

# ECG / ARRHYTHMIAS

## 1. Rhythms & arrhythmias

### • SA nodal rhythms

- Sinus rhythm
- Sinus tachycardia
- Sinus bradycardia
- Sinus arrhythmia
- Sick sinus syndrome
- SA block
- Sinus arrest

### • AV blocks

- First-degree
- Second-degree
  - Mobitz Type I
  - Mobitz Type II
- Third-degree

### • Atrial rhythms

- Atrial tachycardia
- Atrial fibrillation
- Atrial flutter

### • Ectopic beats

- Atrial ectopic beats
- Ventricular ectopics
- AV junctional ectopics
- Bigeminy

### • SVTs

- AV re-entry tachycardia
- AV nodal re-entry tachycardia

### • Ventricular rhythms

- Ventricular tachycardia
- Ventricular fibrillation
- Torsades de pointes
- Idioventricular rhythm
- Accelerated idioventricular rhythm

### • Conduction disturbances

- Left bundle branch block
- Right bundle branch block
- Bifascicular block
- Trifascicular block

## 2. Bradyarrhythmias

### 1. Sinus bradycardia

1. Sinus rate <60bpm
2. Clinically significant when <45bpm
3. Caused by ischemia, inc vagal tone, antiarrhythmic drugs
4. Asymptomatic
5. Fatigue
6. Inability to exercise
7. Angina
8. Atropine

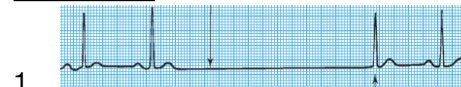
### 2. Sick sinus syndrome

1. Sinus node dysfunction leading to sinus bradycardia and end-organ hypoperfusion
2. Caused by degenerative fibrosis, amyloidosis, CT disease, sarcoidosis, metabolic disturbances, drugs, toxins
3. Asymptomatic
4. Dizziness, syncope
5. Confusion, fatigue
6. CHF, angina, stroke
7. Bradycardia (sinus bradycardia, sinus arrest, SA block)
8. Tachyarrhythmias may be present (due to escape rhythms)
9. Implanted pacemaker
10. SA block



2. Next P wave appears where expected

### 11. Sinus arrest



2. Next P wave does not appear as expected (junctional escape beat)

## 3. AV Block

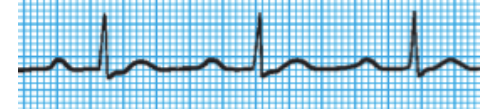
### 1. First-degree AV block

1. Delay in AV node

### 2. Long PR interval

3. QRS complex follows each P wave

4. Benign, no tx



### 2. Second-degree AV block

1. Block in heart causes non-conducting P waves

### 2. Mobitz Type I

1. Block in AV node
2. Progressive lengthening of PR interval until P wave fails to conduct

3. Benign, no tx



### 3. Mobitz type II

1. Block in His-Purkinje system
2. Can lead to complete heart block
3. P wave suddenly fails to conduct
4. Implanted pacemaker



