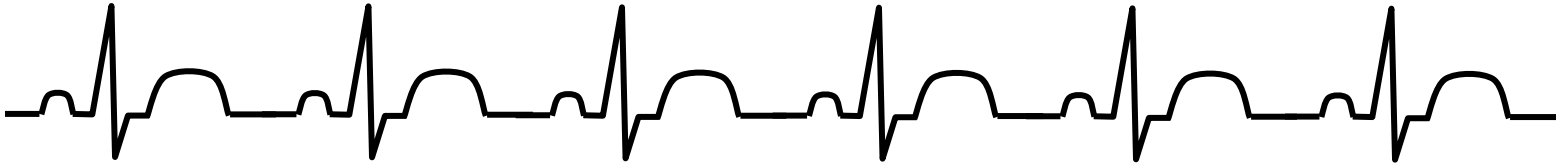
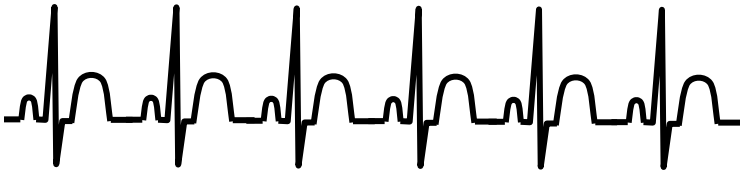
Terminology and Definitions of Arrhythmias

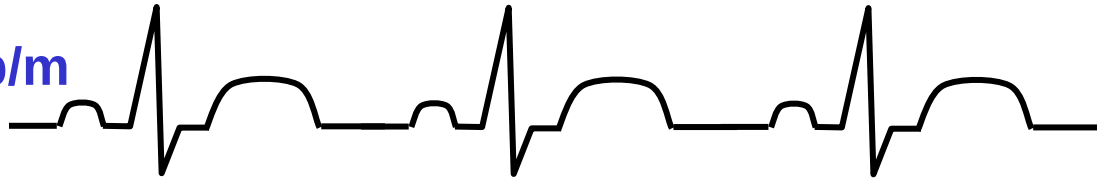
Rhythms from the Sinus Node



Normal Sinus Rhythm (NSR)

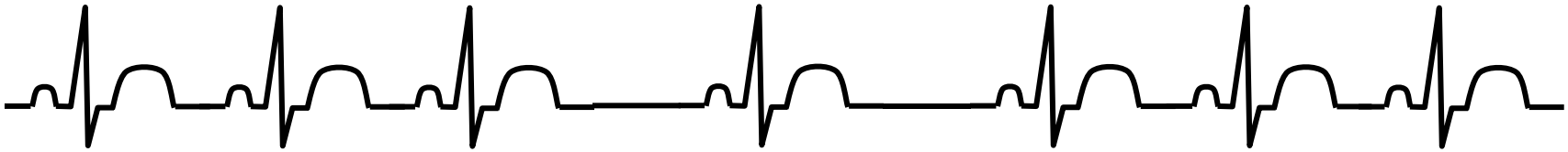


- **Sinus Tachycardia: HR > 100 b/m**
  - Causes:
    - Withdrawal of vagul tone & Sympathetic stimulation (**exercise**, fight or flight)
    - Fever & inflammation
    - Heart Failure or Cardiogenic Shock (both represent hypoperfusion states)
    - Heart Attack (myocardial infarction or extension of infarction)
    - Drugs (alcohol, nicotine, caffeine)

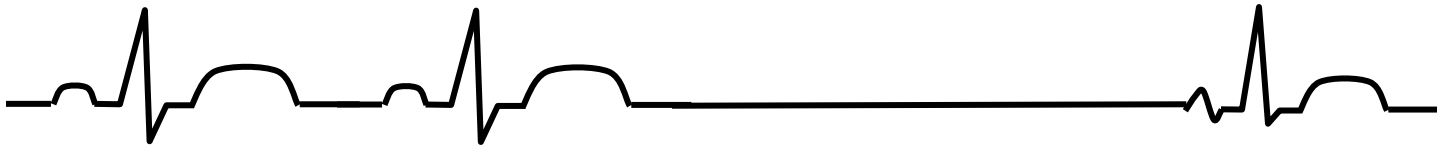


- **Sinus Bradycardia: HR < 60 b/m**
  - Causes:
    - Increased vagul tone, decreased sympathetic output, (**endurance training**)
    - Hypothyroidism
    - Heart Attack (common in inferior wall infarction)
    - Vasovagul syncope (people passing out when they get their blood drawn)
    - Depression

Rhythms from the Sinus Node



- **Sinus Arrhythmia: Variation in HR by more than .16 seconds**
  - Mechanism:
    - Most often: changes in vagul tone associated with respiratory reflexes
    - Benign variant
  - Causes
    - Most often: youth and **endurance training**



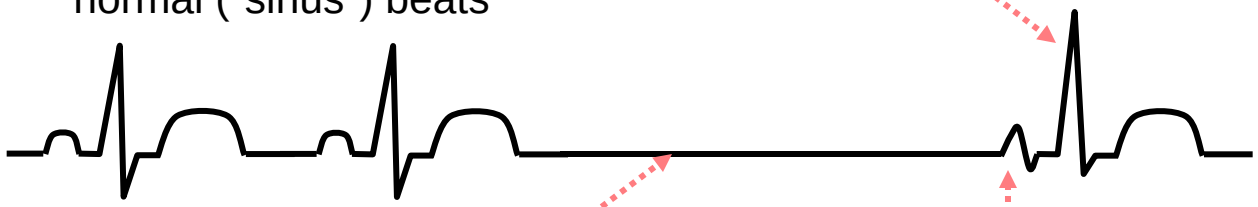
- **Sick Sinus Syndrome: Failure of the heart's pacemaking capabilities**
  - Causes:
    - Idiopathic (no cause can be found)
    - Cardiomyopathy (disease and malformation of the cardiac muscle)
  - Implications and Associations
    - Associated with Tachycardia / Bradycardia arrhythmias
    - Is often followed by an **ectopic** "escape beat" or an **ectopic** "rhythm"

Recognizing and Naming Beats & Rhythms

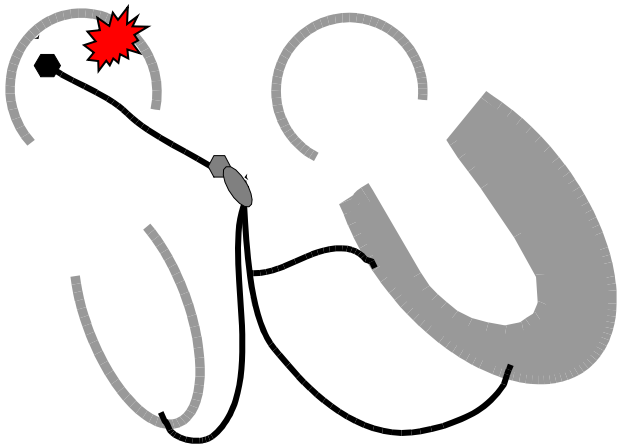
Atrial Escape Beat

QRS is slightly different but still narrow, indicating that conduction through the ventricle is relatively normal

normal ("sinus") beats



sinus node doesn't fire leading to a period of asystole (sick sinus syndrome)

