Cardiac Arrhythmias

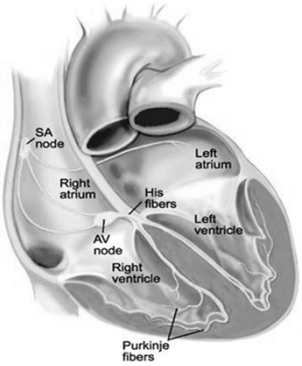
J. Anderson, RN, MSN

Unique Properties of Cardiac Cells

- Automaticity
- Excitability
- Conductivity
- Contractillity

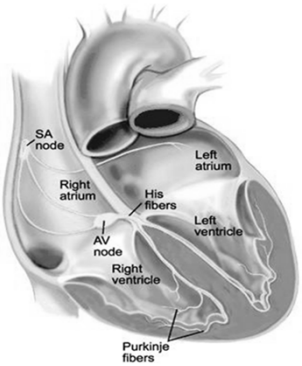
The Cells of the Heart

- Pacemaker cells
  - The normal electrical power source of the heart (impulses)
- Electrical conducting cells
  - The hard wiring of the heart
- Myocardial cells
  - The contractile machinery of the heart



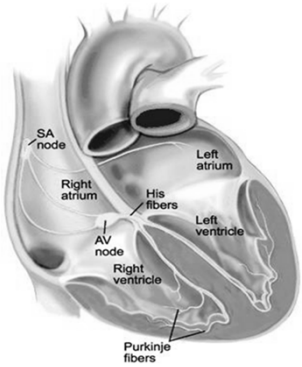
Normal Electrical Conduction System

- SA node – dominant pacemaker
- Inter-nodal pathways
- AV node
- Bundle of his
- Left & Right bundle branches
- Purkinje fibers



Heart cells and automatic ability

- Every cell in the heart has the ability to behave like a pacemaker cell
- SA node (atrium)
  - HR 60 – 100 BPM
- AV node (junction)
  - HR 40 – 60 BPM
- Ventricles
  - HR 20 – 40 BPM



Autonomic Nervous System and the Heart

- Sympathetic (fight or flight)
  - Heart rate
  - Force of contraction
  - Blood vessels
- Parasympathetic (Rest and relax)
  - Heart rate
  - Force of contraction
  - Blood vessels

Receptors and the Heart

- Baroreceptors (presser receptors)
  - at the aortic arch & carotid sinus
  - ↑ pressure → ↓ sympathetic = ↑ parasympathetic

Important definitions

- Systole
- Diastole
- Depolarization
- Repolarization

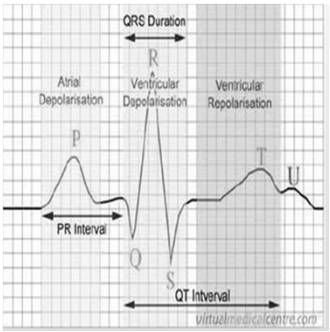
Important definitions

- Action potential
- Absolute refractory period
- Relative refractory period

Electrical Conduction Cycle

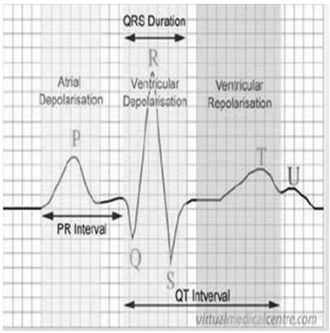
Electrical Conduction Cycle

- One Complete Cardiac Cycle =
  - P wave
  - Q, R, S (QRS Complex)
  - T wave
  - U wave – rare: may indicate hypokalemia or not



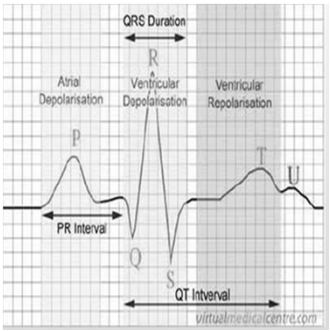
Electrical Conduction Cycle

- EKG wave forms
  - P Wave – Atrial Contraction (depolarization)
  - PR interval – time need for an impulse to travel from the SA node (atrium) to the Bundle of His (ventricle)



Electrical Conduction Cycle

- QRS Complex – Ventricle Contraction (depolarization) & Atrial repolarization
- T Wave – Ventricle repolarization
- QT interval – The time needed for the ventricle to contract (depolarization) and rest to contract again (repolarization)