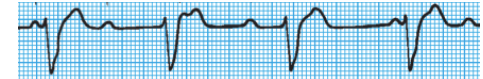
### 3. Third-degree AV block

1. Atrial impulses do not conduct to ventricles = AV dissociation
2. Ventricular escape rhythms create QRS complexes

### 3. Dizziness, syncope

4. Independent P waves and QRS complexes
5. Ventricular rate 25-40 bpm

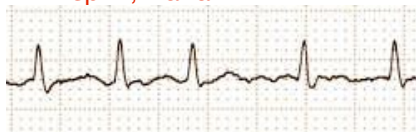
6. Implanted pacemaker



## ECG / ARRHYTHMIAS

### 4. Atrial fibrillation

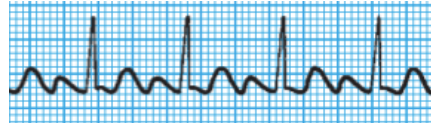
- Cx
  - Multiple foci in atria fire in chaotic pattern causing atria to quiver continuously
- Causes
  - CAD, MI, HTN, mitral valve disease
  - Pericarditis, pericardial trauma
  - Pulmonary disease, PE
  - Hyper/hypo-thyroidism
  - Sepsis, malignancy, DM
  - Stress
  - Alcohol
  - Sick sinus syndrome
  - Pheochromocytoma
- Paroxysmal AF
  - Spontaneously terminating episodes
- Persistent AF
  - Continuous AF
- Permanent AF
  - Continuous AF, with no expectation of restoring sinus rhythm
- Sx / sn
  - Fatigue, dizziness, exertional dyspnea
  - Palpitations, angina, syncope
  - Irregularly irregular pulse
  - Blood stasis (thromboembolism)
- ECG
  - Irregularly irregular rhythm
  - Excessively rapid series of tiny, erratic spikes with wavy baseline (f waves)
  - No P waves
- Acute tx (hemodynamically *unstable*)
  - DC cardioversion
- Acute tx (hemodynamically *stable*)
  - BB, verapamil
  - Digoxin, amiodarone
  - Heparin, aspirin, warfarin
- Chronic tx
  - BB, Ca<sup>++</sup> blocker
  - Asprin, warfarin



11.

### 5. Atrial flutter

- Cx
  - One ectopic focus in atria fires in a re-entry circuit in atrium
  - One out of every 2, 3, or 4 flutter waves conduct to ventricles (blocks)
- Causes
  - Heart failure
  - Rheumatic heart disease
  - CAD
  - COPD
  - ASD
- ECG
  - Saw-tooth baseline (esp. II, III, aVF)
  - QRS complex after every 2 or 3 P waves
- Tx
  - Similar to tx Afib
  - Carotid sinus massage
  - Sotalol, flecainide, amiodarone
  - DC cardioversion
  - Overdrive atrial pacing
  - Ablation



### 6. Multifocal atrial tachycardia

- Several pacemakers compete causing a different rhythm for each beat
- Occurs in COPD pts, hypoxia
- ECG
  - 3+ different P wave morphologies
  - Heart rate >100 bpm
- Oxygenation, ventilation
- BB, Ca<sup>++</sup> blockers, digoxin
- Amiodarone, IV flecainide, IV propafenone



### 7. Wandering atrial pacemaker

- Identical to multifocal atrial tachycardia
- Heart rate 60-100 bpm

### 8. Premature complexes

#### 1. Premature atrial complexes (PACs)

- Premature heartbeats originating from atria
- Caused by adrenergics, drugs, alcohol, tobacco, electrolyte imbalances, ischemia

#### 3. Asx

#### 4. Palpitations

#### 5. PSVTs

#### 6. ECG

##### 1. Early P waves w/ abnormal shape

##### 2. QRS complex normal

#### 7. BB if sx



8.

#### 2. Premature ventricular complexes

- Premature heartbeat originating from ventricle
- Can occur with pts without structural heart disease
- Caused by hypoxia, electrolyte abnormalities, stimulants, caffeine, meds, heart disease
- Frequent PVCs + heart disease are at risk for sudden death (VFib)

#### 5. Asx

#### 6. Palpitations

#### 7. Dizziness

#### 8. ECG

##### 1. Wide, bizarre QRS complex

##### 2. P wave "buried" within QRS

#### 9. BB if sx

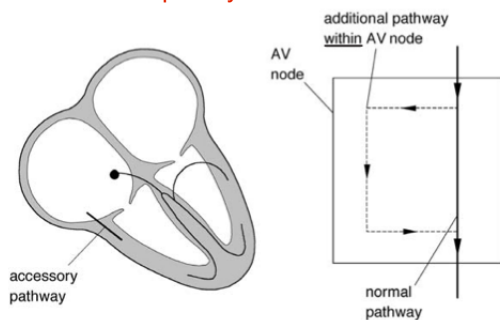


10.

