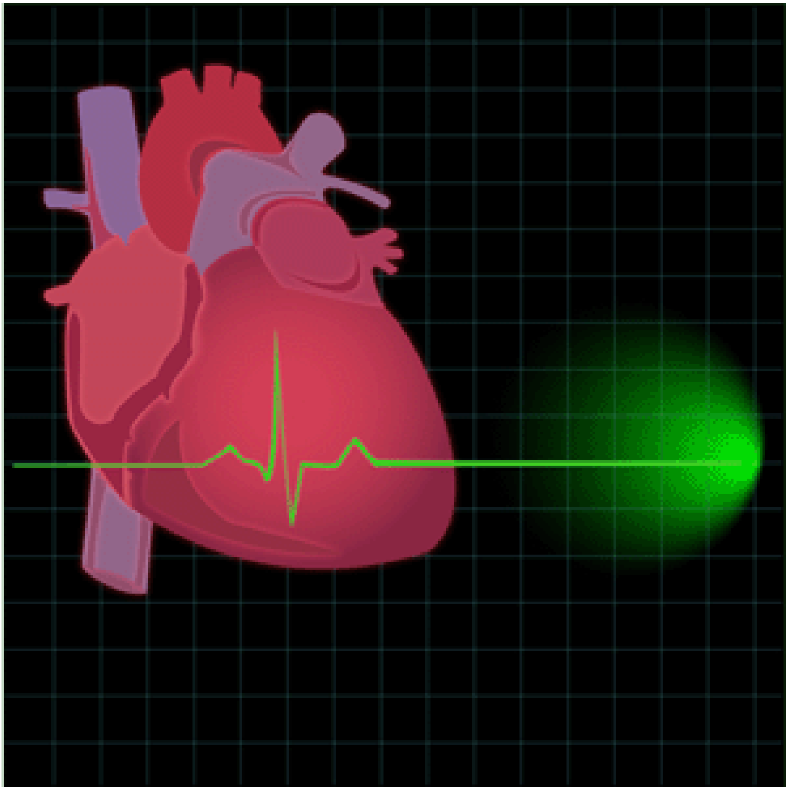
ELECTROCARDIOGRAM

The Basics of ECG

- Reading an ECG or a rhythm strip can be overwhelming for anyone. Most often we just see “squiggles and bumps”
- Today we will learn a quick and easy way to assess the rhythm strip and once you learn the ‘norm’ you can identify the abnormal

Objectives

- At end of presentation you will be able to:
  - Identify normal versus abnormal rhythm strips
  - Verbalize the criteria for identification of rhythm strip interpretation



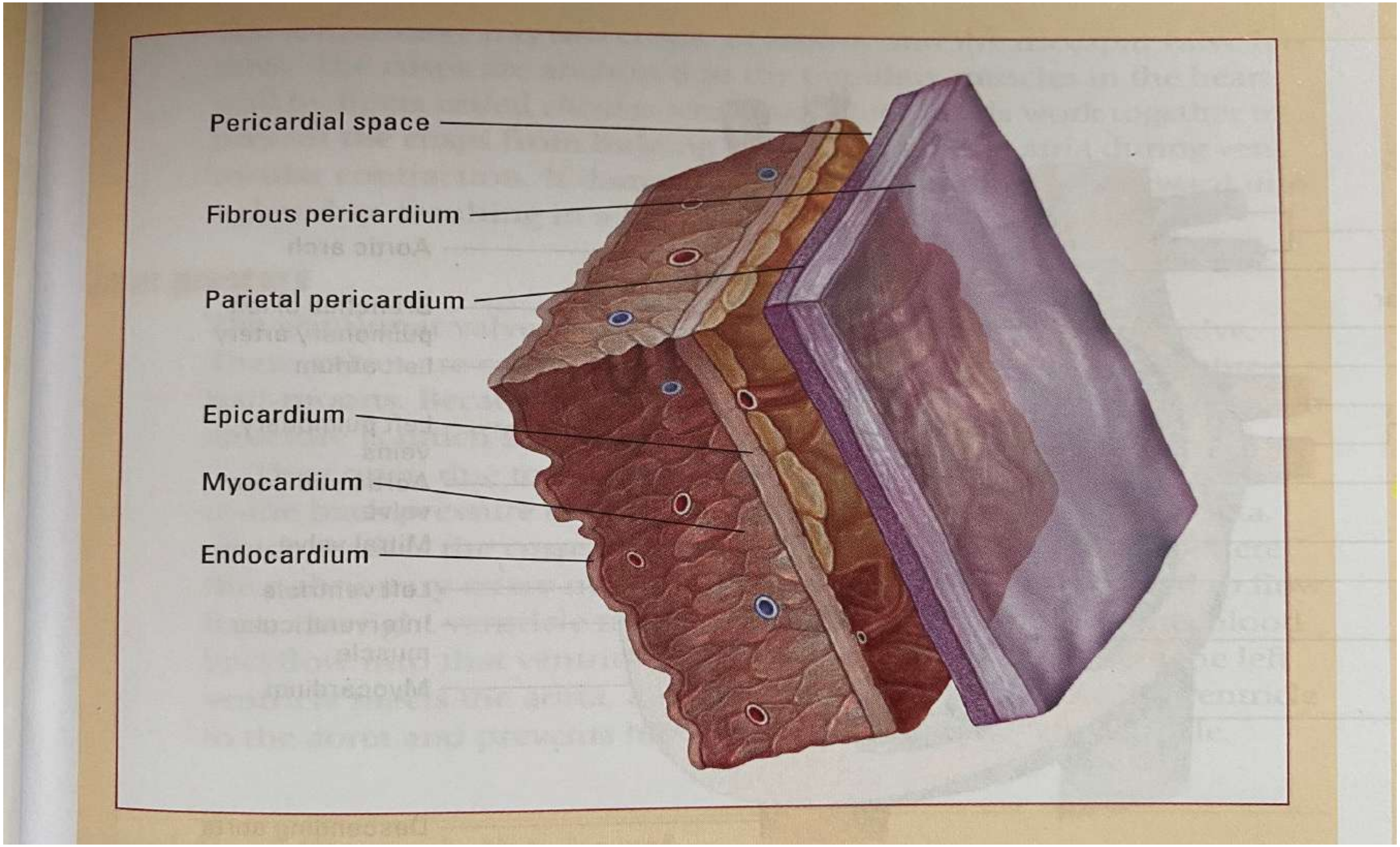
What is an ECG?

- The electrocardiogram (EKG) is a representation of the electrical events of the cardiac cycle.
- Each event has a distinctive waveform, the study of which can lead to greater insight into a patient's cardiac pathophysiology.

What can it tell me?

- Arrhythmias
- Myocardial ischemia and infarction
- Pericarditis
- Chamber hypertrophy
- Electrolyte disturbances (i.e. hyperkalemia, hypokalemia) High/Low Potassium (K^+)in the blood
- Drug toxicity (i.e. digoxin and drugs which prolong the QT interval)

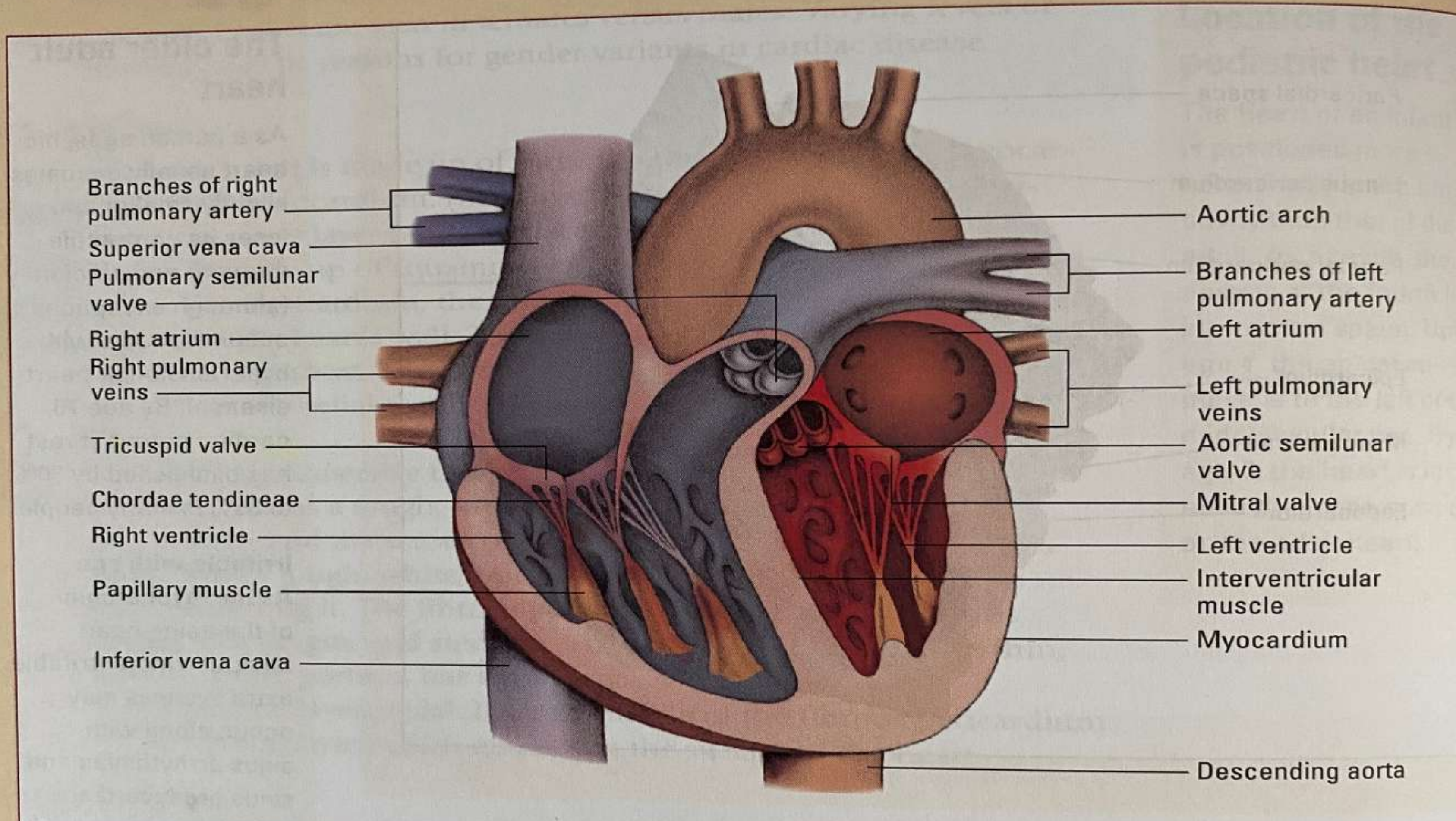
Layers of the heart wall



Inside a Normal Heart

Inside a normal heart

This illustration shows the anatomy of a normal heart.



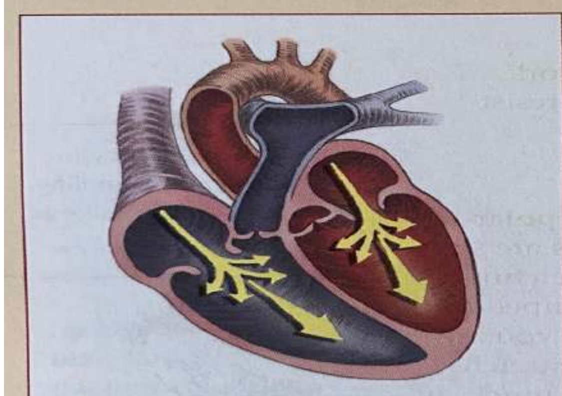
Preload, Afterload & Contractility

Understanding preload, afterload, and contractility

To better understand preload, afterload, and contractility, think of the heart as a balloon.