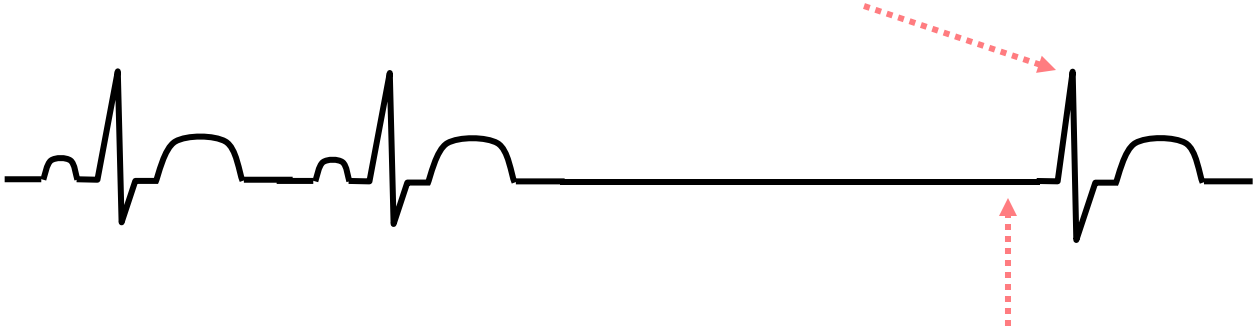


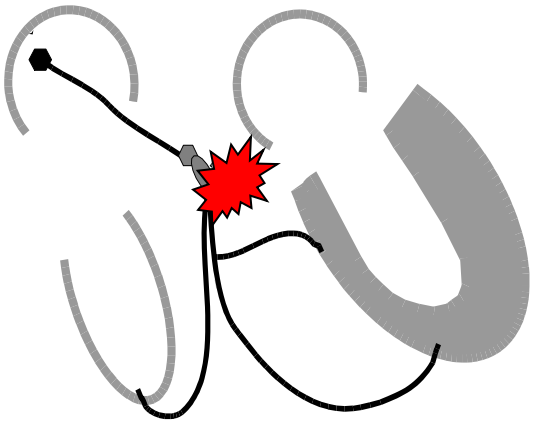
p-wave has different shape indicating it did not originate in the sinus node, but somewhere in the atria. It is therefore called an "atrial" beat

Recognizing and Naming Beats & Rhythms

Junctional Escape Beat

QRS is slightly different but still narrow, indicating that conduction through the ventricle is relatively normal



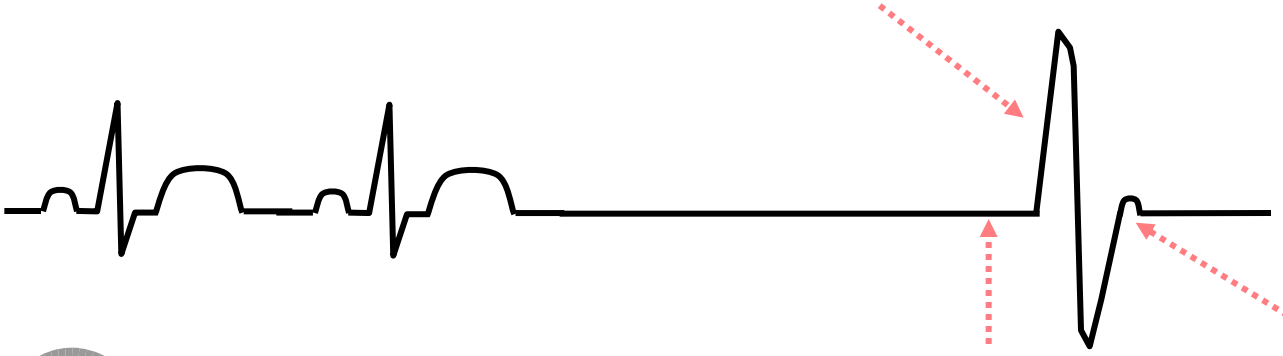


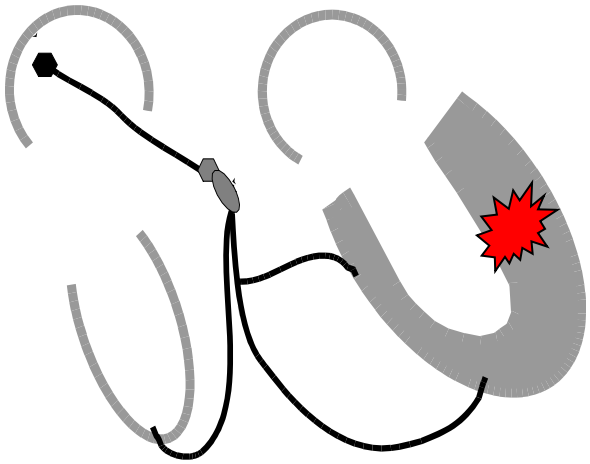
there is no p wave, indicating that it did not originate anywhere in the atria, but since the QRS complex is still thin and normal looking, we can conclude that the beat originated somewhere near the AV junction. The beat is therefore called a "junctional" or a “nodal” beat

Recognizing and Naming Beats & Rhythms

Ventricular Escape Beat

QRS is wide and much different ("bizarre") looking than the normal beats. This indicates that the beat originated somewhere in the ventricles and consequently, conduction through the ventricles did not take place through normal pathways. It is therefore called a "ventricular" beat





there is no p wave, indicating that the beat did not originate anywhere in the atria

actually a "retrograde p-wave may sometimes be seen on the right hand side of beats that originate in the ventricles, indicating that depolarization has spread back up through the atria from the ventricles