## ECG / ARRHYTHMIAS

### 9. Paroxysmal supraventricular tachycardia

1. AV nodal reentrant tachycardia
2. Orthodromic AV reentrant tachycardia
3. Cx
  1. A second connection between atria and ventricles creates a reentrant circuit
  2. Repeated activation of atria & ventricles causes tachycardia
4. Causes
  1. Ischemic heart disease
  2. Digoxin toxicity (2:1 blocks)
  3. AV node reentry
  4. AV reciprocating tachycardia (accessory pathway)
  5. Atrial flutter with RVR
  6. Caffeine, alcohol
5. Sx / sn
  1. Palpitations
  2. Atypical chest pain
  3. Dizziness, syncope
6. ECG
  1. Narrow QRS complex tachycardia
  2. HR 130-250 bpm
  3. Only one P wave per QRS
  4. Narrow but regular QRS
7. Tx
  1. Valsalva maneuver
  2. Carotid sinus massage
  3. Breath holding
  4. Head immersion in cold water
  5. IV adenosine
  6. IV verapamil, IV esmolol
  7. DC cardioversion
  8. Radiofrequency ablation



8.

### 10. AV nodal re-entry tachycardia (AVNRT)

1. Cx
  1. Two pathways within AV node create a reentrant circuit between atria & vent.
2. Pathophysiology
  1. If a supraventricular ectopic beat occurs during refractory period of the fast track, ectopic will conduct down slow track
  2. By the time the conduction reaches the end of the slow track, the fast track is repolarized
  3. Impulse travels back up fast track, then back down slow track = ad infinitum = activating atria & ventr.
3. AV node
  1. Fast track - quick conduction, long refractory period
  2. Slow track - slow conduction, short refractory period
4. ECG
  1. Narrow QRS complex tachycardia
  2. No P waves



5.

### 11. AV re-entry tachycardia (AVRT)

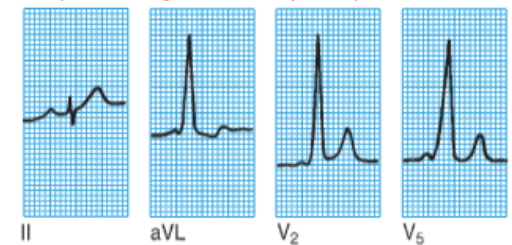
1. Cx
  1. An accessory pathway apart from AV node creates a reentrant circuit between atria & ventricles
  2. Can be found in WPW
2. ECG
  1. Narrow QRS complex tachycardia
  2. P waves may be visible



3.

### 12. Wolff-Parkinson-White syndrome

1. Cx
  1. The Bundle of Kent is an accessory conduction pathway creating a reentrant circuit between atria & vent.
  2. Causes early ventricular excitation
2. Mechanisms causing PSVT
  1. Orthodromic reciprocating tachycardia
    1. Impulse travels anterograde thru AV node to depolarize ventricles
    2. Impulse travels retrograde via accessory pathway creating reentry loop
    3. No delta waves
  2. SVTs (AFib, AFlutter)
    1. Ectopic atrial impulses travel anterograde thru accessory pathway to ventricles
3. Sx
  1. Asx
  2. Recurrent PSVT (AVRT)
  3. Palpitations
  4. Sudden paleness
4. ECG
  1. Narrow complex tachycardia
  2. Delta wave (initial slow vent. depol. causing slurred upstroke of QRS)
  3. Short PR interval
  4. Left axis deviation
5. Tx
  1. Radiofrequency catheter ablation of reentrant loop
  2. Procainamide
  3. Quinidine
  4. (Avoid digoxin, verapamil)



6.

