

ECG Monitoring

**Keith Varnes, RRT, RRT-ACCS
RRT-NPS, AE-C**

Arthur Jones, EdD, RRT

**This Presentation is Approved for
1 CRCE Credit Hour**

1

1

Learning Objectives:

- **Explain the generation and conduction of the electrical impulse in cardiac tissue.**
- **Analyze the components of a normal ECG.**
- **Identify common dysrhythmias on an ECG monitor.**

2

2

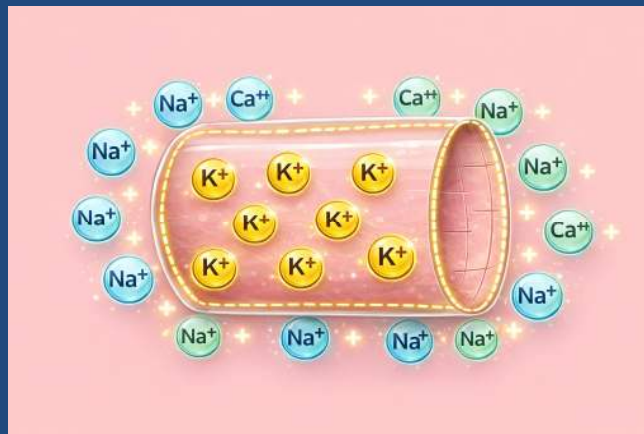
Introduction to Electrocardiography

3

3

Chemical Basis for Electrical Activity

- **Resting potential** – cell interior negative, in relation to exterior

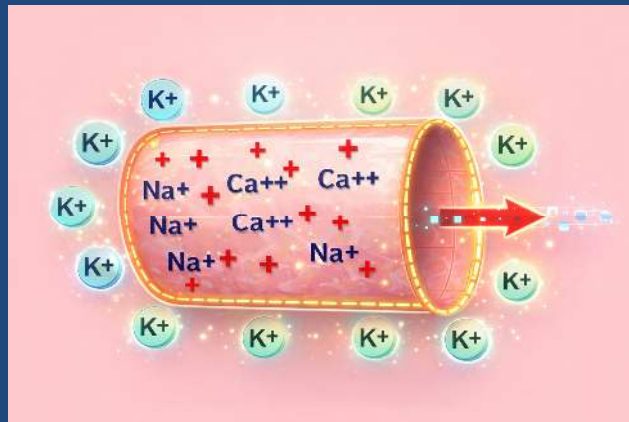


4

4

Electrochemical Basis for ECG

- Na^+ , Ca^{++} channels open → influx of + → negative charge external cell → current → conduction & contraction

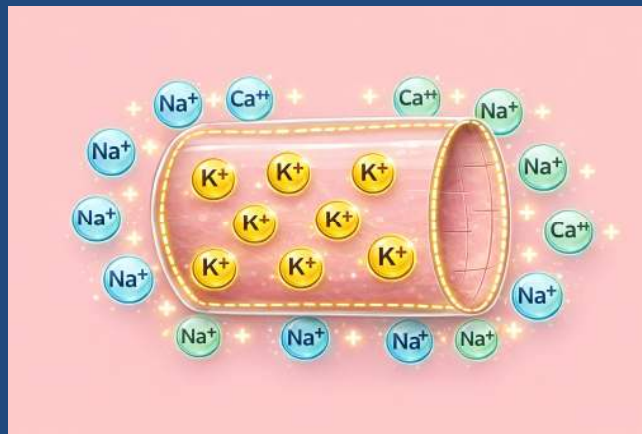


5

5

Electrochemical Basis for ECG

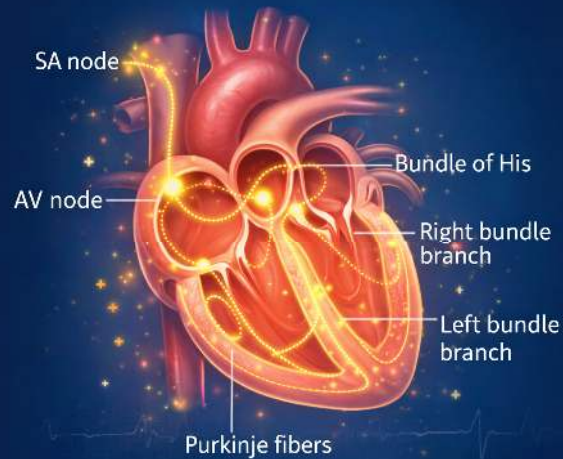
- Refractory period – K^+ enters cell and restores action potential