Recognizing and Naming Beats & Rhythms

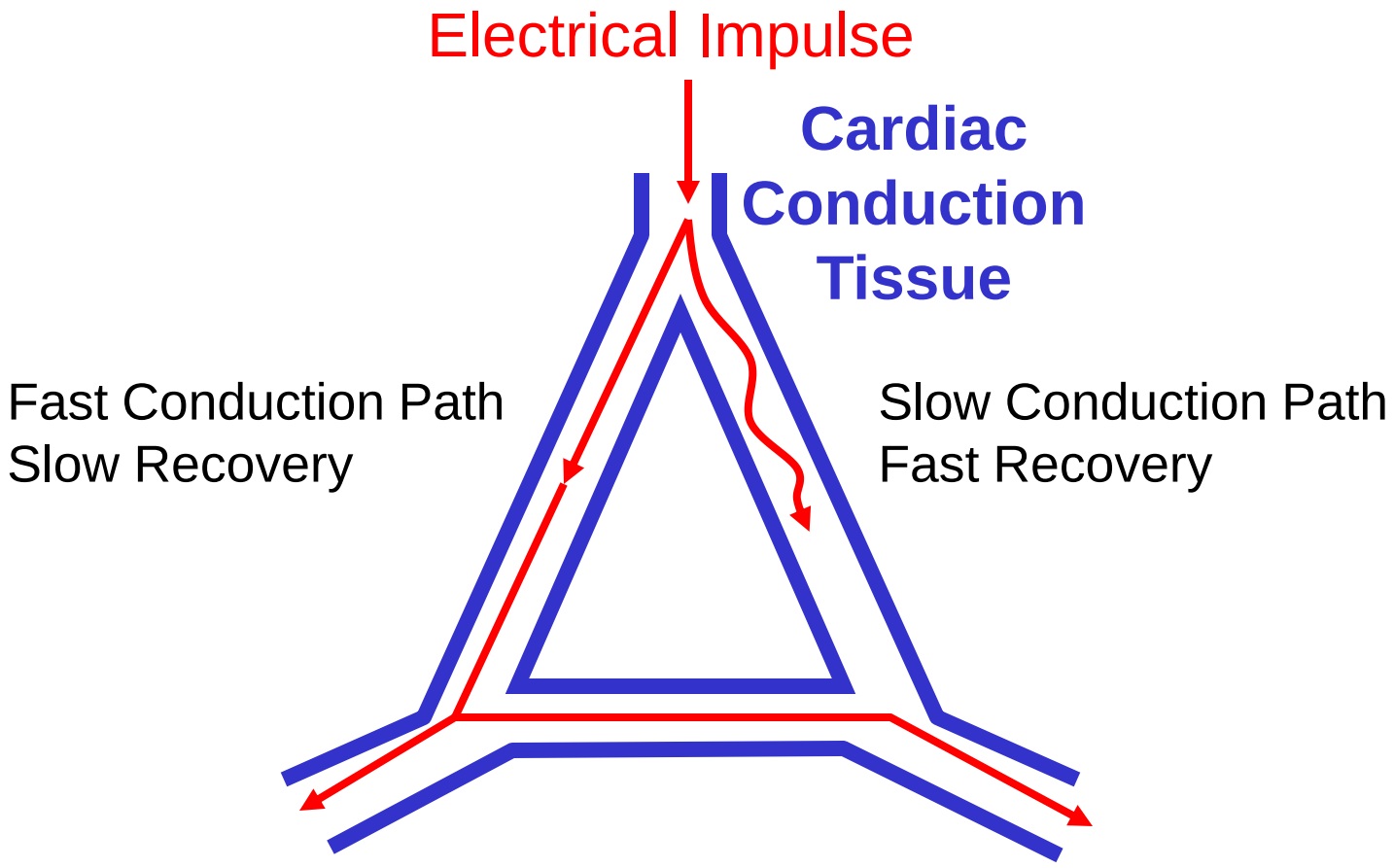
Ectopic Beats or Rhythms

- beats or rhythms that originate in places other than the SA node
- the ectopic focus may cause single beats or take over and pace the heart, dictating its entire rhythm
- they may or may not be dangerous depending on **how they affect the cardiac output**

Causes of Ectopic Beats or Rhythms

- hypoxic myocardium - chronic pulmonary disease, pulmonary embolus
- ischemic myocardium - acute MI, expanding MI, angina
- sympathetic stimulation - nervousness, exercise, CHF, hyperthyroidism
- drugs & electrolyte imbalances - antiarrhythmic drugs, hypokalemia, imbalances of calcium and magnesium
- bradycardia - a slow HR predisposes one to arrhythmias
- enlargement of the atria or ventricles producing stretch in pacemaker cells

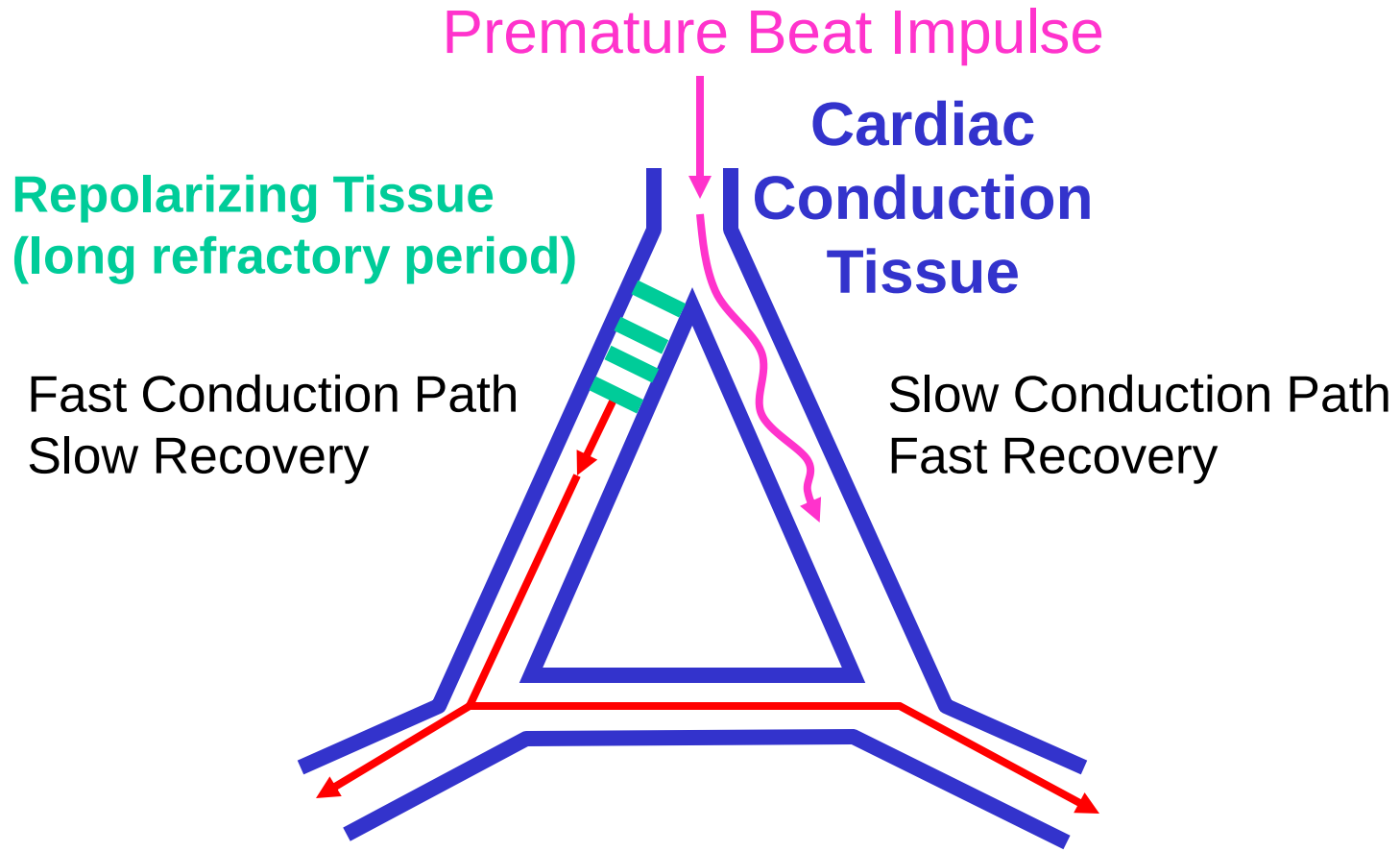
The “Re-Entry” Mechanism of Ectopic Beats & Rhythms