## ECG / ARRHYTHMIAS

### 13. Ventricular tachycardia

- Cx
  - A reentry circuit or ventricular focus with inc automaticity causes tachycardia
- Causes
  - CAD with prior MI (most common)
  - Active ischemia, hypotension
  - Cardiomyopathies
  - Congenital defects
  - Prolonged QT syndrome
  - Drug toxicity, electrolyte disturbance
- Sx / sn
  - Palpitations**
  - Dyspnea, angina
  - Lightheadedness, syncope
  - Cardiogenic shock sn
  - Cannon A waves** in neck
  - S1 varying in intensity**
- Nonsustained VT**
  - Brief, self-limited runs of VT
  - Asymptomatic
  - Independent risk factor for sudden death if CAD & LV dysfunction present
  - EP study**
  - None** (if no heart disease)
  - ICD** (if EP study pos.)
  - Amiodarone** (2nd line)
- Sustained VT**
  - >30 sec**, symptomatic
  - Hypotension, hemodynamic compromise
  - Life-threatening, can lead to VFib
  - IV amiodarone**, procainamide, sotalol (stable pt)
  - DC cardioversion** (unstable pt)
  - ICD**
- ECG**
  - Wide, bizarre QRS complexes**
  - Monomorphic or polymorphic QRSs
  - 3+ PVCs** in a row
  - 100-250 bpm

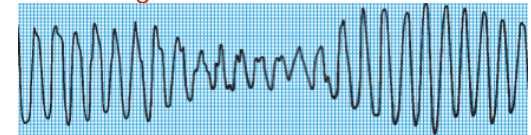


### 14. Ventricular fibrillation

- Cx
  - Multiple foci in ventricle fire in chaotic pattern causing ventricle to quiver continuously
  - Most VFib episodes begin as VT
  - Fatal if untreated
- Causes
  - Ischemic heart dis. (most common)
  - Antiarrhythmic drugs
  - AFib with RVR in WPW pts
- Sx / sn
  - Unmeasurable BP**
  - Absent heart sounds**
  - Absent pulse**
  - Unconscious pt**
- ECG**
  - No P waves
  - No QRS complexes
  - Irregular rhythm
- Acute tx
  - CPR**
  - Defibrillation**
  - Epinephrine**
  - Intubation
- Refractory acute tx
  - IV amiodarone (followed by shock)
  - Lidocaine, magnesium, procainamide
- Chronic tx
  - Implanted defibrillator**
  - Amiodarone
  - BB
  - Lidocaine
- An ECG strip on a blue grid showing ventricular fibrillation. The waveform is chaotic and irregular, with no discernible P waves, QRS complexes, or T waves. The rate is very fast and irregular.

### 15. Torsades de points

- Cx
  - Polymorphic variant of ventricular tachycardia
  - Can lead to VFib
- Causes (prolongation of QT)
  - TCAs, anticholinergics
  - Electrolyte abnormalities
  - Ischemia
  - Amiodarone, sotalol
  - Fluconazole, moxifloxacin
  - Familial long QT syndrome
  - Hypomagnesemia (malnourished alcoholics)
- Tx
  - IV Magnesium**



## ECG / ARRHYTHMIAS

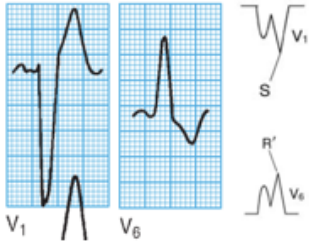
### 16. Conduction disturbances

1. Left bundle branch block
2. Right bundle branch block

### 17. Left bundle branch block

#### 1. ECG

1. QRS > 0.12s
2. Septum depolarizes right to left
  1. Small Q wave in lead V1
  2. Small R wave in lead V6
3. Right ventricle depolarizes via RBB
  1. R wave in lead V1
  2. S wave in lead V6
4. Left ventricle depolarizes via right
  1. S wave in lead V1
  2. R' wave in lead V6

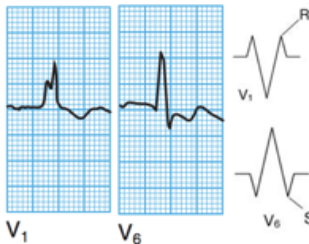


2.

### 18. Right bundle branch block

#### 1. ECG

1. QRS > 0.12s
2. Septum depolarizes normally, left to right
  1. Tiny R wave in lead V1
  2. Small 'septal' Q wave in lead V6
3. Left ventricle depolarizes normally via LBB
  1. S wave in lead V1
  2. R wave in lead V6
4. Right ventricle depolarizes via left
  1. R' wave in lead V1
  2. S wave in lead V6



2.

