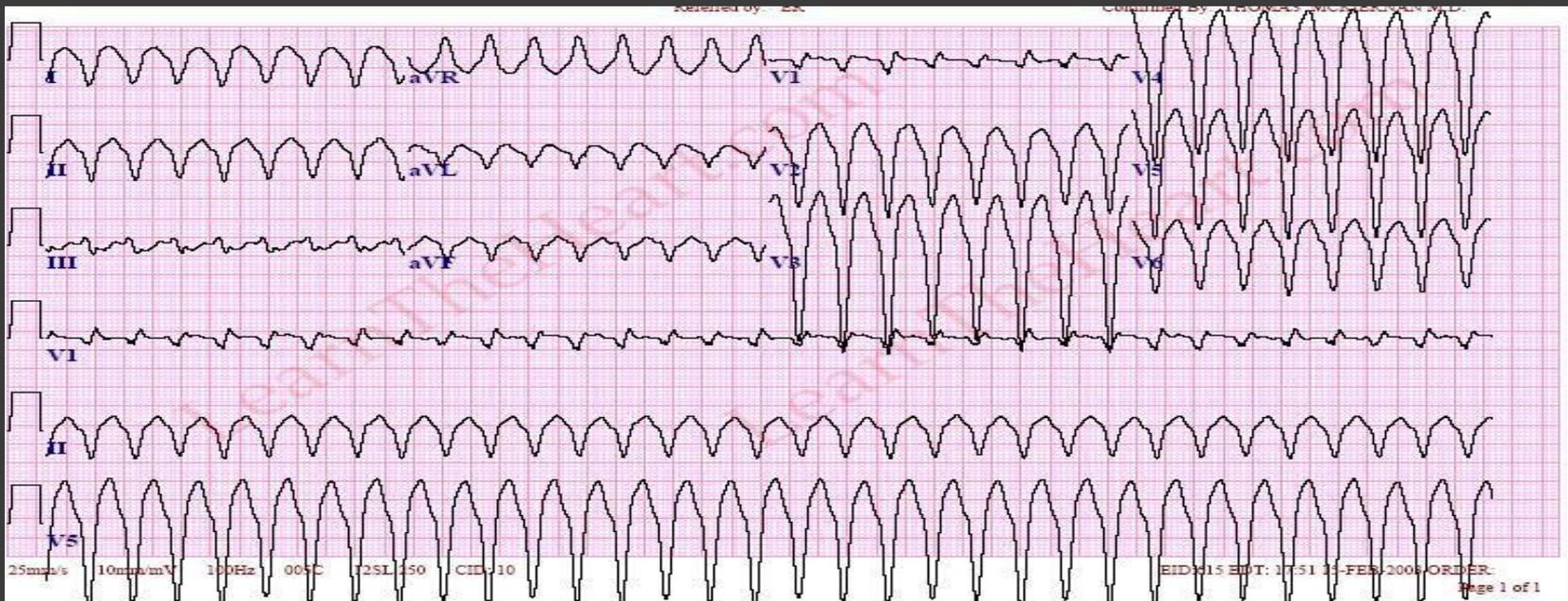
Ventricular Fibrillation

- Rhythm: irregular-coarse or fine, wave form varies in size and shape
- Fires continuously from multiple foci
- No organized electrical activity
- No cardiac output
- Causes: MI, ischemia, untreated VT, underlying CAD, acid base imbalance, electrolyte imbalance, hypothermia,



Ventricular Tachycardia

- Ventricular cells fire continuously due to a looping re-entrant circuit
- Rate usually regular, 100 - 250 bpm
- P wave: may be absent, inverted or retrograde
- QRS: complexes bizarre, $> .12$
- Rhythm: usually regular



Asystole

- Ventricular standstill, no electrical activity, no cardiac output – no pulse!
- Cardiac arrest, may follow VF or PEA
- Remember! No defibrillation with Asystole
- Rate: absent due to absence of ventricular activity. Occasional P wave may be identified.