Preload

Preload is the passive stretching of muscle fibers in the ventricles. This stretching results from blood volume in the ventricles at end-diastole. According to Starling's law, the more the heart muscles stretch during diastole, the more forcefully they contract during systole. Think of preload as the balloon stretching as air is blown into it. The more air the greater the stretch.

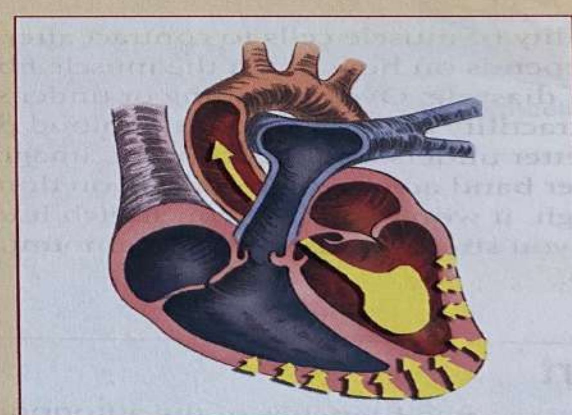


Contractility

Contractility refers to the inherent ability of the myocardium to contract normally. Contractility is influenced by preload. The greater the stretch the more forceful the contraction—or, the more air in the balloon, the greater the stretch and the farther the balloon will fly when air is allowed to expel.

Afterload

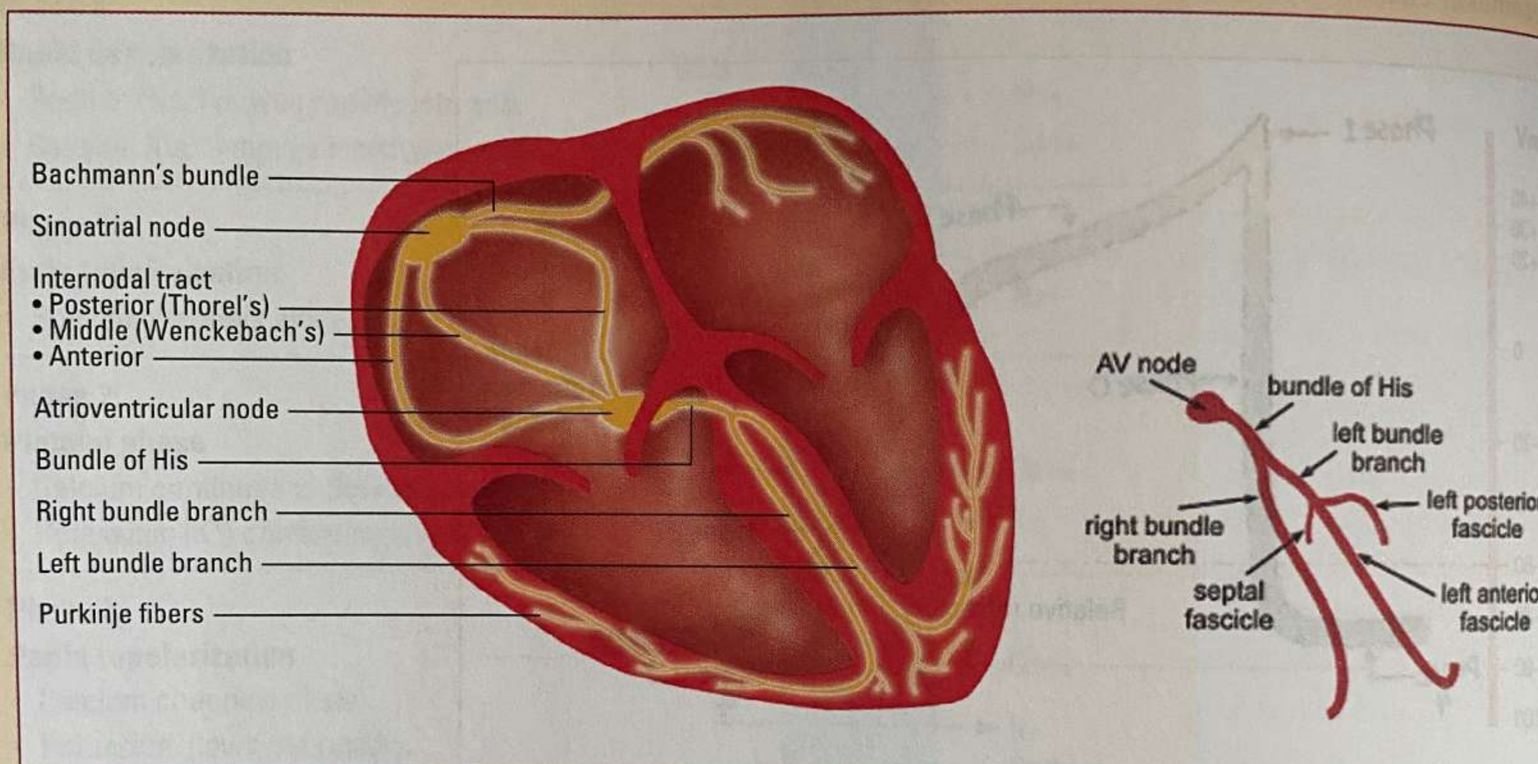
Afterload refers to the pressure that the ventricular muscles must generate to overcome the higher pressure in the aorta to get the blood out of the heart. *Resistance* is the knot on the end of the balloon, which the balloon has to work against to get the air out.



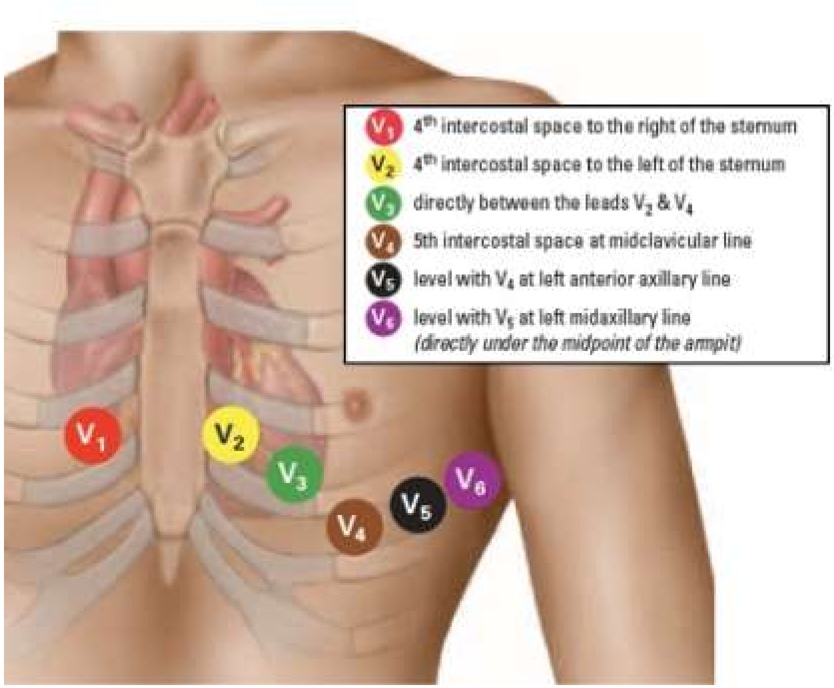
Cardiac Conduction System

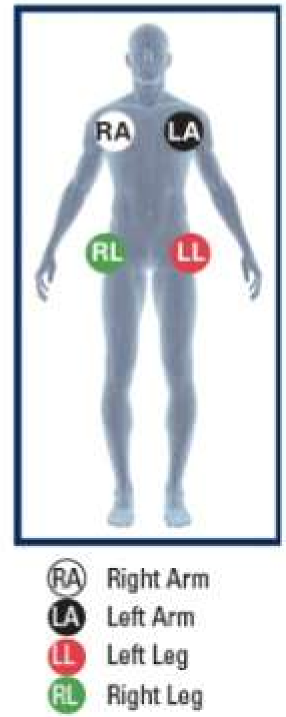
The cardiac conduction system

Specialized fibers propagate electrical impulses throughout the heart's cells, causing the heart to contract. This illustration shows the elements of the cardiac conduction system.



All About Leads

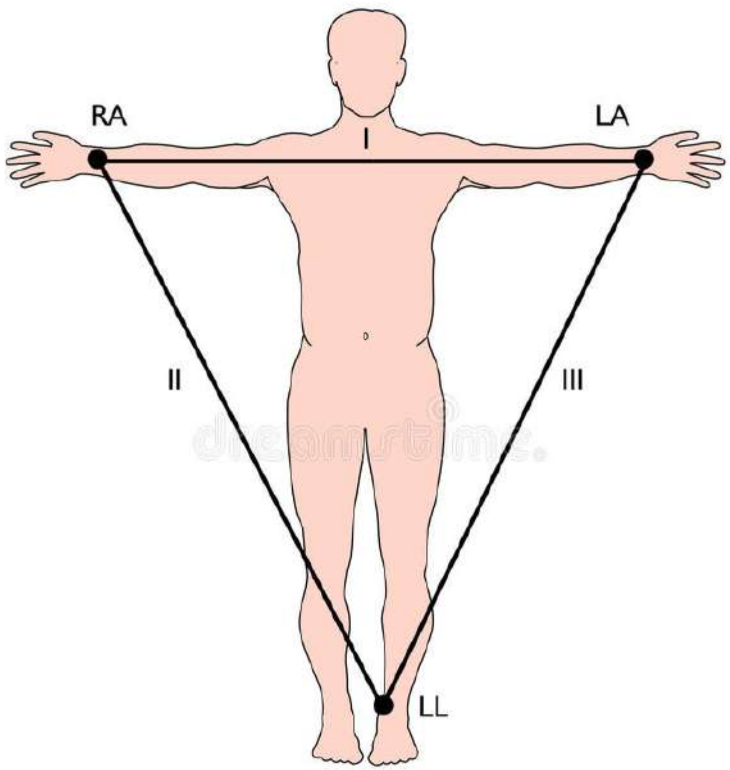




Why is it a 12-Lead but only 10 wires?