6

6

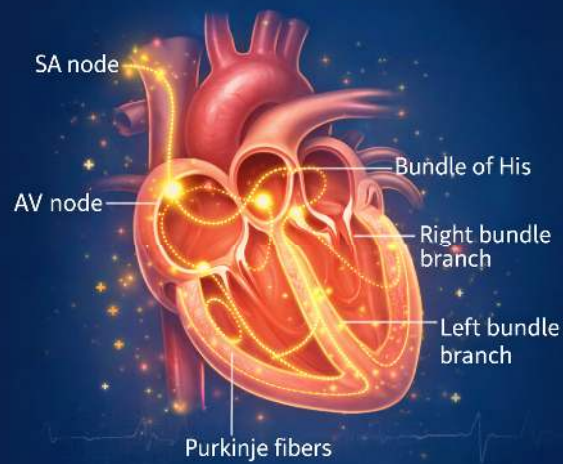
Conduction Pathway



7

7

Conduction Pathway



8

8

Pacemaker Cells

➤ Automatic rates for different sites

SA Node	60 – 100/min
AV Node	40 – 60/min
Bundle branches	30 – 40/min

9

9

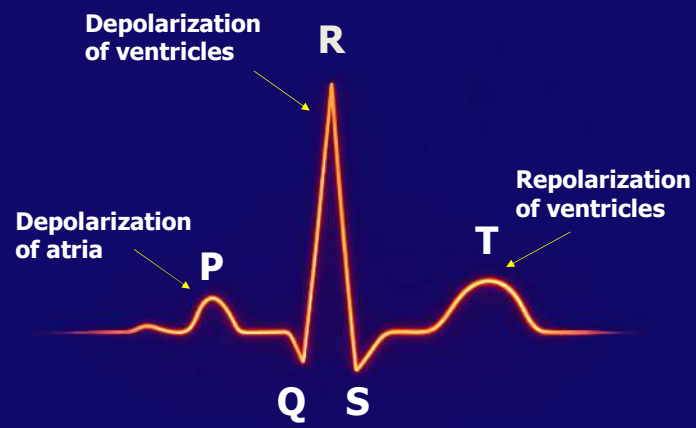
Definitions

- Ectopic beats - fibers outside the SA node
- Escape - alternate sites

10

10

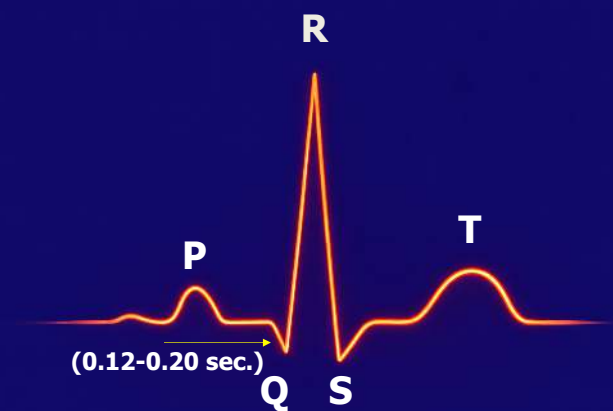
ECG Waves



11

11