### 19. Cardiac pacemakers

1. Cx
  1. Delivers direct electrical stimulation to heart when natural pacemaker fails
2. Permanent implants
  1. Long-term tx
3. Temporary implants
  1. Transcutaneous (electrode pads) or transvenous
  2. External pulse generator at waist
4. Indications
  1. Sinus node dysfunction
  2. Mobitz II AV block
  3. Complete third-degree AV block
  4. Sx bradyarrhythmias
  5. Tachyarrhythmias

### 20. Stimulating vagus inhibition of AV node

1. Carotid massage
  1. Pt supine, neck extended
  2. Ci carotid bruits, hx cerebral thromboembolism
  3. Massage carotid for 5s



- 4.
2. Valsalva maneuver
  1. Forced expiration against a closed glottis
  2. Ask pt to breath in and then strain
  3. Or blow into a 20mL syringe attempting to push out plunger
3. Indications
  1. Atrial flutter?
  2. SVTs (AVNRT, AVRT)

### 21. Cardioversion vs. defibrillation

#### 1. Cardioversion

1. Cx
  1. Delivery of a shock that is *in synchrony* with QRS complex
2. DC cardioversion
  1. Preferred over pharmacological
  2. Try to control rate beforehand
3. Pharmacological cardioversion
  1. Only if electrical fails
  2. Parenteral ibutilide, procainamide, flecainide, sotalol, amiodarone
4. Indications
  1. AFib
  2. Atrial flutter
  3. SVT
  4. VT with a pulse

#### 2. Defibrillation

1. Cx
  1. Delivery of a shock *not in synchrony* with QRS complex
  2. Can only change one rhythm to another rhythm
  3. Useless for asystole or PEA
2. Indications
  1. VT without a pulse
  2. VFib

#### 3. Automatic implantable defibrillator

1. Cx
  1. Delivers electric shock to defibrillate when it detects lethal dysrhythmia
  2. Used when medical therapy fails
2. Indications
  1. VT
  2. VFib

## **ECG / ARRHYTHMIAS**

### **22. Basic life support**

#### **1. Assessment**

1. "Are you okay?"
2. Check breathing for 5-10s
3. Call 911
4. Tell someone to get AED
5. Check pulse for 5-10s
6. If no pulse start CPR

#### **2. CAB (1-rescuer)**

1. Compressions: 30
2. Airway: head tilt, chin lift
3. Breathing: 2 breaths
4. Repeat CAB until breathing

#### **3. Notes**

1. 2 inch compressions
2. 100 compressions per minute
3. 1-rescuer: 30:2
4. 2-rescuer: 30:2

### **23. Advanced life support**

#### **1. Shockable rhythms**

1. **One shock**
2. **CPR for 2 min**
3. **Assess rhythm**
4. **Repeat cycle**
5. Epinephrine (every other cycle)
6. Consider amiodarone, atropine, magnesium

#### **2. Non-shockable rhythms**

1. **CPR for 2 min**
2. **Assess rhythm**
3. **Repeat cycle**
4. Epinephrine (every other cycle)
5. Consider atropine

### **24. Cardiac terms**

#### **1. Sudden cardiac death**

1. Unexpected death within 1h of sx onset
2. Secondary to cardiac cause

#### **2. Cardiac arrest (asystole)**

1. Sudden loss of CO
2. Potentially reversible

#### **3. CPR**

#### **4. Epinephrine**

#### **5. Atropine**

#### **3. Pulseless electrical activity (PEA)**

1. Electrical activity on monitor (sinus, AFib, SVT, etc) but no pulses
2. Tx possible causes (hypoxia, hypovolemia, hypotension, hyperkalemia, tamponade, PE)

#### **3. CPR**

#### **4. Epinephrine**

### **25. Reversible causes**

1. Hypoxia
2. Hypovolemia
3. Hyper/hypokalemia
4. Metabolic
5. Hypothermia
6. Tension pneumothorax
7. Tamponade, cardiac
8. Toxins
9. Thrombosis