- 4 electrodes are placed on the limbs
- 6 electrodes are placed on the chest
- Two points create a lead, which is an imaginary line formed between two electrodes or a reference point
  - One point is always “looking” at the heart and creating a snapshot of the electrical impulses

Standard Limb Leads



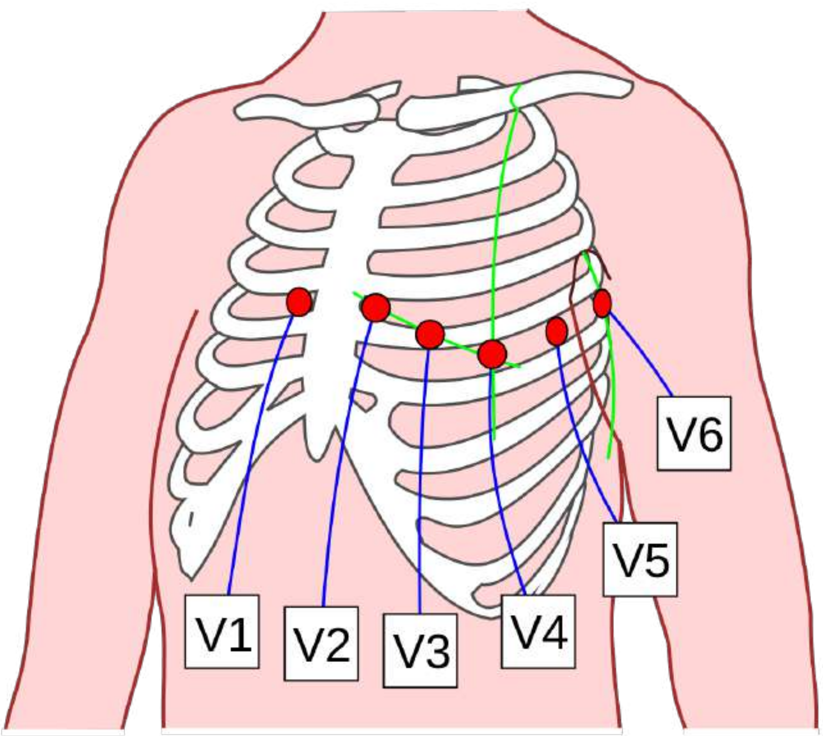
Limb leads

Lead I: traces electrical activity from the RA to the LA

Lead II: traces the electrical activity from the RA to the LL

Lead III: traces the electrical activity from the LA to the LL

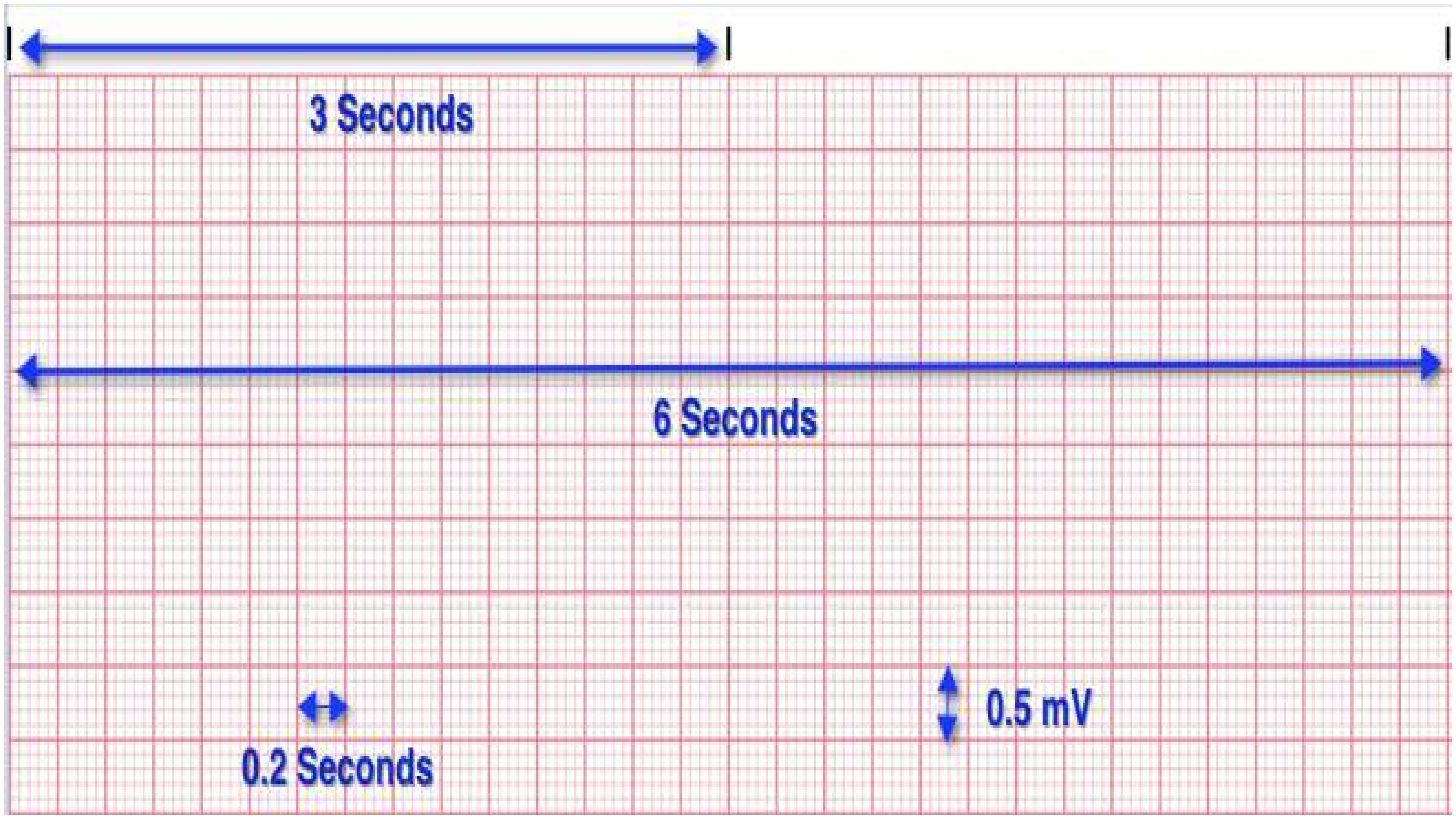
Chest (Precordial) Leads



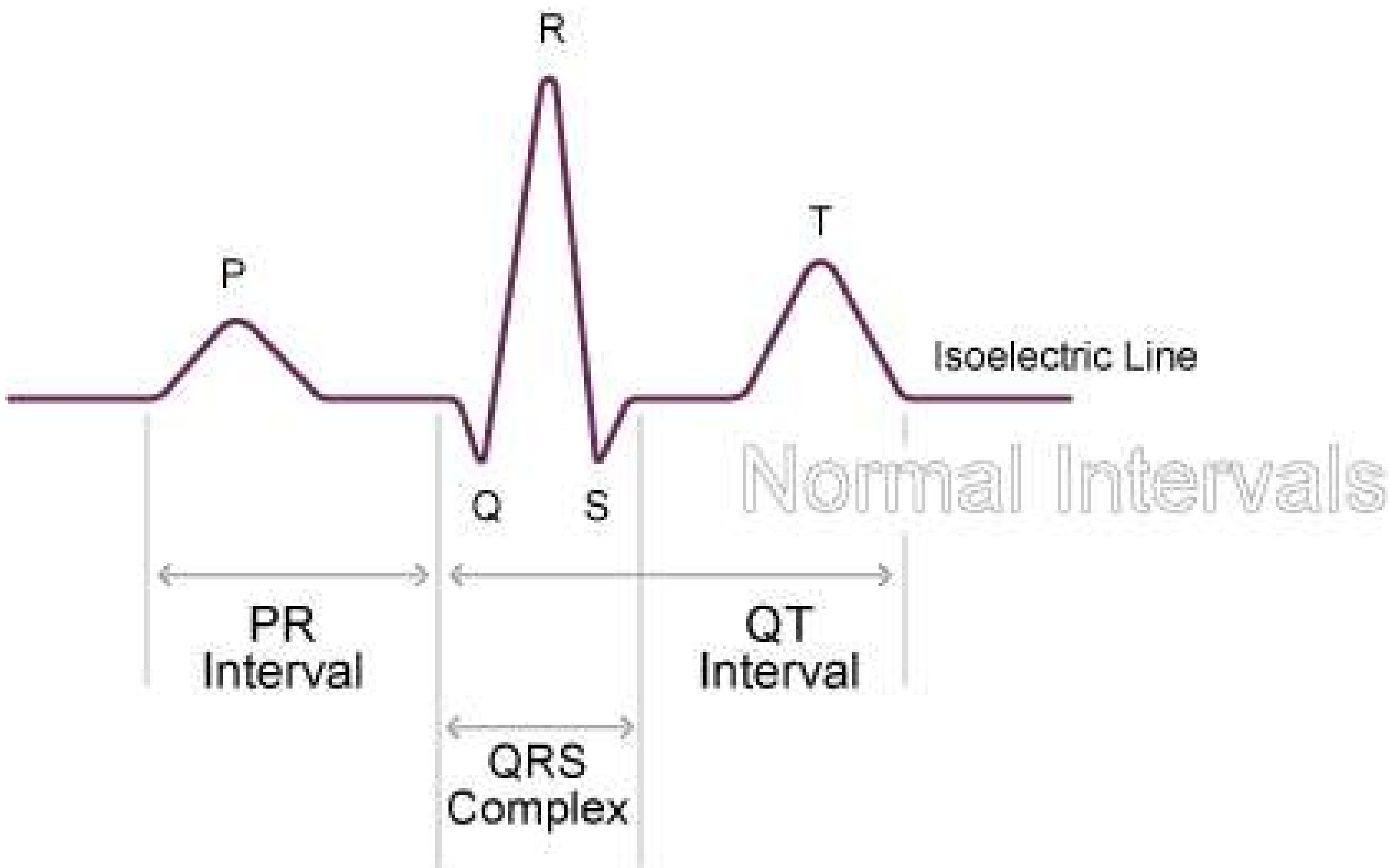
- *Pre*- means “in front of”, and *cor* means “heart”
- The chest leads trace the electrical activity between the chest electrodes and a point in the center of the body

- **V1**: traces electrical activity at the 4th ICS on the right side
- **V2**: traces electrical activity at the 4th ICS on the left side
- **V3**: traces the electrical activity midway between V2 and V4
- **V4**: traces the electrical activity at the 5th ICS on the midclavicular line
- **V5**: traces the electrical activity at the 5th ICS on the anterior axillary line
- **V6**: traces the electrical activity at the 5th ICS on the mid-axillary line

Why are there so many squares?



What do all those bumps and spikes mean?



