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**REFERENCE PRESENTATION:** 

Vorster J. Electrocardiogram: A valuable diagnostic tool. Presentation presented at; 2015; Netcare Unitas, STEMI Early Reperfusion initiative. AVAILABLE AT:

http://www.sasci.co.za/uploads/files/STEMI\_Ear ly\_Reperfusion\_Template.pdf



# ELECTROCARDIOGRAM

### A VALUABLE DIAGNOSTIC TOOL FOR MYOCARDIAL IRREGULARITIES





# **OVERVIEW**



 ARRHYTHMIAS
STRUCTURAL HEART DISEASE
ISCHAEMIA



# **1. ARRHYTHMIAS**









# **CAUSES OF SINUS BRADYCARDIA**

- 1. Drugs
- 2. Well-trained athletes
- Physiological (Sleep adolescents, young adults)
- 4. Myxedema
- 5. Hypothermia
- 6. Gram negative sepsis
- 7. Vomiting
- 8. Vasovagal syncope
- 9. Sick sinus syndrome
- 10. Intracranial tumours
- 11. Increased intracranial pressure





Rawshani A. Sinus bradycardia: definitions, ECG, causes and management – ECG learning [Internet]. ECG learning. 2016 [cited 5 February 2019]. Available from: https://ecgwaves.com/sinus-bradycardia-ecg-causes-treatment/ *File: Rawshani 4* 







#### **ELECTRICAL SYSTEM OF THE HEART**



9

quard your heart



864



<sup>ch1</sup>\*





#### **ELECTRICAL SYSTEM OF THE HEART**



11

quard your heart





# 2<sup>ND</sup> DEGREE AV BLOCK

Eitiology / causes of 2nd degree av block? Unsure how the list below relates to AV block



- 1. Increased vagal tone
- 2. Athletes
- 3. Sick sinus syndrome
- 4. Acute carditis
- 5. Ischaemic heart disease
- 6. Hyperkalaemia
- 7. Digoxin
- 8. Beta-blockers
- 9. Calcium-channel blockers



 Scher D. Evaluation and Treatment of Sick Sinus Syndrome - The Cardiology Advisor [Internet]. The Cardiology Advisor. 2017 [cited 26 February 2019]. Available from: https://www.thecardiologyadvisor.com/home/decision-support-inmedicine/cardiology/evaluation-and-treatment-of-sick-sinus-syndrome/

 Sovari A, Gaeta T, Kocheril A, Levine M. Second-Degree Atrioventricular Block: Practice Essentials, Background, Pathophysiology [Internet]. Emedicine.medscape.com. 2017 [cited 26 February 2019]. Available from: https://emedicine.medscape.com/article/161919-overview#a5

File: 2AVB 1









## **3<sup>RD</sup> DEGREE AV BLOCK**

- 1. Idiopathic (Conduction tissue fibrosis)
- 2. Congenital
- 3. Ischaemic heart disease
- 4. Associated with aortic valve disease (Stenosis)
- 5. Cardiac surgery and trauma
- 6. Digoxin toxicity
- 7. Bundle branch interruption by tumors, granulomas, injury, etc.





Agrawal A, Guzman D. Third-Degree Atrioventricular Block (Complete Heart Block): Background, Pathophysiology, Etiology [Internet]. Emedicine.medscape.com. 2018 [cited 26 February 2019]. Available from: https://emedicine.medscape.com/article/162007-overview#a5 *File: 3AVB 1* 























## ATRIOVENTRICULAR NODAL REENTRY PATHWAY (AVNRT)

















#### ATRIOVENTRICULAR REENTRY PATHWAY (AVNRT)











#### **INCIDENTAL FINDING OF AN IRREGULAR PULSE**









# **ATRIAL FIBRILLATION**

- 1. Most common arrhythmia
- 2. Fivefold increase in risk of stroke
- 3. Twofold increase in all-cause mortality
- 4. Etiology/Underlying substrate:
  - a. Hypertension
  - b. Ischaemic heart disease
  - c. Mitral valve diseased
  - d. Cardiomyopathy (hypertrophic and dilated)
  - e. Hyperthyroidism
  - f. Open heart/thoracic surgery
  - g. Myocardial infarction
  - h. Pericarditis