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**

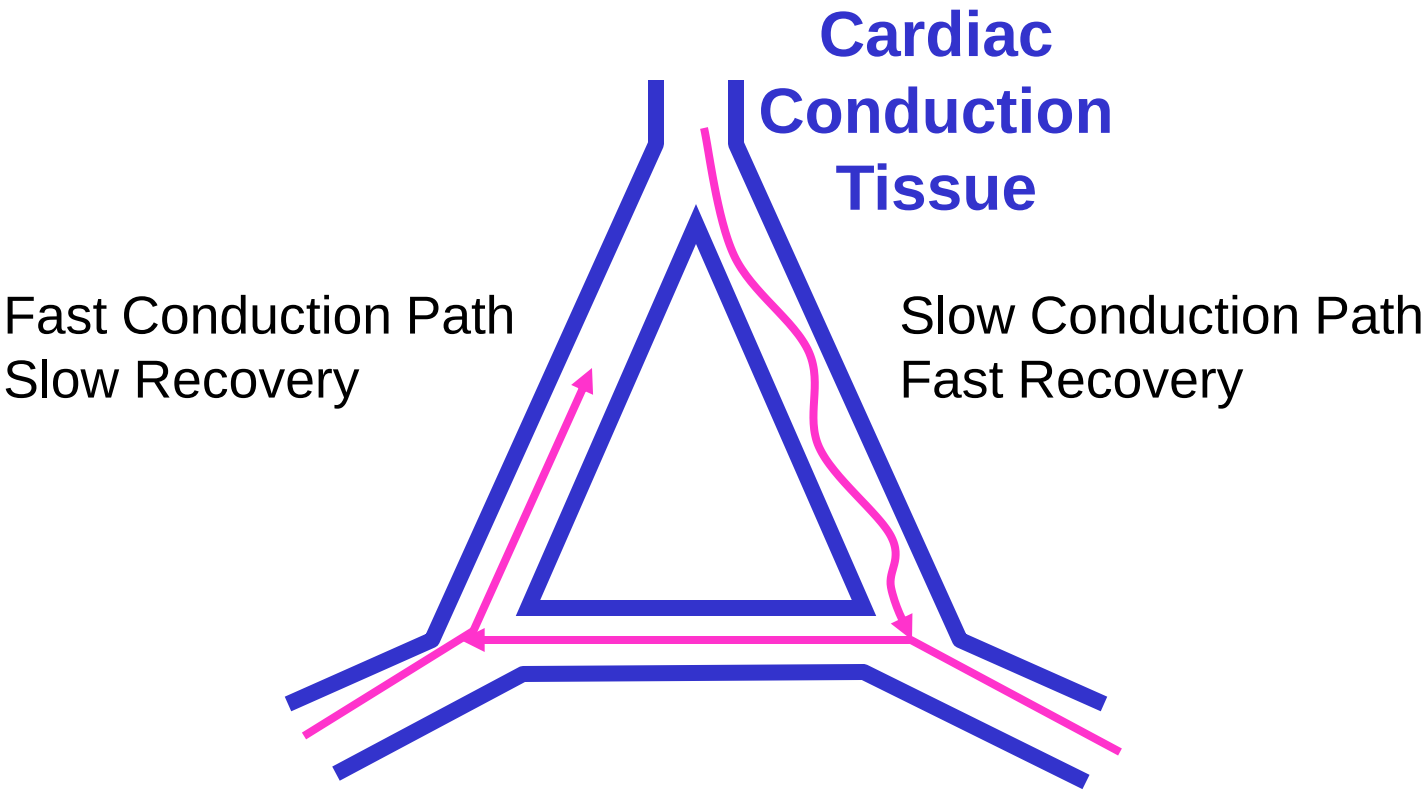
The "Re-Entry" Mechanism of Ectopic Beats & Rhythms



1. **An arrhythmia is triggered by a premature beat**

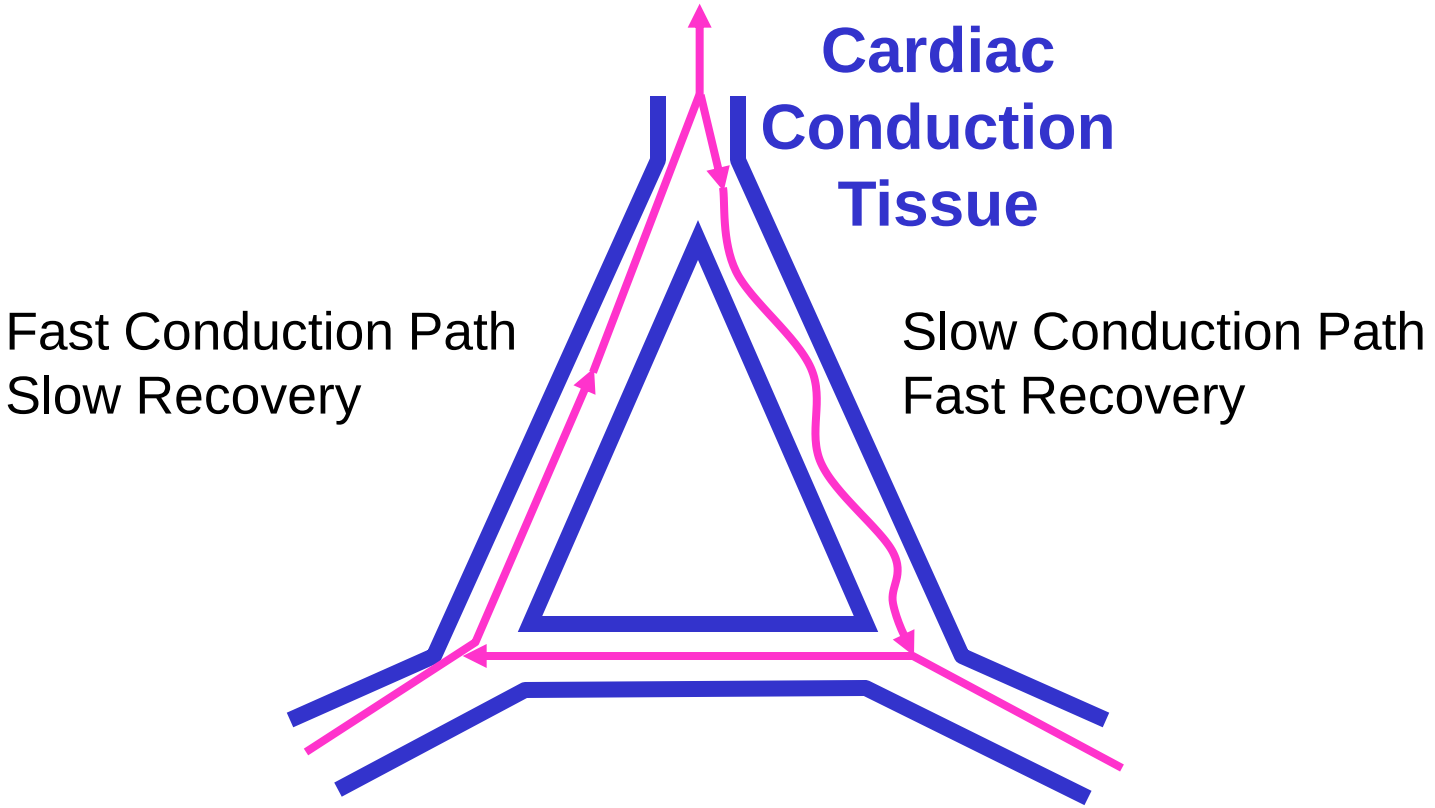
2. **The beat cannot gain entry into the fast conducting pathway because of its long refractory period and therefore travels down the slow conducting pathway only**