Electrical Activity

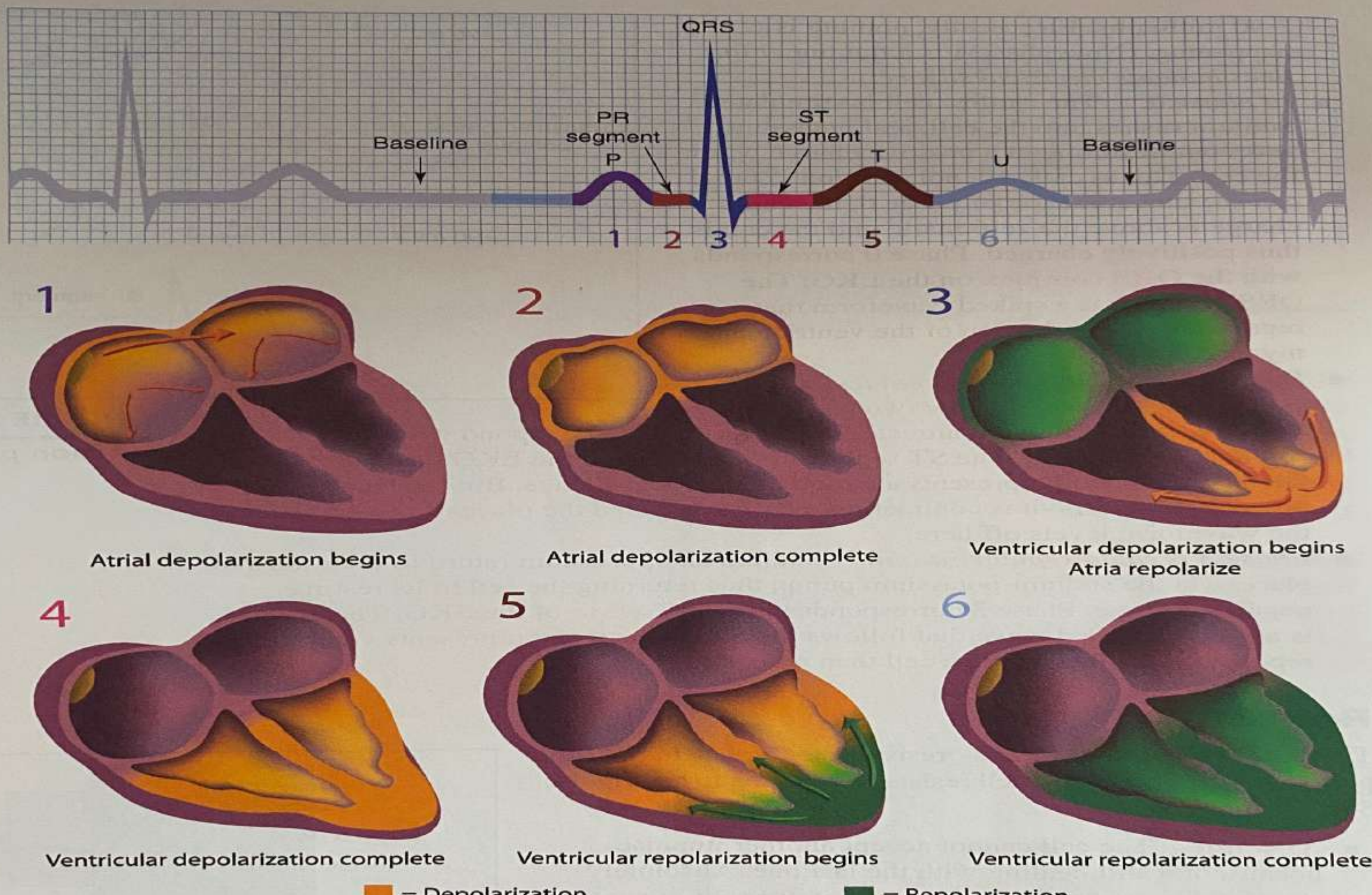


FIGURE 2–4

EKG and electrical activity of the myocardium (Alila Medical Media/Shutterstock).

P Wave

- The first part of the complex is called the P wave.
- The P wave represents the initiation of atrial **depolarization** in the sinoatrial node and subsequent atrial **contraction**. It is relatively small due to the small muscle mass of each of the atriums
- Characteristics of the P Wave:
  - normal P wave is small, rounded and upright
  - should only be ONE P wave (which precedes the QRS complex)
  - amplitude: <0.25 mV (2.5 mm or 2.5 small squares high)
  - duration: <0.12 seconds (3 small squares in length; each horizontal square equals 0.04 seconds)
  - configuration: usually rounded and upright
  - deflection:
    - positive (upright) in Leads I, II, aVf, V2 to V6
    - variable in leads III and V1
    - negative (inverted) in aVr

The Odd P Wave

- When a P wave has an amplitude of > 2.5 mm in Lead II or 1.5 mm in V1, Right Atrial enlargement may be indicated
- Prolonged P wave, >0.12 seconds, in Lead II, can suggest Left atrial enlargement
- Absent P wave
  - junctional rhythm, atrial flutter or fibrillation

PR interval

- measured on the horizontal axis from the beginning of the P wave to the beginning of the QRS
- tracts the atrial impulse from the atria through the AV node, bundle of His and right & left bundle branches
- duration:
  - 0.12 to 0.20 second (3-5 small squares)
- Short PR interval (<0.12 sec)
  - indicates the impulse originated somewhere other than the SA node
- Prolonged PR interval (>0.20 sec)
  - represent a conduction delay (digoxin toxicity, heart block or MI)

QRS Wave (Complex)

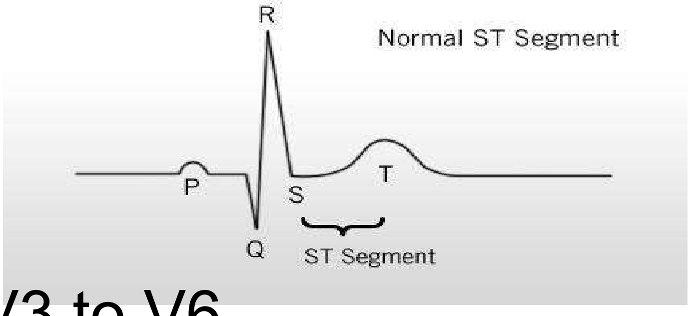
- The QRS complex represents ventricular depolarization or contraction of the ventricles (ventricular systole). The atria repolarizes and relaxes.
- Ventricular rate can be calculated (we will talk about this on a later slide)
- Characteristics:
  - follows PR Interval
  - amplitude-5-30 mV (1mm or 6 small squares high)(will differ for each lead)
  - duration--0.06-0.12 seconds (1.5 to 3 small squares) (measured from the beginning of the Q wave to the end of the S wave)
  - Configuration--
    - Q wave-first negative deflection after the P Wave
    - R wave-first positive deflection after the P wave or Q wave
    - S wave-first negative deflection after the R wave
    - Note--All waves may not always be evident on EKG
  - Deflection
    - Positive in leads I, II, III, aVl, aVf and V4-v6
    - Negative in leads aVr and V1to V3

ST Segment

- represents the end of ventricular depolarization and the beginning of ventricular repolarization (recovery)
- location
  - extends from the S wave to the beginning of the T wave
- Deflections
  - usually isoelectric (neither positive or negative)
- Not so normal ST Segment
  - changes in the ST segment may indicate myocardial ischemia or infarction
    - may become either elevated or depressed

T Wave

- The T wave is the relaxation (recovery) of the ventricles also known as repolarization
- Location
  - after the S wave
- Amplitude
  - 0.5 mm in leads I, II, and III and up to 10 MM in precordial leads
- Configuration
  - Round and smooth
- Deflection
  - usually upright in Lead I, II and V3 to V6
  - inverted in lead aVr; variable in all other leads



QT Interval

- measures ventricular depolarization and repolarization
- length varies according to heart rate
- Location
  - beginning of the QRS complex to the end of the T wave
- Duration
  - usually last from 0.36-0.44 second
- Abnormal QT interval increases the risk of arrhythmias and can be caused by certain medications

U Wave

- represents the recovery period of the Purkinje fibers
- small deflection following the T wave
- Is NOT always present on every strip
- if seen, should be upright

Types of Abnormals

Sinus

- Sinus Bradycardia
- Sinus Tachycardia
- Sinus Arrhythmia

AV Blocks

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

Atrial Arrhythmias

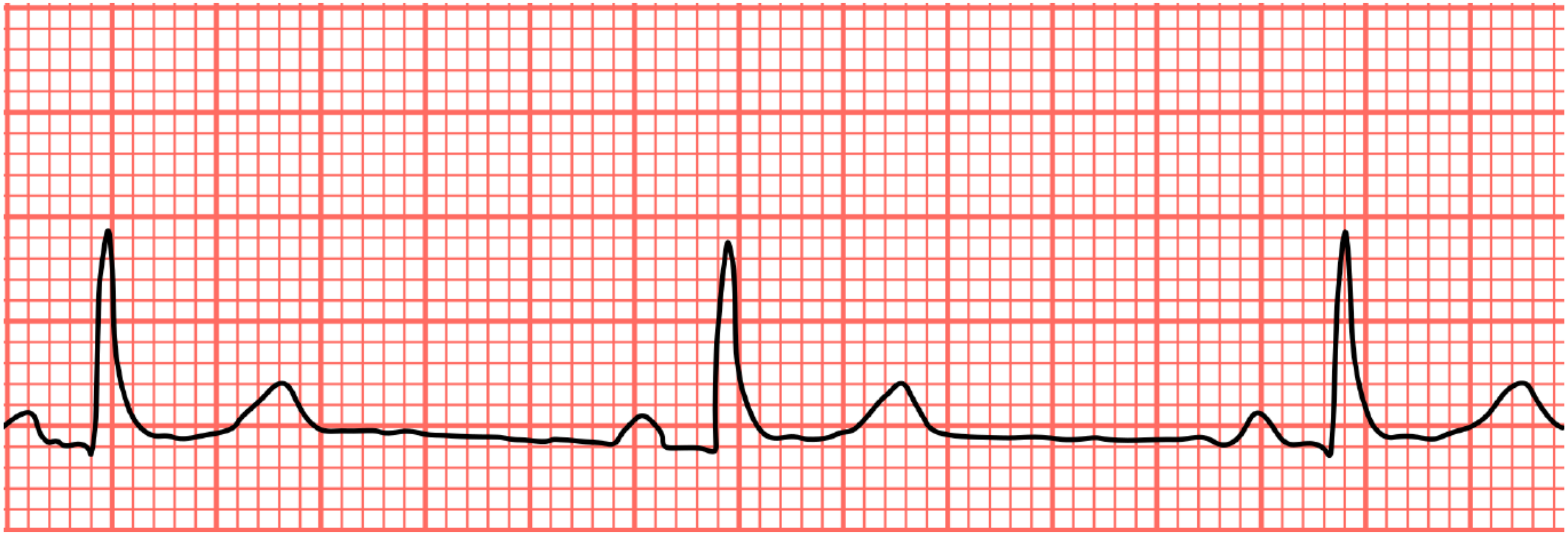
- Atrial Flutter
- Atrial Fibrillation

Ventricular Arrhythmias

- Bundle Branch Blocks
- PVC's
- Ventricular Tachycardia

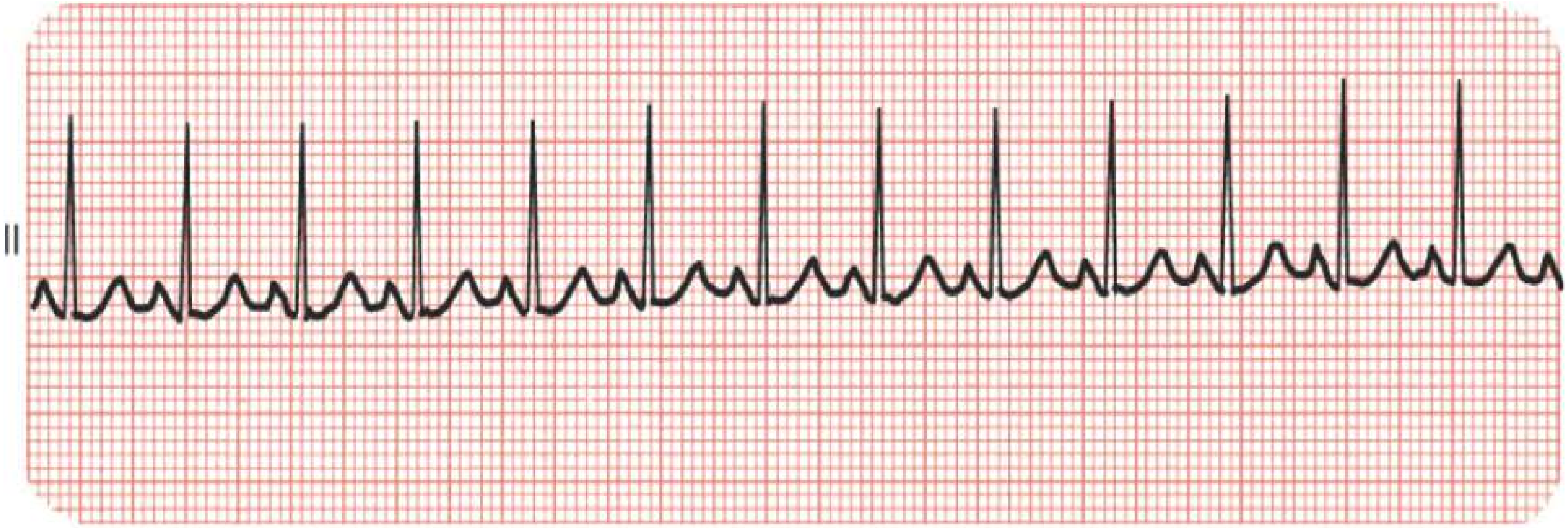
Sinus Bradycardia

- This is Sinus but not normal because the rate is too slow. All other criteria are met.