Chopra H, Wander G, Chandra P, Kumar V. Atrial fibrillation update. 1st ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.; 2017. *File: AF1; AF2* 



# **ARTIAL FIBRILLATION - CONSEQUENCES**



#### **HEART FAILURE:**

Loss of atrial contribution to LV filling:

Client to provide source of these percentages

• Loss of atrial systole – decrease in stroke volume: 15 – 20%



#### Accelerated ventricular response:

- Decrease in LV diastolic filling time
- Myocardial ischaemic



#### Tachycardia-induced Cardiomyopathy



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# **ARTIAL FIBRILLATION - CONSEQUENCES**



#### SYSTEMIC THROMBO-EMBOLISATION:

Loss of atrial systole (contraction/transport function)



Stasis of blood in LA



Thrombus formation (90% in left atrial appendage)



Fragmentation/Embolisation





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# **ARTIAL FIBRILLATION - CONSEQUENCES**



## SYNCOPE

#### **Associated arrhythmias:**

- Sick Sinus Syndrome
- AV blocks

#### Accelerated ventricular response

- Structural heart disease e.g. Aortic Stenosis (fixed cardiac output)
- Underlying:
  - Ischaemia
  - LV dysfunvtion















# **ATRIAL FLUTTER**

#### Less common than atrial fibrillation Can occur as a result of atrial dilation from:

- Septal defects
- Pulmonary emboli
- Mitral or tricuspid valve disease (stenosis/regurgitation)
- Heart failure
- Aging

# Can also occur without underlying heart disease:

- Thyrotoxicosis
- Alcoholism
- Pericarditis





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# **ATRIAL FLUTTER - TREATMENT**

#### 1. Cardioversion:

- Electrical (≈ 50J DCC)
- Chemical-anti-arrhythmic drugs (Class IA, IC or III)
- 2. Ablation:
  - Highly effective (success rate >90%)
  - Preferred approach because of high relapse rate after cardioversion and difficult to control ventricular response with medical therapy (β-blockers, Ca-channel antagonist, digoxin or anti-arrhythmic drugs)

#### 3. Risk of thrombo-embolism:

- Lower than with atrial fibrillation
- Indications for anticoagulation similar to atrial fibrillation














## VENTRICULAR PREMATURE COMPLEXES

#### 1. Occur in association with:

- Aging
- Excessive use of:
  - Tobacco
  - Caffeine
  - Alcohol
- Various medications
- Electrolyte imbalances (e.g. hypokalemia)
- Ischaemic or inflamed myocardium
- Infections
- Hypoxia
- Autonomic stimulation
- Anaesthesia
- Surgery

#### 2. Importance depends on clinical setting:

- In the absence of underlying heart disease:
  - No impact on longevity or limitation of activity
  - Anti-arrhythmic drugs are not indicated



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## VENTRICULAR PREMATURE COMPLEXES

#### In the setting of an acute myocardial infarction:

- Occur in the early phase
- Seldom cause ventricular fibrillation (VF)
  - Frequent VPC's
  - Multiform configuration
  - Early coupling ("R-on-T")
  - Repetitive patterns (couplets/salvos)
- Check for:
  - Recurrent ischaemia
  - Electrolyte or metabolic disturbances
- Maintain S-K<sup>+</sup> > 4.Smmol/I and S-Mg<sup>2+</sup> > 2mmol/I
- B-blocker if sinus tachycardia
- Anti-arrhythmic drugs not indicated, may increase risk for fatal bradycardic and asystolic events



Low sensitivity and specificity for identifying patients at risk for VF







## CHAOTIC (MULTIFOCAL) ATRIAL TACHYCARDIA

#### 1. Characteristics:

- Atrial rates between 100 and 130 beats/min
- Marked variation in P-wave morphology (at least 3 P-wave contours)
- Irregular P-P intervals
- Variable PR-intervals

#### 2. Etiology/Associations:

- COPD
- Congestive heart failure (elderly patients)
- Digitalis (unusual cause)
- Theophylline
- May develop into atrial fibrillation

#### 3. Treatment:

- Avoid beta-blockers (COPD)
- Verapamil/Amioderone
- K-/Mg supplementation



46-year old male Mitral valve prolapse Infective endocarditis in 2012 -managed medically Rupture of chord with severe mitral regurgitation Underwent mitral valve repair in April 2014 This arrhythmia documented during routine follow up (asymptomatic)