The “Re-Entry” Mechanism of Ectopic Beats & Rhythms



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

The “Re-Entry” Mechanism of Ectopic Beats & Rhythms



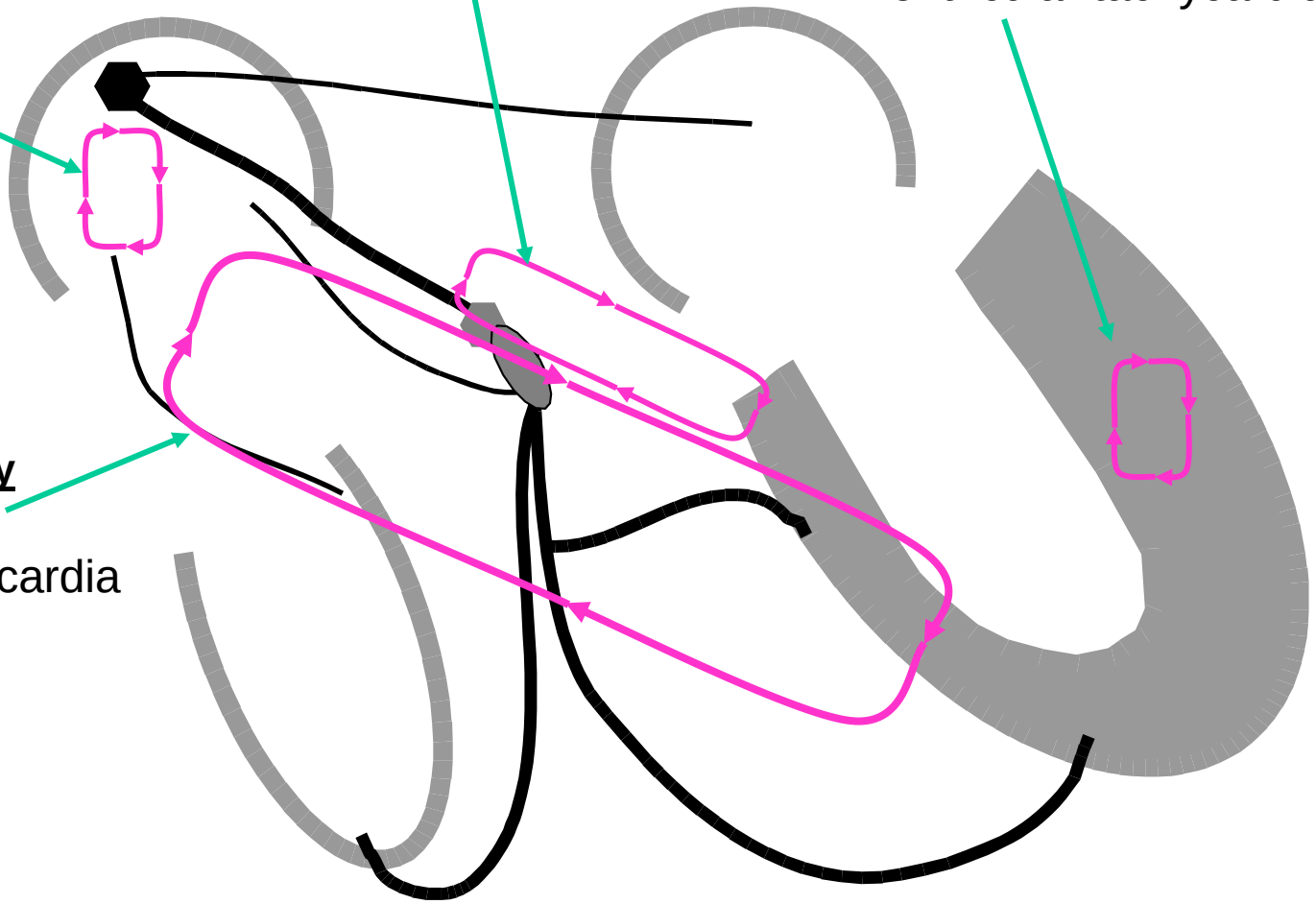
4. On arriving at the top of the fast pathway it finds the slow pathway has recovered and therefore the wave of excitation ‘re-enters’ the pathway and continues in a ‘circular’ movement. This creates the re-entry circuit