Sinus Tachycardia

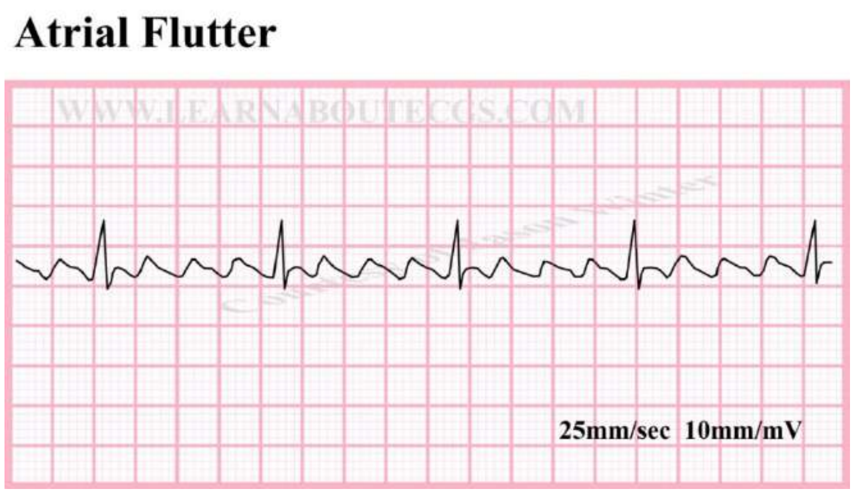
- This is Sinus, but not normal because the rate is too fast

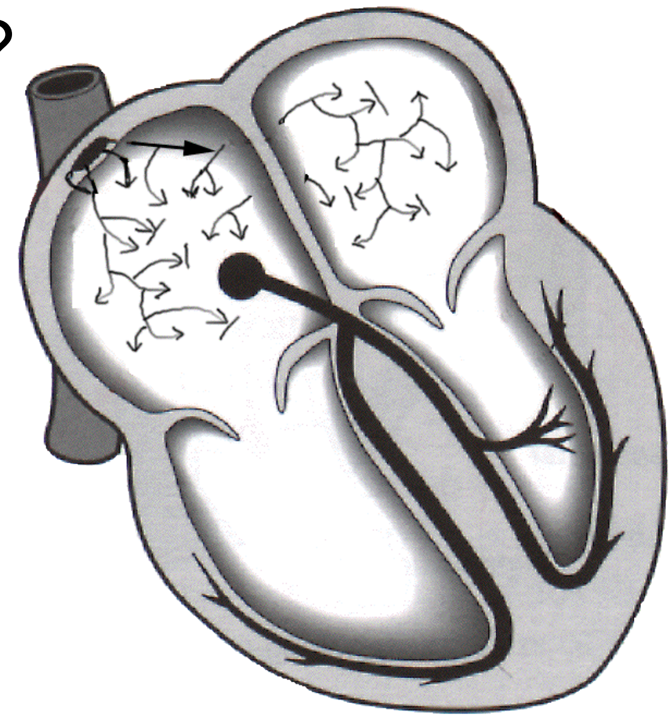


sinus tachycardia

A Flutter

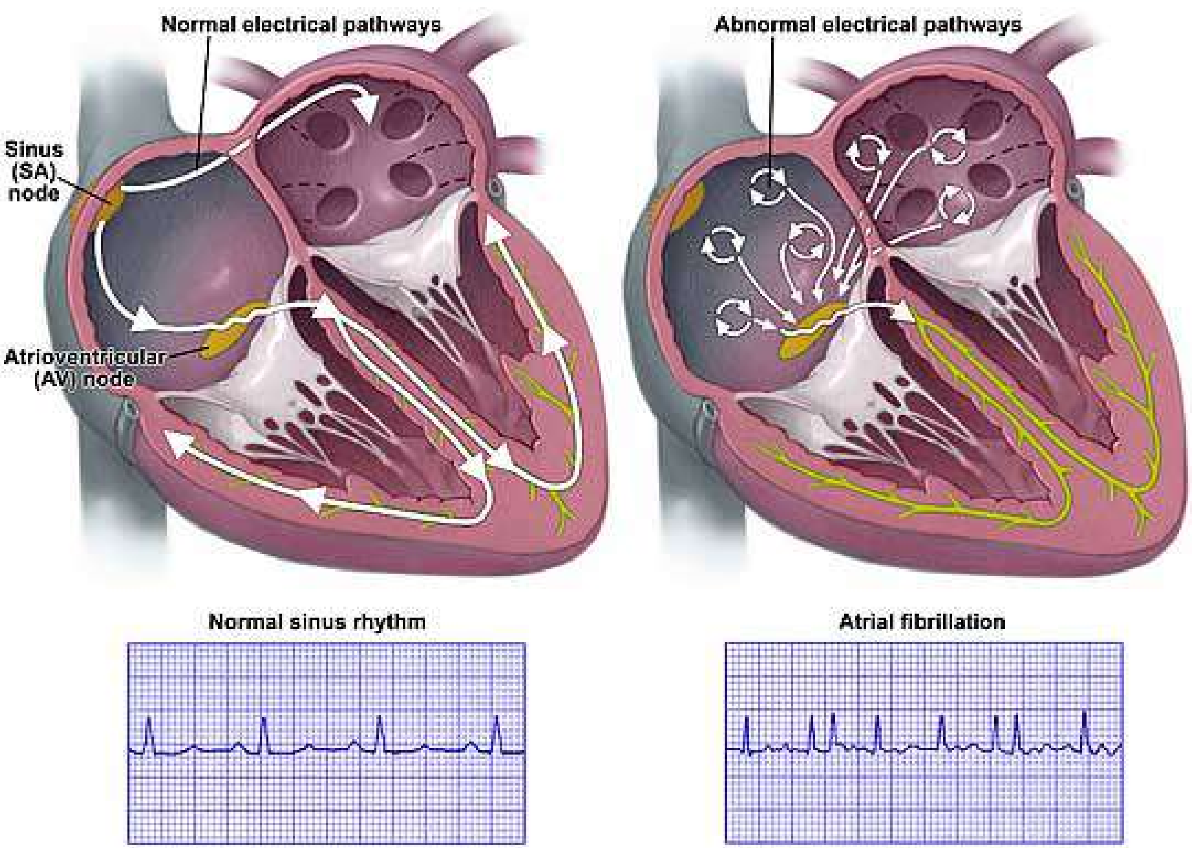
- "Saw toothed" pattern where Sinus has fired, but AV node is not receiving it and ventricles just fire when they want
- 1:1 or 2:1 or 3:1 etc
- No P waves: is this sinus then?
- Called flutter waves
- Can you live with flutter?