## FOCAL ATRIAL TACHYCARDIA

#### 1. Characteristics:

- Atrial rates between 150 and 200 beats/min
- P-wave contour different from sinus P-wave
- At the onset there may be some warming up of the rate that results in an increase in heart rate over the initial several complexes
- Frequently occur in short, recurrent burst with spontaneous terminations; may also be incessant

#### 2. Etiology/Associations:

- Coronary artery disease (with or without myocardial infarction)
- Heart failure
- Digitalis intoxication
- Potassium depletion
- Theophylline

#### 3. May develop tachycardia-induced cardiomyopathy if incessant

#### 4. Treatment:

- Beta-blockers/ Calcium channel blocker
- Discontinue digitalis
- K-supplementation



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## ACCELERATED IDIOVENTRICULAR RHYTHM

#### 1. Characteristics:

- Rate: 55 to 110 beats/min
- Broad QRS complex
- AV dissociation

## 2. Setting:

- Seen in 20% of STEMI patients
- Frequently occurs in first 2 days
- Most episodes are of short duration
- Occurs with about equal frequency in both anterior and inferior infarctions
- Often seen after successful reperfusion
- Not a reliable marker of reperfusion
- Not thought to affect prognosis
- No treatment required



Ischemic Cardiomyopathy (LV ejection fraction = 39%) Previous inferior myocardial infarction CABG - graft to right coronary artery Recurrent palpitations (no syncope)













## VENTRICULAR TACHYCARDIA (VT)

## 1. Etiology:

- Most patients with symptomatic recurrent VT have ischemic heart disease
  - Sustained VT displays a circadian variation-peak frequency in the morning
- Next largest group has cardiomyopathy (congestive and hypertrophic)
- Lesser percentages:
  - Inherited ion channel abnormalities
  - Idiopathic VT
  - Congenital heart disease

## 2. Patients with sustained VT are more likely to have:

- Reduced ejection fraction
- ECG abnormalities (e.g., wide QRS)
- Previous myocardial infarction



## **POLYMORPHIC VT FROM HYPOKALEMIA**







## VENTRICULAR TACHYCARDIA (VT) - MUSCLE MANAGEMENT

## 1. Acute (Termination):

- No hemodynamic decompensation:
  - Anti-arrhythmic drug (e.g., Amioderone)
- Hemodynamic compromise/ decompensation:
  - Synchronized DC cardioversion (10 to 50J)
- Search for reversible cause:
  - Ischemia
  - Hypotension
  - Hypokalemia

#### 2. Prevention of recurrences or sudden death:

- Implantable Cardioverter/Defibrillator (ICD):
  - LV ejection fraction < 35%
  - Survivors of cardiac arrest
  - Structural heart disease
  - Sustained VT with hemodynamic decompensation







## ECG AND HEMODYNAMIC TRACING DURING ANGIOGRAPHY





## **VENTRICULAR FIBRILLATION**

### 1. Clinical scenario's:

- Most commonly in association with coronary artery disease
  - As such a terminal event
  - Most frequently in the morning
- Anti-arrhythmic drug administration
- Hypoxia
- Ischaemia
- Electrical cardioversion (non-synchronized, faulty)
- Accidental electrical shock (improperly grounded)
- AF with pre-excitation (WPW)

#### 2. Severe derangement of cardiac contractility:

• Terminate fatally or produce significant brain damage within 3 to 5 min unless corrective measures are undertaken promptly

#### 3. Management:

• CPR and non-synchronized DC shock (200 to 400J)





# 2. STRUCTURAL HEART DISEASE









67 year old man Presented with unstable angina due to left main stem disease (underwent CABG)







## RIGHT BUNDLE BRANCH BLOCK - SIGNIFICANCE

## 1. Common finding in general population:

- a. Many people with RBBB have no structural heart disease
- b. Fragility of RBBB