Common Causes of Arrhythmias

- Heart related
  - Cardiomyopathy
  - Conduction defects
  - Heart failure
  - Myocardial Ischemia/infarction

Common Causes of Arrhythmias

- Other conditions
  - Acid-base imbalance
  - Drugs – Alcohol, caffeine, tobacco, choke, meth, etc.
  - Medications – Digoxin, stimulants, etc.
  - Electrolyte imbalances
  - Hypoxia
  - Metabolic conditions - Thyroid

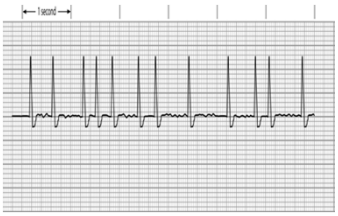
Cardiac Rhythms

Normal Sinus Rhythm (NSR)

- **NSR** – All the complexes are present P-wave, QRS, T- wave with no abnormalities at a rate of 60 – 100 BPM
- **Sinus Bradycardia** – the same as NSR except the HR is ↓ 60 BPM
- Symptomatic Bradycardia – SOB, dizziness, syncope etc. from ↓ cardiac output
- **RX** – Medications: atropine or adregerics
- **Sinus Tachycardia** – the same as NSR except the HR is ↑ 101-200 BPM
- Symptomatic Tachycardia – SOB, dizziness, hypotension from ↓ cardiac output
- **RX**- Underlying cause and medications: Beta blockers, calcium channel blockers, etc.

Atrial fibrillation

- Totally disorganized atrial electrical activity
- Irregularly irregular
- Atrial rate 350 – 600 BPM
- Not clear P-waves
- Control A-Fib is a ventricle rate of 60 – 100 BPM
- Symptomatic A-fib – s/s of ↓ cardiac output and risk of Clot formation
- **RX**:
- ↓ ventricle rate with medications (beta blockers, digoxin, Calcium channel blockers)
- electronic conversion
- Medication conversion (Adenosine)
- medications to prevent clot formation



AV block I

- Has a prolonged PR interval and is in all other ways same a NSR
- Asymptomatic
- **RX**: monitor for changes or progression a more serious form of AV block

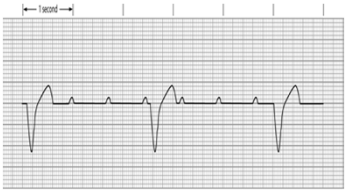
AV block II

- **Type 1 (Wenckebach)**
- Gradually prolonged PR interval until P-wave is not conducted and drops a QRS complex
- More P-waves than QRS
- May be symptomatic or not – symptoms of ↓ cardiac output
- Possible warning sign of more serious AV block coming
- **RX**: if symptomatic – atropine, pacemaker, close observation

- **Type 2(Mobitz II)**
- P-waves are not conducted without the gradually prolonged PR interval
- More P-waves than QRS
- Symptoms of ↓ cardiac output
- Often progresses to Av block III
- **RX**: pacemaker

AV block III

- **Complete heart block**
- No conduction between the atrium and the ventricle
- Atrial rate 60 – 100 BPM (normal P-wave rate and regular)
- Ventricle rate 20 – 40 BPM (QRS complexes wide and regular)
- More P-waves then QRS
- **RX**: pacemaker



Premature Contractions Atrial (PAC)

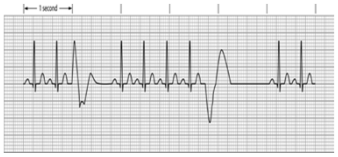
PAC

- An irritated/stimulated cardiac cell fire an impulse in the atrium before the Sinus node
- P-wave, QRS, and T-wave come before expected
- Resets the rhythm
- **RX**: withdraw/ correct the source of stimulation (caffeine), may use beta blockers to reduce PACs

Premature Contractions ventricle (PVC)

PVC

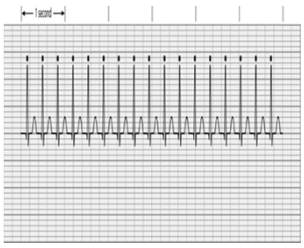
- An irritated/stimulated cardiac cell fire an impulse in the ventricle before expected
- The QRS is wide and distorted, often facing the opposite direction of the normal QRSs
- Can ↓ cardiac output
- **R-on-T phenomenon**
- If a PVC falls on a T-wave during repolarization (when the cell is excitable) it can trigger Ventricle tachycardia or ventricle fibrillation
- **RX**: withdraw/ correct the source of stimulation (hypoxia, caffeine, electrolyte imbalance, etc.). Also use medications such as beta blockers, procainamide, amiodarone.