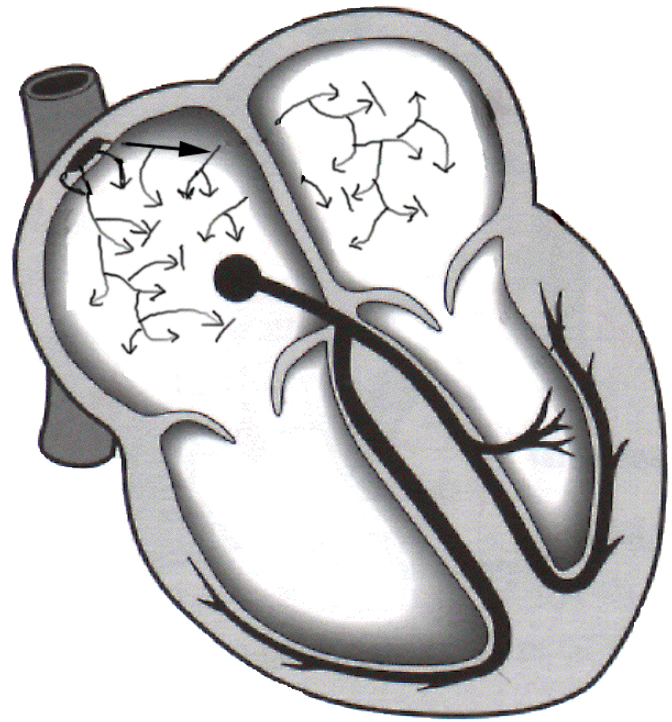




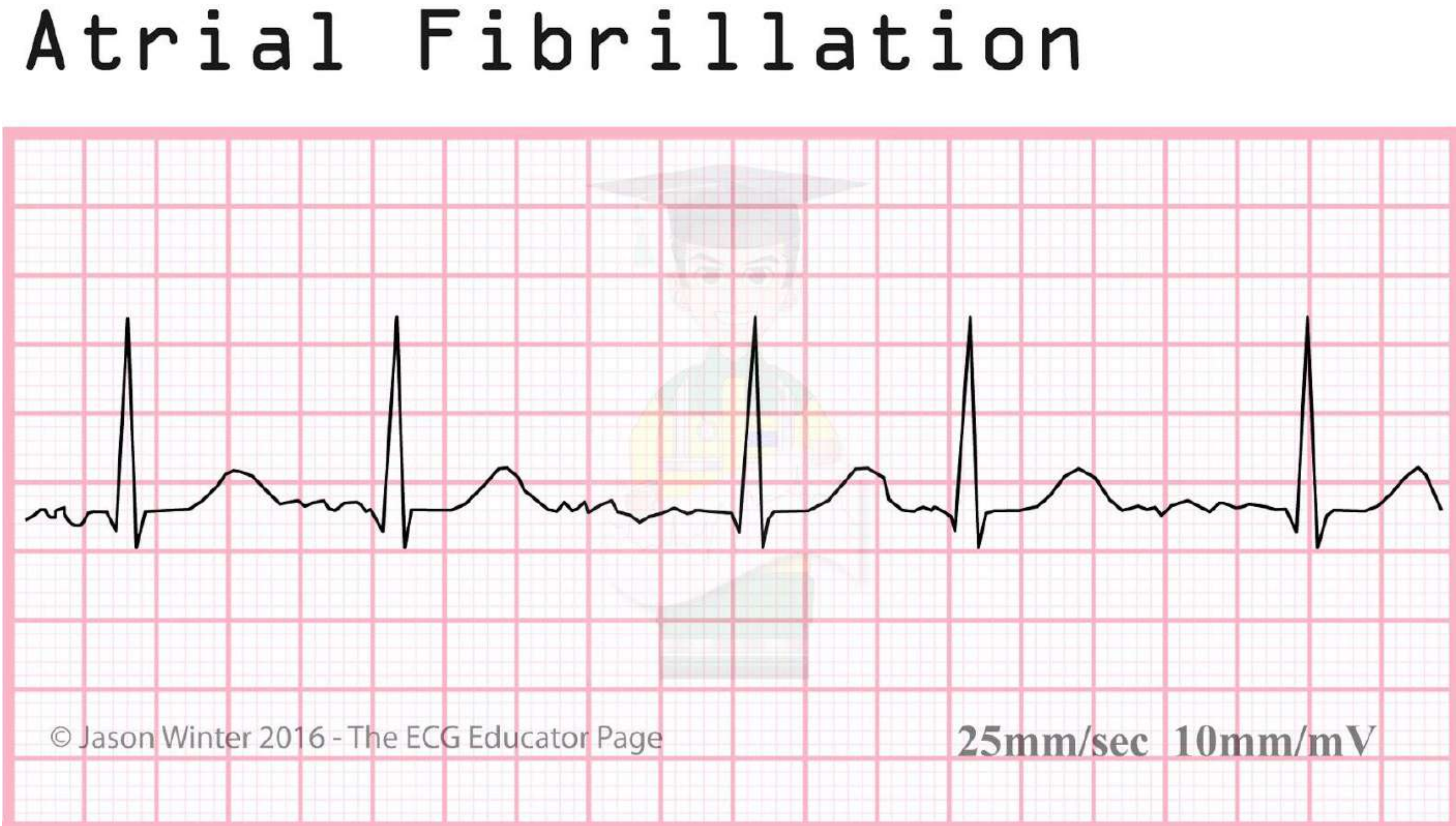
A-fib

- Chaotic firing of the atria and no organized contraction. Quivering of the atria, but the ventricles still contract



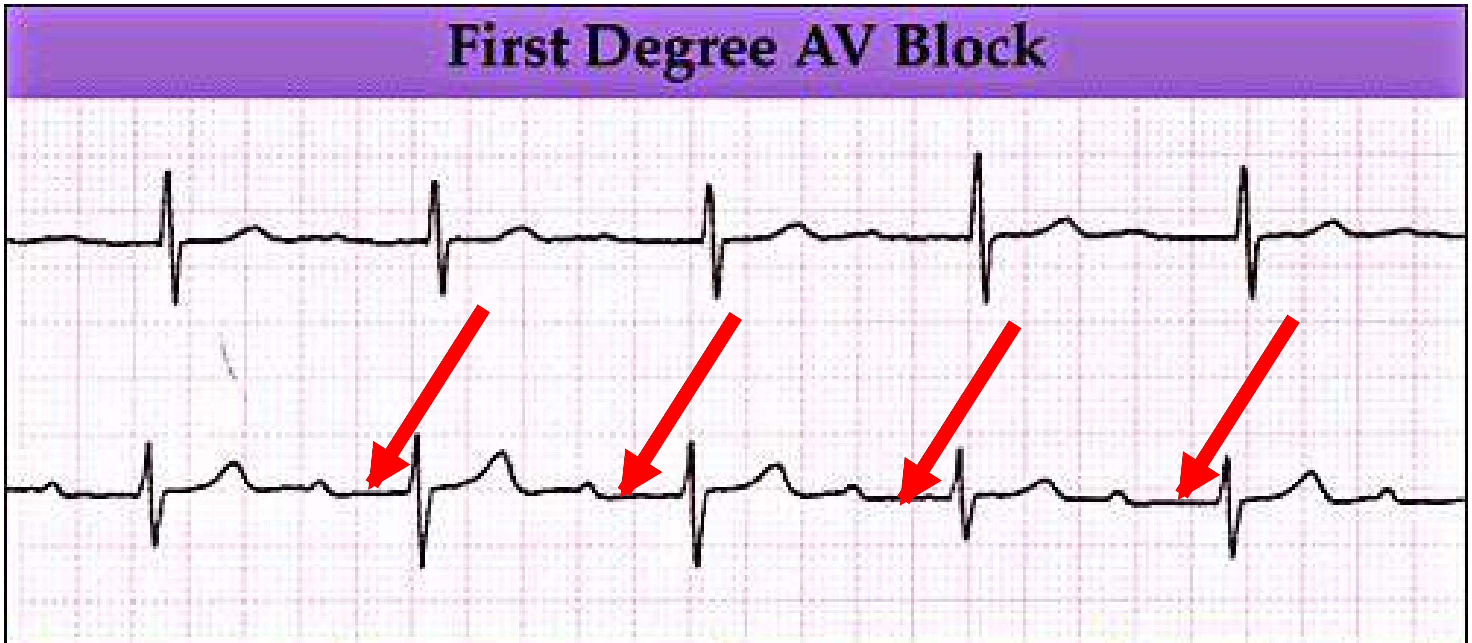


Atrial Fibrillation



1st degree Heart Block

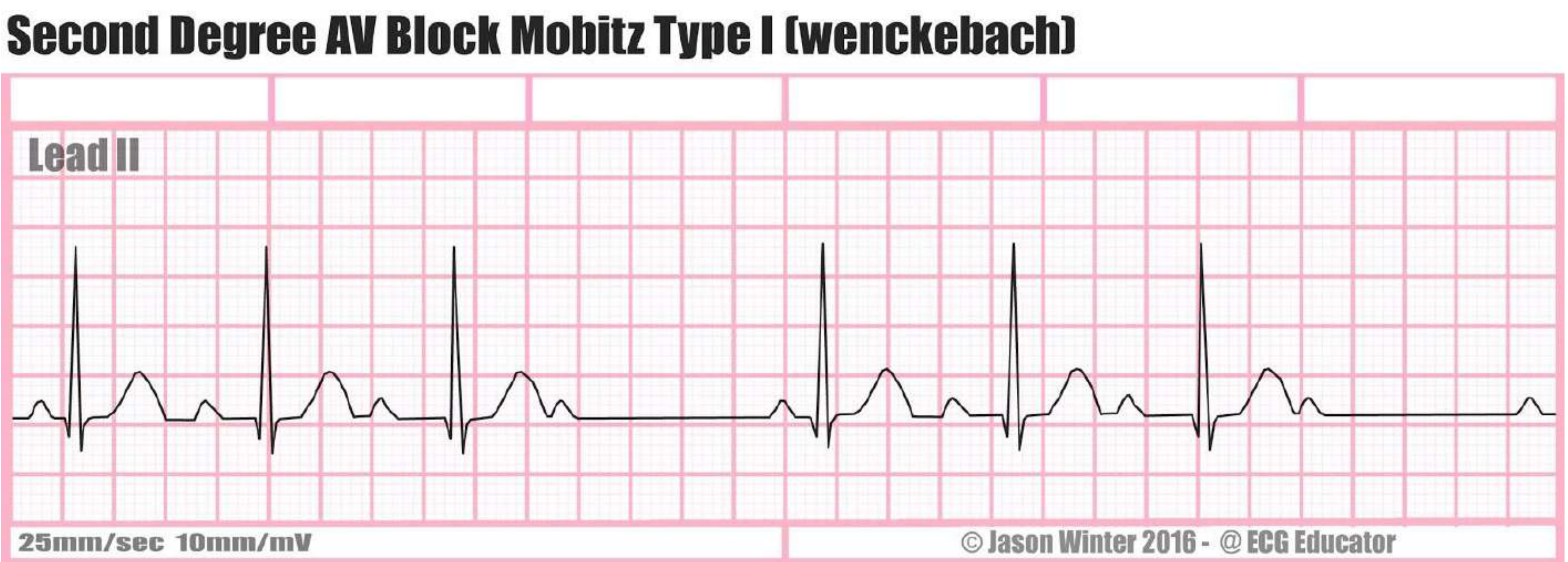
- PR Interval greater than 0.20 sec and that's it! Everything else is normal.



P Wave	PR Interval (in seconds)	QRS (in seconds)	Characteristics
Before each QRS, identical	>.20	>.12	Regular rhythm

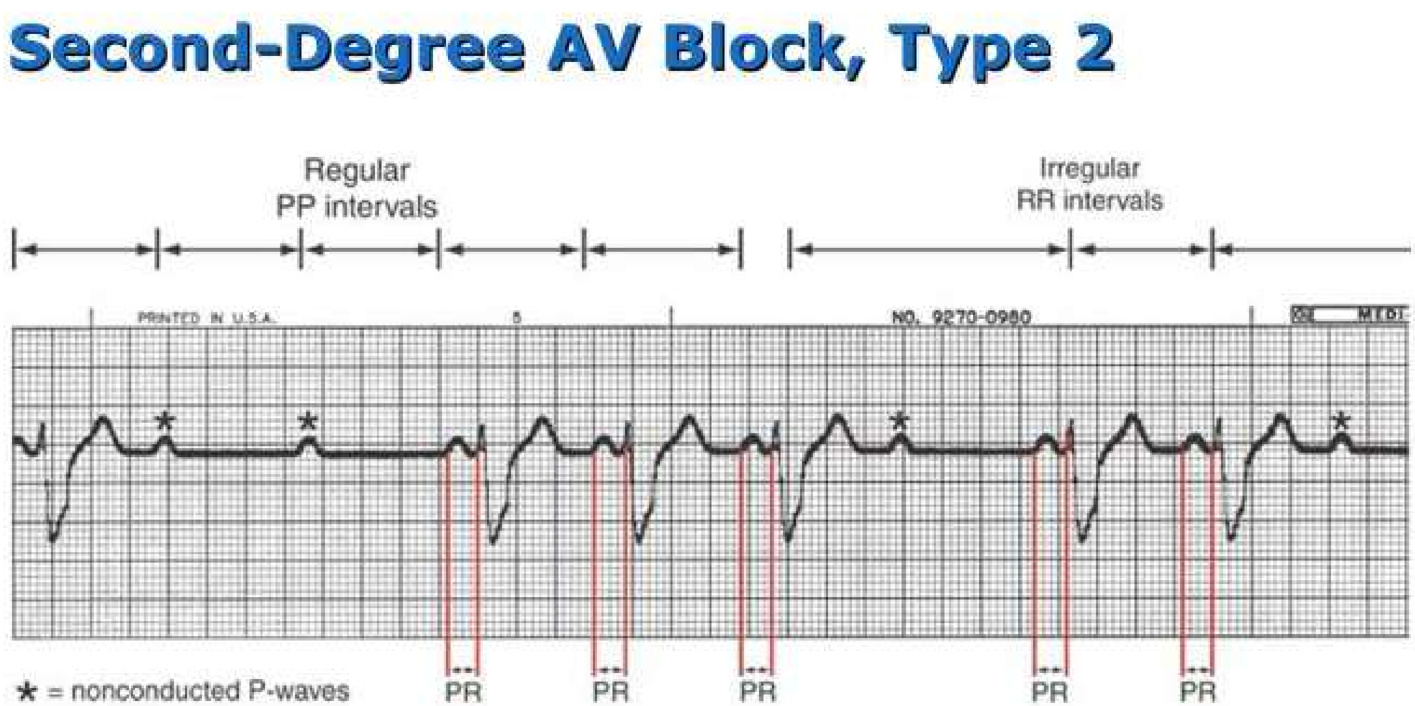
2nd Degree AV Block – Type I

- Also known as Mobitz I or Wenckebach
- PR Interval > 0.20 sec and gets progressively longer until there is a P wave without a QRS and then it resets to the beginning pattern (still >0.20 sec)