### 2. New onset RBBB predicts a higher rate of:

- a. Coronary artery disease
- b. Heart failure
- c. Cardiovascular mortality

## 3. In the presence of cardiac disease, coexistence of RBBB suggests:

- a. Advanced disease
- b. Extensive multi-vessel disease

# Reduced long-term survival in ischaemic heart disease







Р 42

QRS 72





Client to provide source - unable to locate

60





61







## LEFT BUNDLE BRANCH BLOCK

#### 1. Criteria:

- QRS duration >120ms
- Broad, notched, or slurred R waves in leads I, aVL,  $\rm V_5$  and  $\rm V_6$
- Prolonged time to peak R wave (>60msec) in V<sub>5</sub> and V<sub>6</sub>

## 2. ST-T wave changes

• ST-segment and T-wave discordant with QRS complex









## LEFT BUNDLE BRANCH BLOCK - SIGNIFICANCE

- 1. Usually in patients with underlying heart disease:
  - 30% of patients with CCF have LBBB
  - 70% of people developing LBBB have preceding LVH (Only 12% of patients with LBBB have no demonstrable disease)

## 2. Prognostic implications:

- Higher risk of CV mortality from infarction and heart failure
- Higher risk of AV block and cardiac death
- CAD: more extensive disease and LV dysfunction and reduced survival rates

## 3. Obscuring other ECG patterns:

- Myocardial infarction (ST-segment elevation-equivalent) /ischaemia
- LV hypertrophy





## **LEFT ANTERIOR FASCICULAR (HEMI) BLOCK**











## **LEFT ANTERIOR FASCICULAR (HEMI) BLOCK**

























## LEFT VENTRICULAR HYPERTROPHY

## 1. Criteria:

- Sokolow Lyon:  $SV_1 + RV_{5/6} > 35mV$
- Cornell voltage:  $SV_3 + RaVL \ge 28mV$  (men)

 $SV_3 + RaVL \ge 20mV$  (women)

## 2. Etiology:

- Hypertension
- Aortic stenosis
- LV outflow tract obstruction




# LEFT VENTRICULAR HYPERTROPHY

## 1. Other QRS changes in LVH:

- Widening of the QRS complex beyond 110ms
- Delay in the intrinsicoid deflection (ventricular activation)
- Notching of the QRS complex

## 2. ST-T wave patterns:

- Normal
- Somewhat elevated in leads with tall R-waves
- ST-segment slopes downward from depressed J-point and T-wave is asymmetrically inverted

# 3. Additional abnormalities:

- Prolongation of QT-interval
- Left atrial abnormality





# LEFT VENTRICULAR HYPERTROPHY - SIGNIFICANCE

- 1. Increased risk for cardiovascular morbidity & mortality: LIFE study – Losartan antihypertensive therapy:
  - A 1 SD decrease in Cornell product associated with:
    - o 25% decrease in cardiovascular death
    - $\circ~$  17% lower rate of myocardial infarction

# 2. Repolarization abnormalities:

- More severe degrees of anatomic LV hypertrophy
- LIFE study Greater risk of future cardiovascular events:
  - Significant increases:
    - Risk of cardiovascular death (HR, 2.42)
    - Myocardial infarction (HR, 1.95)



74 year old lady Cor Pulmonale with severe pulmonary hypertension secondary to chronic and multiple pulmonary emboli





#### 48 year old female Cor Pulmonale Severe Pulmonary hypertension — PAP = 75 to 95mmHg Dilated RV and main pulmonary artery, paradoxical septal motion Spontaneous pulmonary embolism in 2007







# **RIGHT VENTRICULAR HYPERTROPHY**

## 1. Criteria:

- $\operatorname{RinV}_1 \ge 0.7 \mathrm{mV}$
- R vs. S ratio in  $V_1 > 1$  with R > 0.5mV
- Right axis deviation (> 90°)
- P-pulmonale

### 2. Etiology: Pulmonary hypertension

- Respiratory disease COPD, Interstitial lung disease
- Pulmonary emboli
- Left to right shunting ASD
- Idiopathic



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# 3. ISCHAEMIA











# AFTER RESTORING FLOW TO LAD WITH PERCUTANEOUS CORONARY INTERVENTION





Rate	84	
PR	153	
QRSD	85	
QT	355	
QTc	420	
Ax i	g	
P	72	
QRS	27	





47 year old man with an occluded LAD

















85



























38 year old man Ischaemic chest pain





























QRS T -3 130




















































## Don't be caught between a rock and a hard place!