Re-entry Circuits as Ectopic Foci and Arrhythmia Generators

Atrio-Ventricular Nodal Re-entry
- supraventricular tachycardia

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

Ventricular Re-entry
- ventricular tachycardia



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

Recognizing and Naming Beats & Rhythms

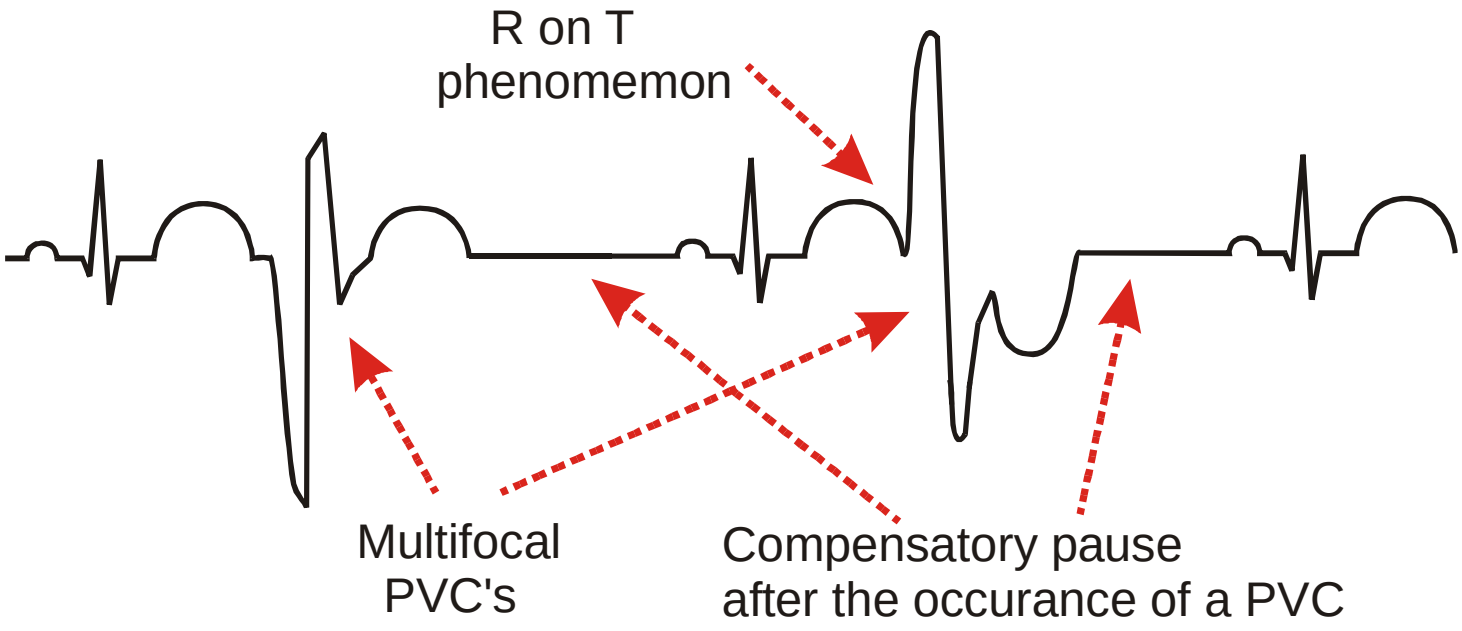
Clinical Manifestations of Arrhythmias

- many go unnoticed and produce no symptoms
- palpitations – ranging from “noticing” or “being aware” of ones heart beat to a sensation of the heart “beating out of the chest”
- if Q is affected (HR > 300) – lightheadedness and syncope, fainting
- drugs & electrolyte imbalances - antiarrhythmic drugs, hypokalemia, imbalances of calcium and magnesium
- very rapid arrhythmias u myocardial oxygen demand r ischemia and angina
- sudden death – especially in the case of an acute MI

Recognizing and Naming Beats & Rhythms

Premature Ventricular Contractions (PVC's, VPB's, extrasystoles):

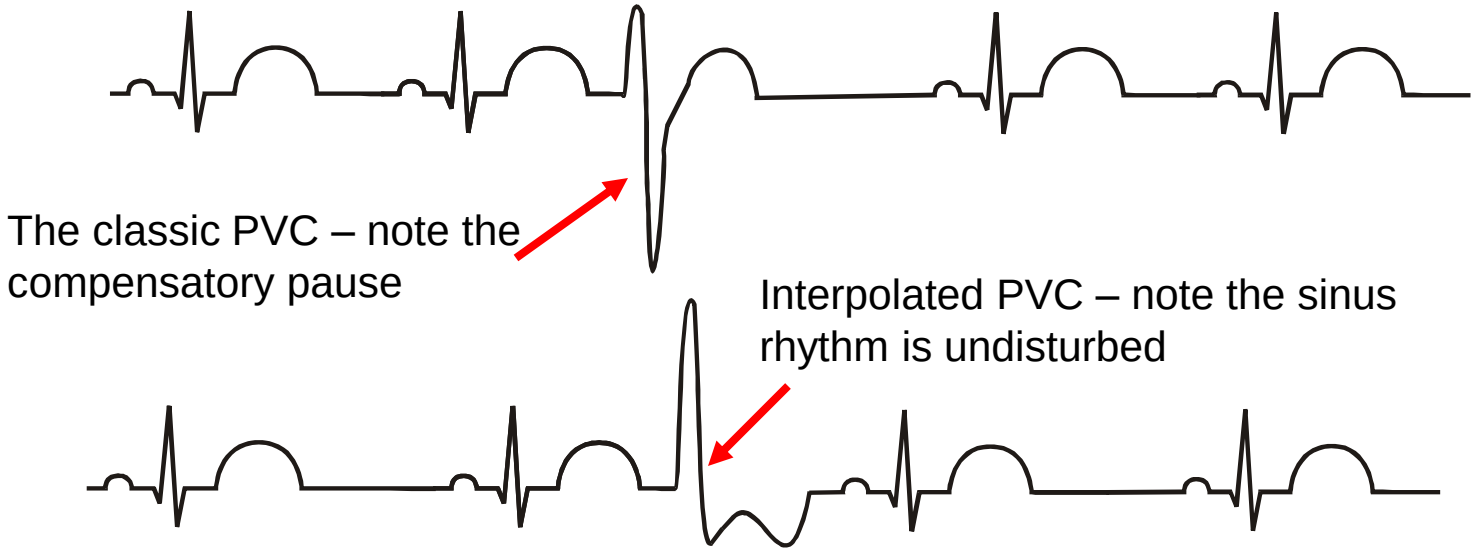
- A ventricular ectopic focus discharges causing an early beat
- Ectopic beat has no P-wave (maybe retrograde), and QRS complex is "wide and bizarre"
- QRS is wide because the spread of depolarization through the ventricles is abnormal (aberrant)
- In most cases, the heart circulates no blood (no pulse because of an irregular squeezing motion
- PVC's are sometimes described by lay people as "skipped heart beats"



Recognizing and Naming Beats & Rhythms

Characteristics of PVC's

- PVC's don't have P-waves unless they are retrograde (may be buried in T-Wave)
- T-waves for PVC's are usually large and opposite in polarity to terminal QRS
- Wide (> .16 sec) notched PVC's may indicate a dilated hypokinetic left ventricle
- Every other beat being a PVC (bigeminy) may indicate coronary artery disease
- Some PVC's come between 2 normal sinus beats and are called "interpolated" PVC's



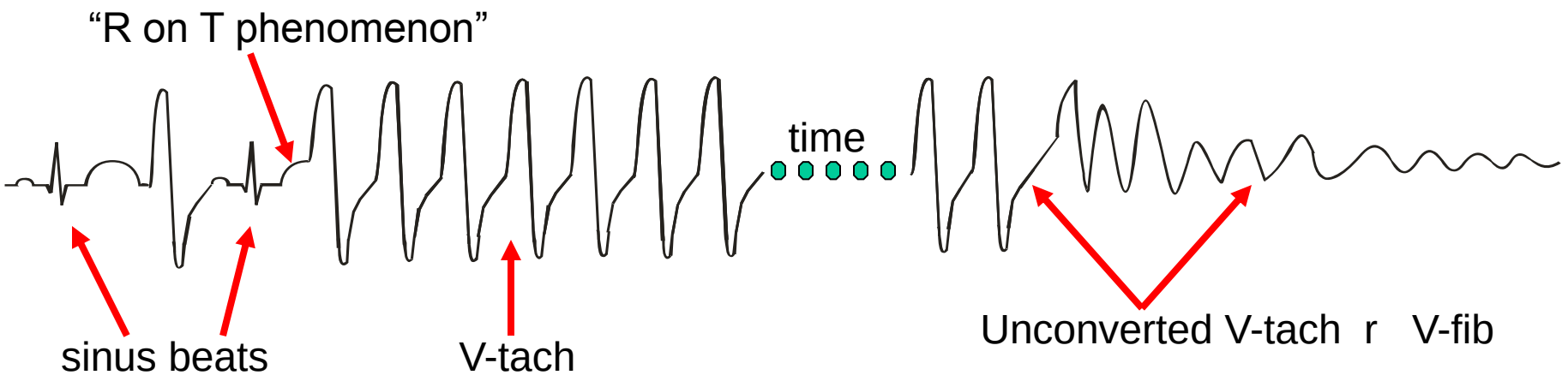
Recognizing and Naming Beats & Rhythms

PVC's are Dangerous When:

- They are frequent (> 30% of complexes) or are increasing in frequency
- The come close to or on top of a preceding T-wave (R on T)
- Three or more PVC's in a row (run of V-tach)
- Any PVC in the setting of an acute MI
- PVC's come from different foci ("multifocal" or "multiformed")

These dangerous phenomenon may preclude the occurrence of deadly arrhythmias:

- **Ventricular Tachycardia** → **The sooner defibrillation takes place,**
- **Ventricular Fibrillation** → **the increased likelihood of survival**

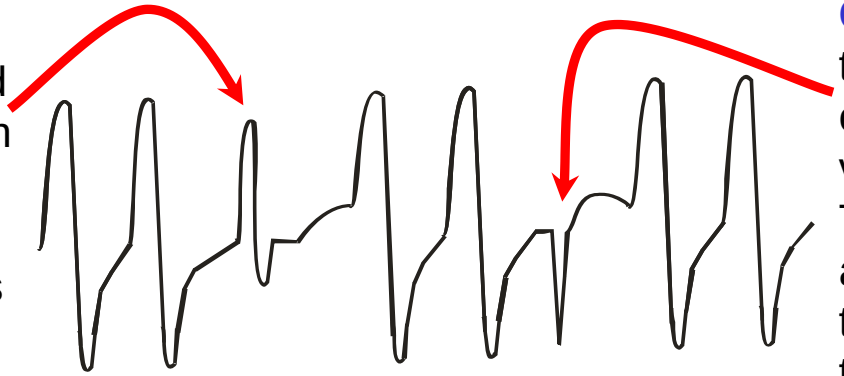


Recognizing and Naming Beats & Rhythms

Notes on V-tach:

- Causes of V-tach
  - Prior MI, CAD, dilated cardiomyopathy, or it may be idiopathic (no known cause)
- Typical V-tach patient
  - MI with complications & extensive necrosis, EF<40%, d wall motion, v-aneurysm)
- V-tach complexes are likely to be similar and the rhythm regular
  - Irregular V-Tach rhythms may be due to to:
    - breakthrough of atrial conduction
      - atria may “capture” the entire beat beat
      - an atrial beat may “merge” with an ectopic ventricular beat (fusion beat)

Fusion beat - note p-wave in front of PVC and the PVC is narrower than the other PVC’s – this indicates the beat is a product of both the sinus node and an ectopic ventricular focus

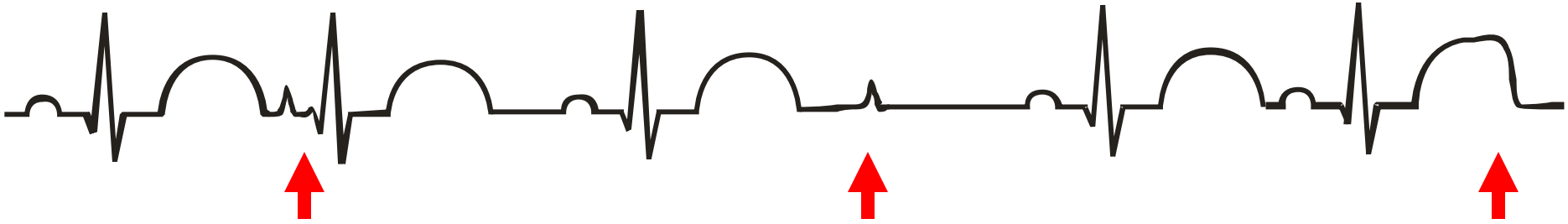


Capture beat - note that the complex is narrow enough to suggest normal ventricular conduction. This indicates that an atrial impulse has made it through and conduction through the ventricles is relatively normal.

Recognizing and Naming Beats & Rhythms

Premature Atrial Contractions (PAC's):

- An ectopic focus in the atria discharges causing an early beat
- The P-wave of the PAC will not look like a normal sinus P-wave (different morphology)
- QRS is narrow and normal looking because ventricular depolarization is normal
- PAC's may not activate the myocardium if it is still refractory (non-conducted PAC's)
- PAC's may be benign: caused by stress, alcohol, caffeine, and tobacco
- PAC's may also be caused by ischemia, acute MI's, d electrolytes, atrial hypertrophy
- PAC's may also precede PSVT



PAC

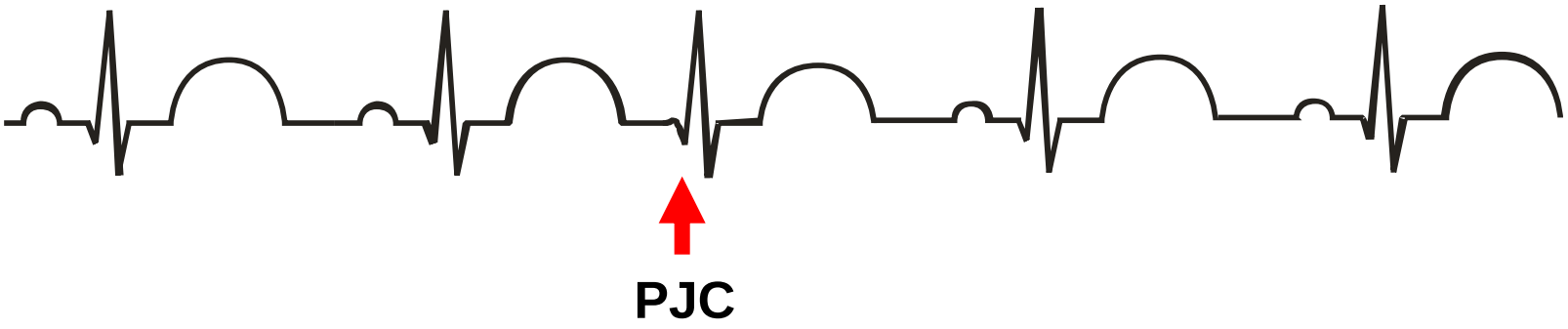
Non conducted PAC

Non conducted PAC distorting a T-wave

Recognizing and Naming Beats & Rhythms

Premature Junctional Contractions (PJC's):