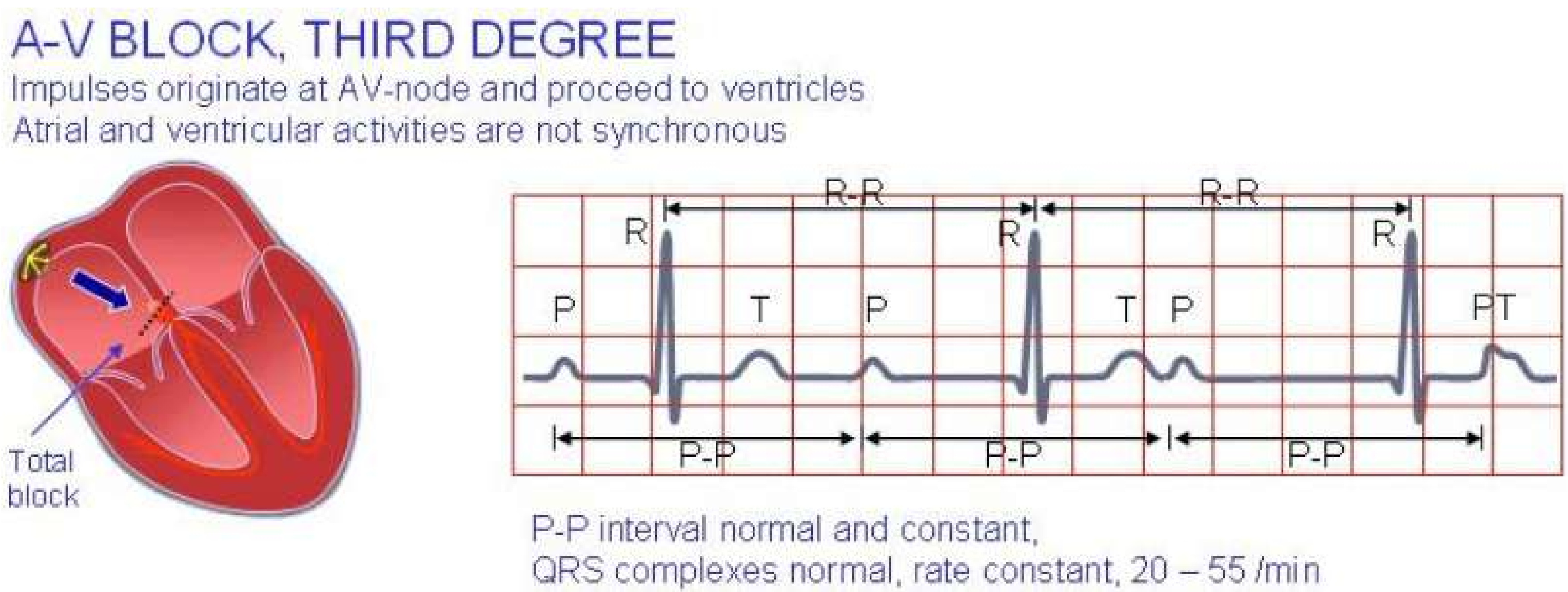
2nd Degree AV Block – Type II

- PR Interval is > 0.20 sec but on occasion there is a dropped beat completely
- Also called Mobitz II

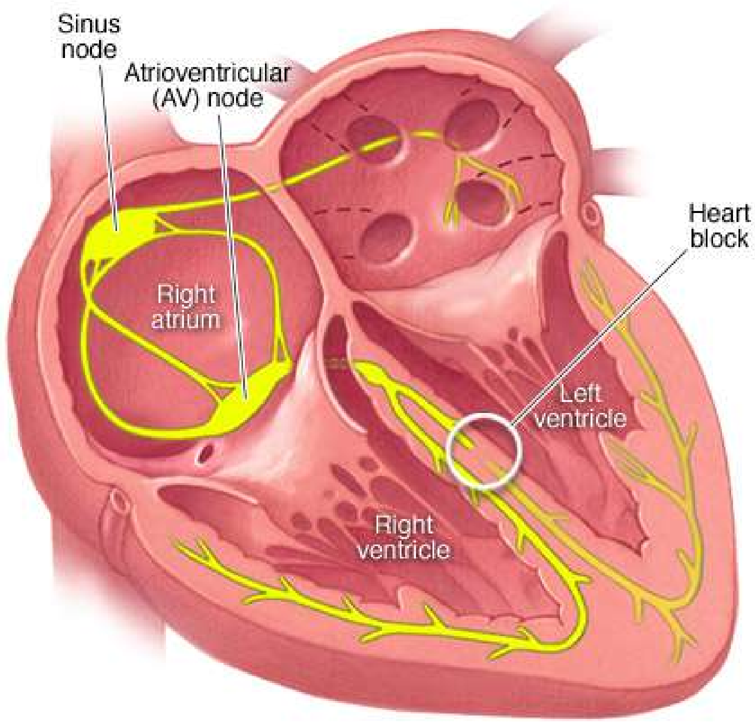


3rd Degree Heart Block

- NO correlation between the atrial beats and the ventricular beats
- Each usually march on their own



Bundle Branch Block

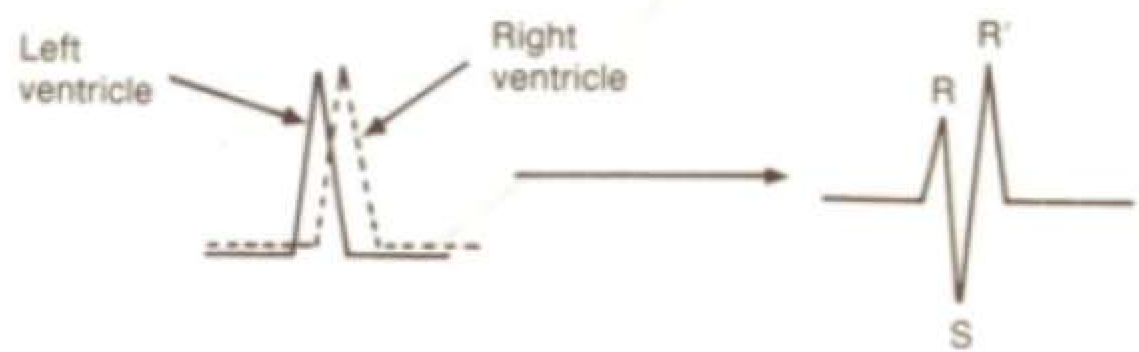


A defect of the bundle branches in the heart

- Right Bundle Branch Block (RBBB)
- Left Bundle Branch Block (LBBB)

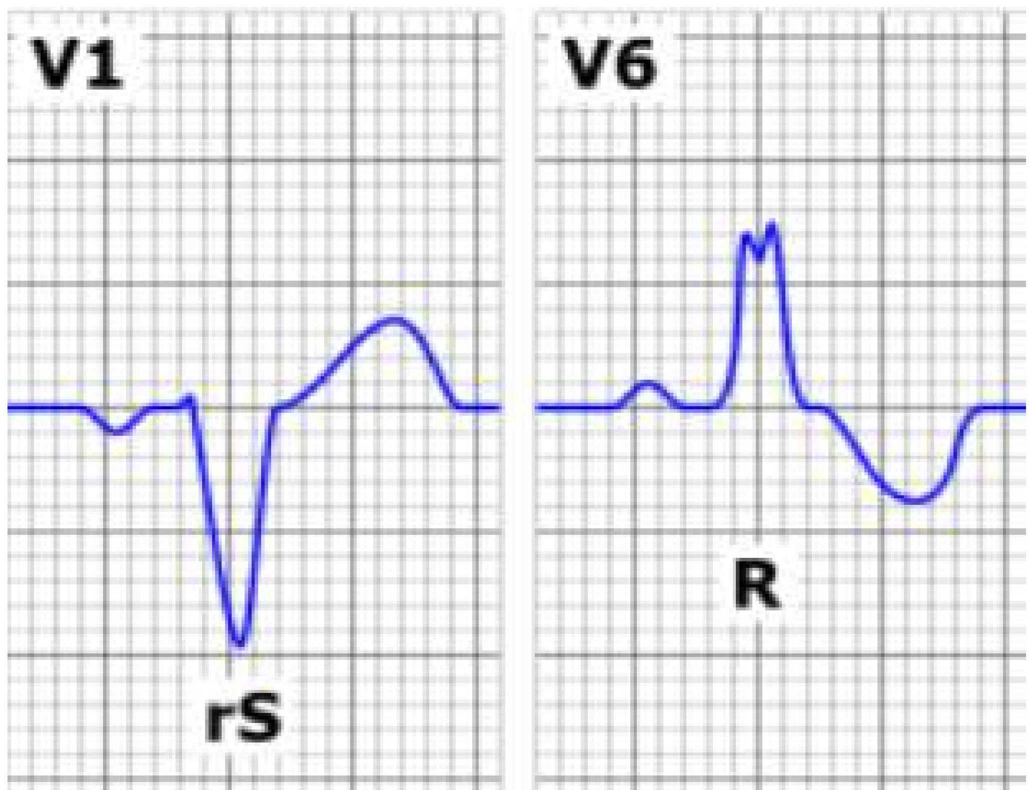
Right Bundle Branch Block

- Right ventricle is not directly activated by impulses traveling through the Right Bundle Branch
- Impulses travel through the left ventricle instead and depolarize
  - This depolarization then causes the right bundle branch to receive enough impulse to contract
  - This delay in activation will show up on an ECG as a widened QRS complex (≥0.12) or even an extra deflection (“rabbit ears”)
  - T wave could be negative