Supraventricular Tachycardia

SVT

- HR is 150 – 220 BPM
- Tends to be regular
- P-waves often hidden by the proceeding T-wave
- QRS is normal
- Excessive heart rate → ↓ cardiac output (rate that ↓ cardiac output occurs is somewhat patient dependent)
- **RX**: Valsalva, medications – beta blockers, Calcium channel blockers, Amiodarone
- May RX patient with Adenosine to slow rate to differentiate between SVT and uncontrolled atrial fibrillation or to try and reset the normal pacemaker (sinus node)

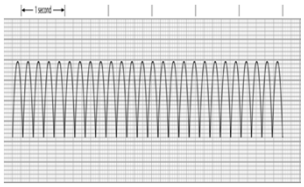


Ventricular Tachycardia (V-Tach)

V-Tach

- A run of 3 or more PVCs is considered v-tach
- An irritated/stimulated cardiac cell repeatedly fire an impulse in the ventricle and takes over as the pacemaker
- Looks like a string of PVC/wide QRSs
- Rate of 150 – 250 BPM
- **Life threating drop in cardiac output**
- Commonly lose pulse

- **RX**: Priority is rapid Defibrillation, followed by vasopressors and antidysrhythmics

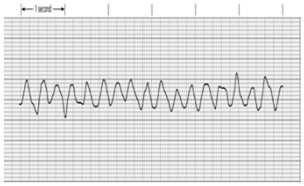


Ventricular Fibrillation (V-fib)

V-fib

- Severe derangement of heart rhythm
- Heart is mechanically quivering
- No effective conduction → no cardiac output
- **Lethal - Not compatible with life**
- Commonly follows unsuccessful treatment of V-tach

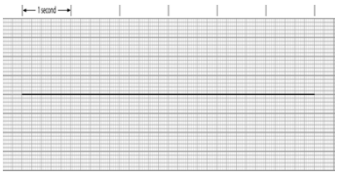
- **Rx**: immediate initiation of CPR and advanced cardiac life support (ACLS). **NO delay in use of defibrillation**



Asystole

- Total absence of ventricle electrical activity
- Patient is unresponsive, pulseless, and apneic

- **RX**: Initiation of CPR and ACLS, Medications – epinephrine and or vasopressin, intubation



Electronic Interventions

- Defibrillation
  - RX for V-fib and pulseless V-Tach critical for successful patient outcome
  - Within 2 minutes
  - Depolarizes all the cell in the myocardium
  - The goal is that when the cells repolarizes the SA node resumes role of pacemaker

Electronic Interventions

- Cardioversion
  - Synchronized to deliver shock on the R wave in the QRS complex
  - Depolarizes cells similar to Defibrillation to reset the pacemaker
  - Uses less power
  - RX: V-tack with pulse, A-fib, and SVT

Electronic Interventions

- Implantable cardioverter-defibrillator (ICD)
  - ICD are implanted into the patient to monitor the HR and rhythm and identifies V-tach and V-fib
  - Defibrillate the heart if a lethal rhythm is detected
  - Patient teaching is extremely important(see text table 36-10)
  - Emotional support

Pacemaker

Electronic device acts as an artificial pacemaker, battery powered

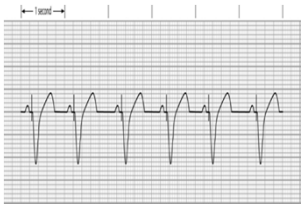
Monitors the patients rhythm and sends an electrical signal (stimulus) through leads (wires) to the heart to stimulate a contraction

Can be set as a atrial or ventricle, or atrial/ventricle pacing

Permanent pacemaker or Temporary pacemaker

Capture or non-capture

Non-capture can lead to R-on-T phenomenon
See text tables 36-11, 36-12, 36-13 on pacemakers



Correlation between Hemodynamics and Cardiac Rhythms

- Cardiac Arrhythmias
- Cardiac output
- Tissue perfusion