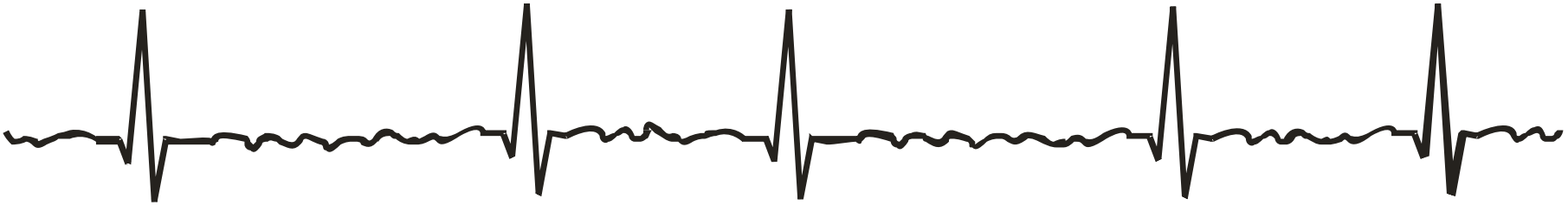
- An ectopic focus in or around the AV junction discharges causing an early beat
- The beat has no P-wave
- QRS is narrow and normal looking because ventricular depolarization is normal
- PJC's are usually benign and require not treatment unless they initiate a more serious rhythm



Recognizing and Naming Beats & Rhythms

Atrial Fibrillation (A-Fib):

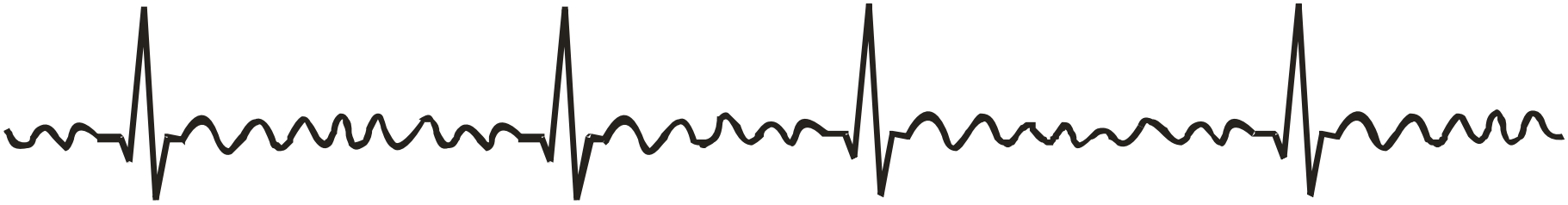
- Multiple ectopic reentrant focuses fire in the atria causing a chaotic baseline
- The rhythm is irregular and rapid (approx. 140 – 150 beats per minute)
- Q is usually d by 10% to 20% (no atrial “kick” to ventricular filling)
- May be seen in CAD (especially following surgery), mitral valve stenosis, LV hypertrophy, CHF
- Treatment: DC cardioversion & O2 if patient is unstable
    - drugs: (rate control) β & Ca^{++} channel blockers, digitalis, to d AV Conduction
    - amiodarone to d AV conduction + prolong myocardial AP (u refractoriness of myocardium)
- The danger of thromboembolic events are enhanced due to d flow in left atrial appendage
    - Treatment: anticoagulant drugs (Warfarin / Coumadin)
        - International Normalized Ratio (INR – normalized PT time) should be between 2 and 3.



Recognizing and Naming Beats & Rhythms

Atrial Flutter:

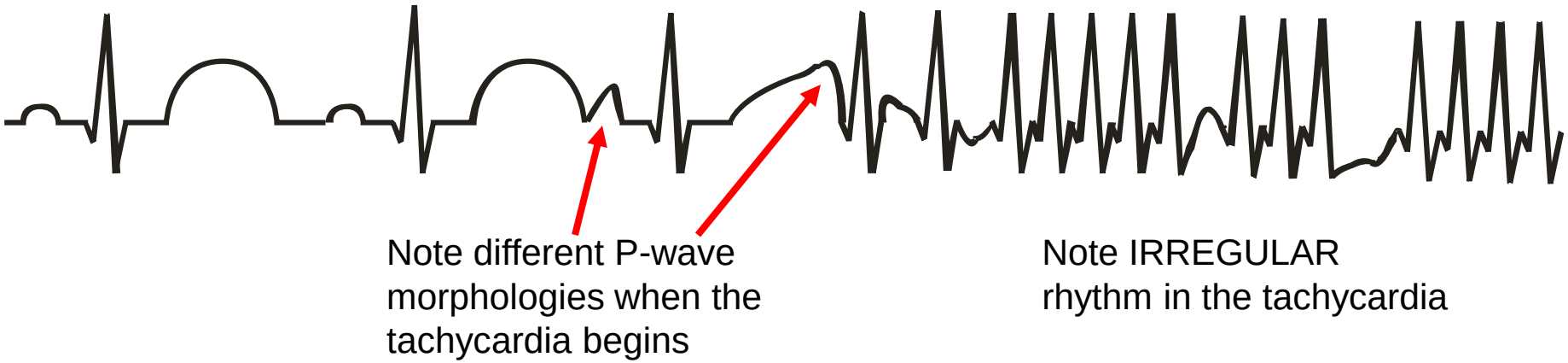
- A single ectopic macroreentrant focuses fire in the atria causing the “fluttering” baseline
- AV node cannot transmit all impulses (atrial rate: 250 –350 per minute)
    - ventricular rhythm may be regular or irregular and range from 150 –170 beats / minute
- Q may d, especially at high ventricular rates
- A-fib and A-flutter rhythm may alternate – these rhythms may also alternate with SVT’s
- May be seen in CAD (especially following surgery), VHD, history of hypertension, LVH, CHF
- Treatment: DC cardioversion if patient is unstable
    - drugs: (goal: rate control) Ca^{++} channel blockers to d AV conduction
    - amiodarone to d AV conduction + prolong myocardial AP (u refractoriness of myocardium)
- The danger of thromboembolic events is also high in A-flutter



Recognizing and Naming Beats & Rhythms

Multifocal Atrial Tachycardia (MAT):

- Multiple ectopic focuses fire in the atria, all of which are conducted normally to the ventricles
    - QRS complexes are almost identical to the sinus beats
- Rate is usually between 100 and 200 beats per minute
- The rhythm is always IRREGULAR
- P-waves of different morphologies (shapes) may be seen if the rhythm is slow
    - If the rate < 100 bpm, the rhythm may be referred to as “wandering pacemaker”
- Commonly seen in pulmonary disease, acute cardiorespiratory problems, and CHF
- Treatments: Ca^{++} channel blockers, β blockers, potassium, magnesium, supportive therapy for underlying causes mentioned above (antiarrhythmic drugs are often ineffective)



Recognizing and Naming Beats & Rhythms

Paroxysmal (of sudden onset) Supraventricular Tachycardia (PSVT):

- A single reentrant ectopic focuses fires in and around the AV node, all of which are conducted normally to the ventricles (usually initiated by a PAC)
    - QRS complexes are almost identical to the sinus beats
- Rate is usually between 150 and 250 beats per minute
- The rhythm is always REGULAR
- Possible symptoms: palpitations, angina, anxiety, polyuruia, syncope (d Q)
- Prolonged runs of PSVT may result in atrial fibrillation or atrial flutter
- May be terminated by carotid massage
    - u carotid pressure r u baroreceptor firing rate r u vagal tone r d AV conduction
- Treatment: ablation of focus, Adenosine (d AV conduction), Ca^{++} Channel blockers