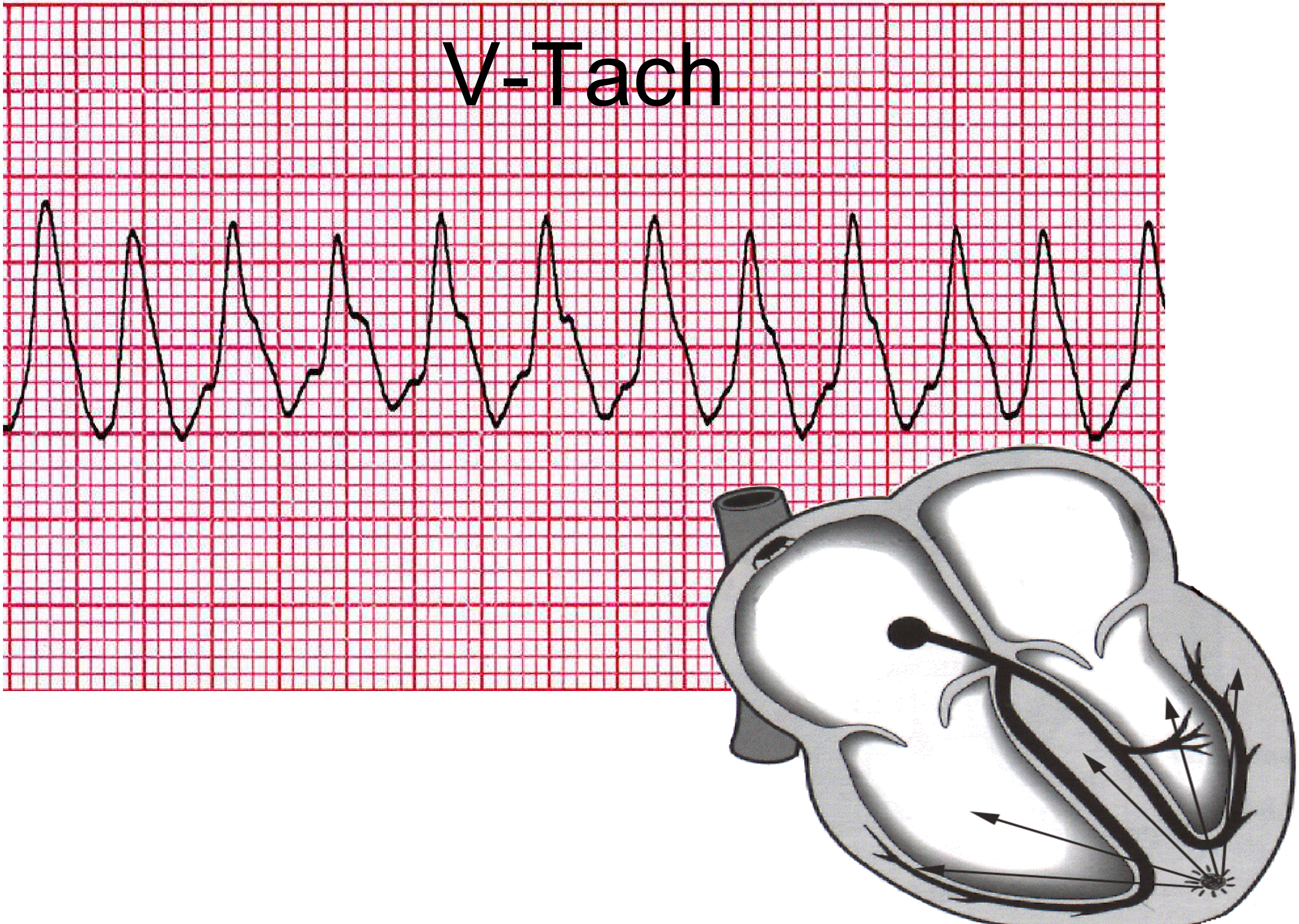


Left Bundle Branch Block

- Activation of the Left Bundle Branch is delayed so left ventricle contracts later than the right ventricle
- Widened QRS wave
- Consider ischemia if it's a new finding
- Almost always considered to have underlying cardiac pathology



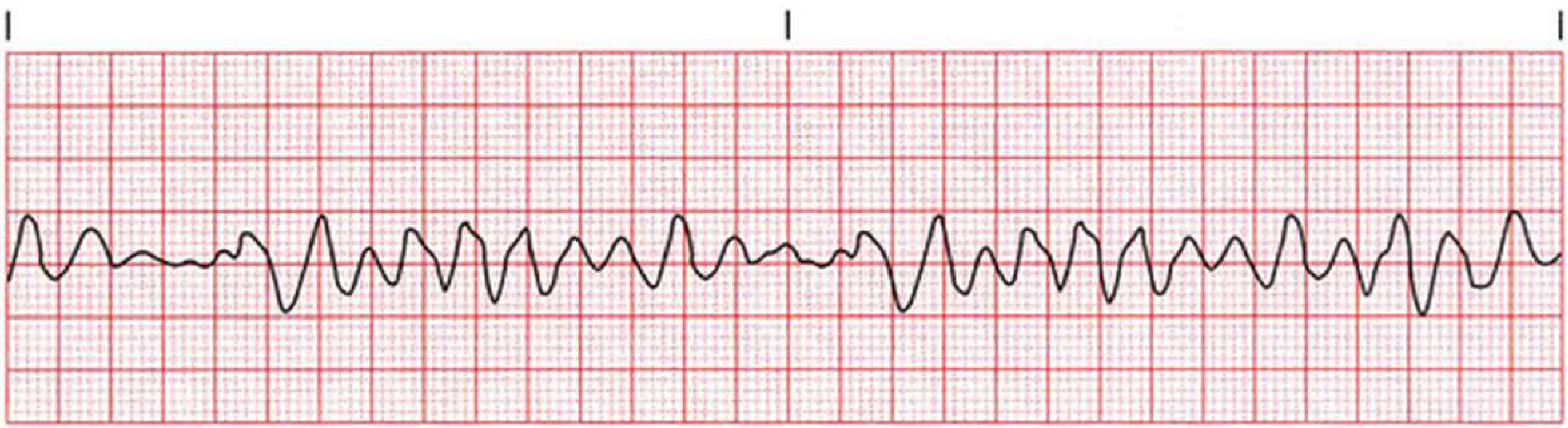
Ventricular Tachycardia



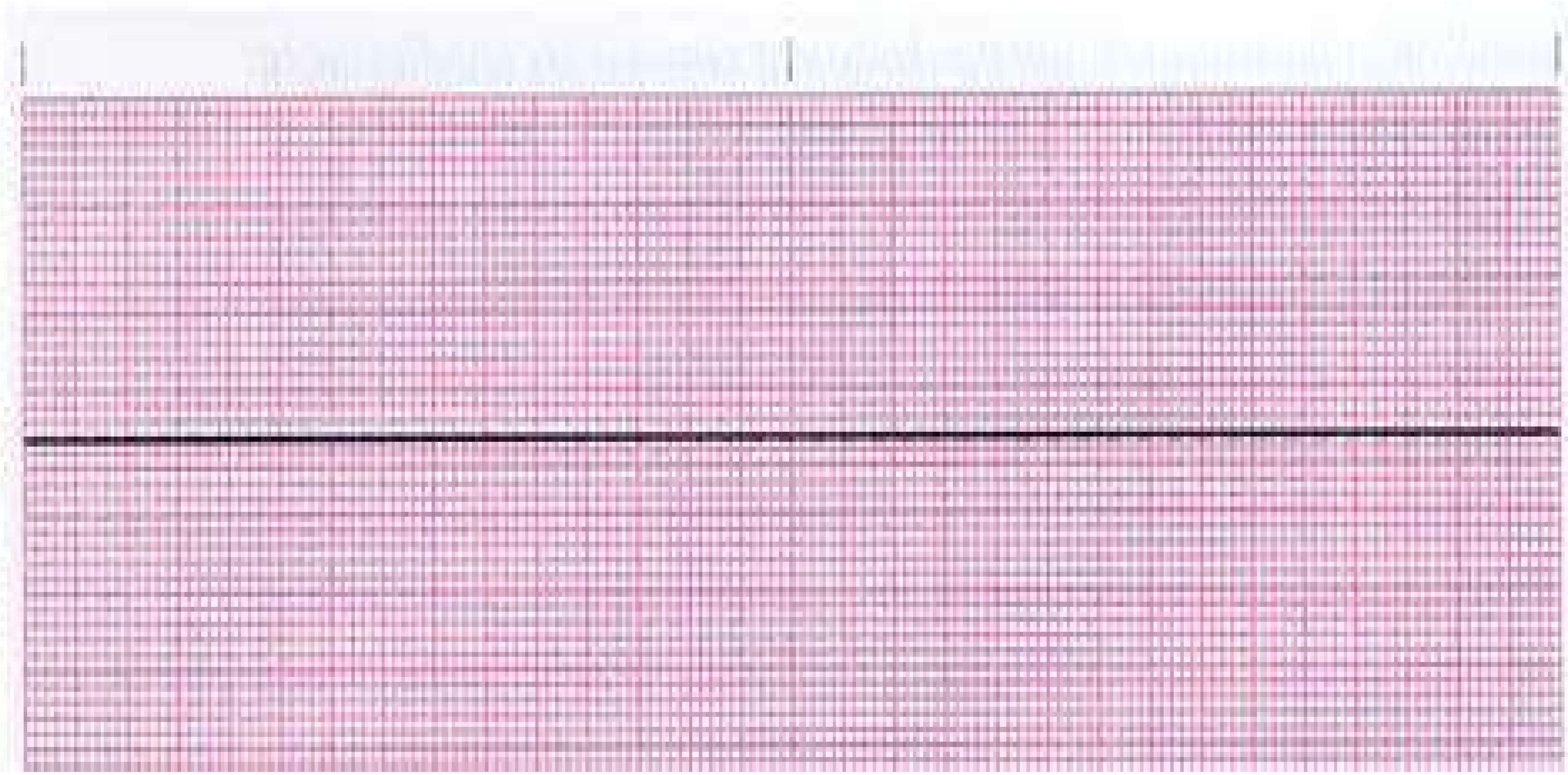
Ventricular Fibrillation (V-Fib)

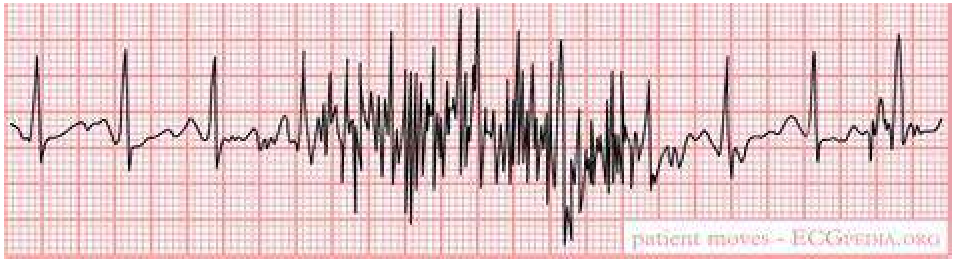
Characteristics of ventricular fibrillation

Rate: can't be determined
Rhythm: can't be determined
P wave: can't be discerned; usually inverted
PR interval: none
QRS complex: can't be discerned

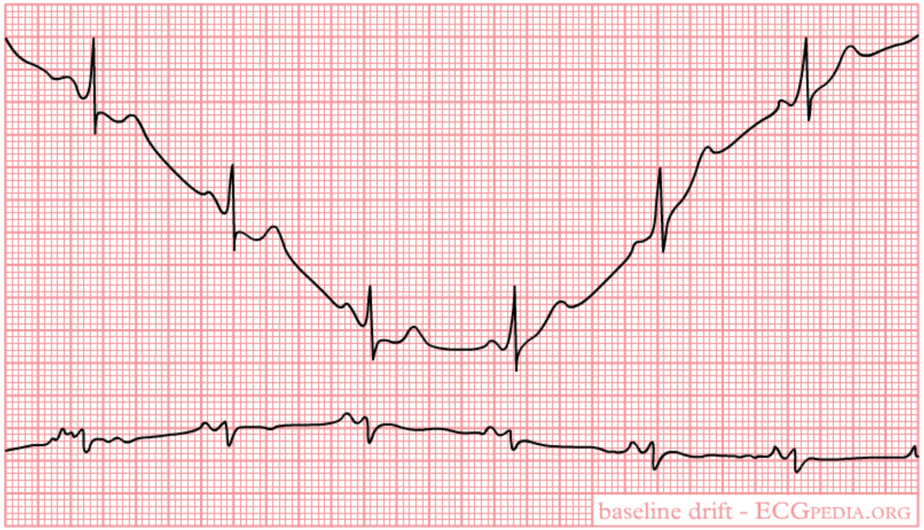


Asystole





Artifact



- Electrical appliances nearby
- Movement
- Trembling or shivering
- Dry electrode gel
- A loose lead
- Hair
- You can use tincture of benzoin or be sure to prep correctly