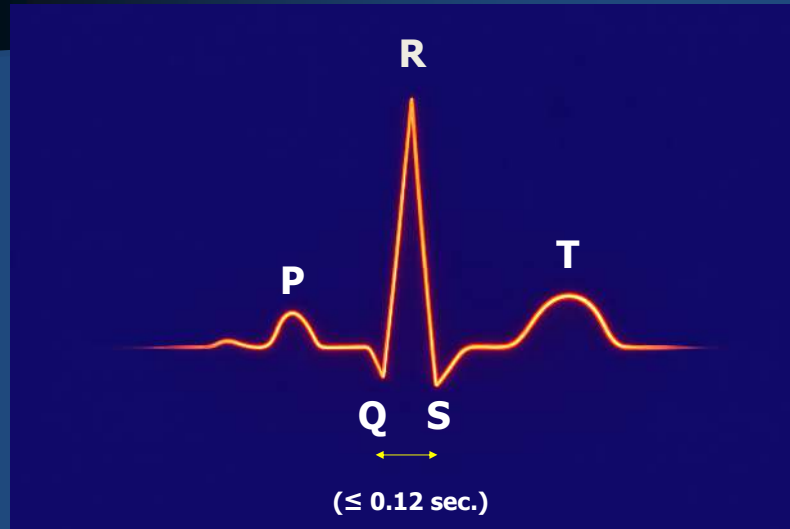
ECG Wave Intervals



12

12

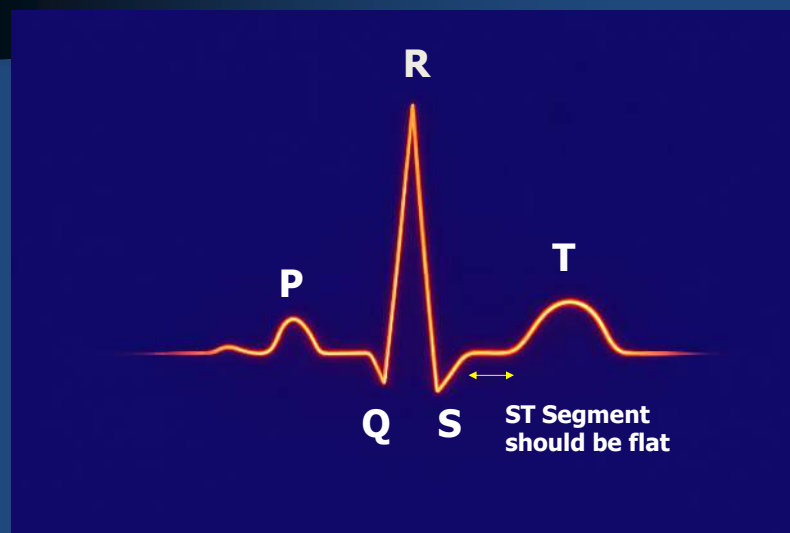
ECG Wave Intervals



13

13

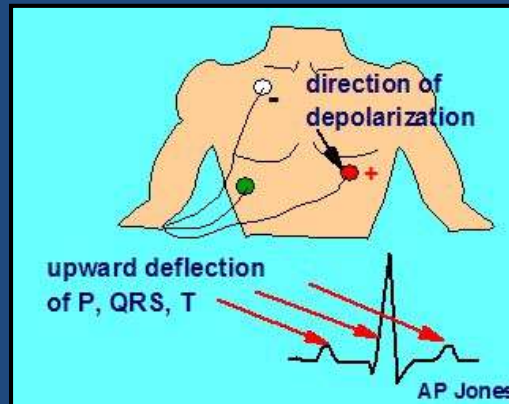
ECG Wave Intervals



14

14

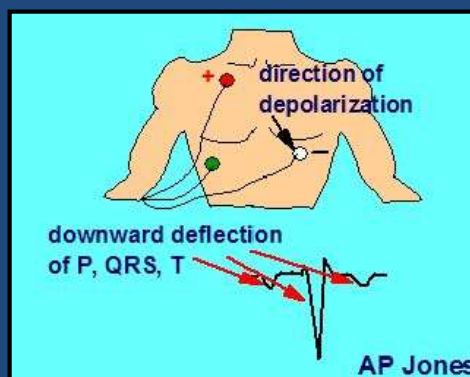
ECG Leads & Waves



15

15

ECG Leads & Waves

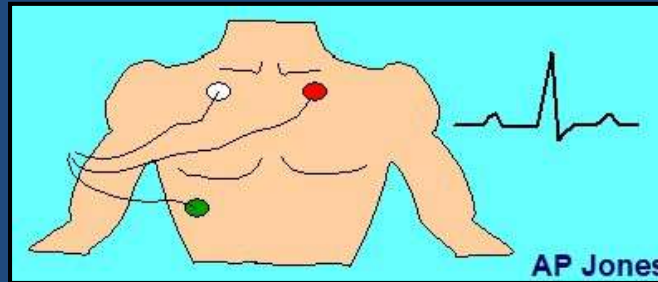


16

16

ECG Electrode Placement

- **Lead 1**
 - + under L clavicle
 - - under R clavicle

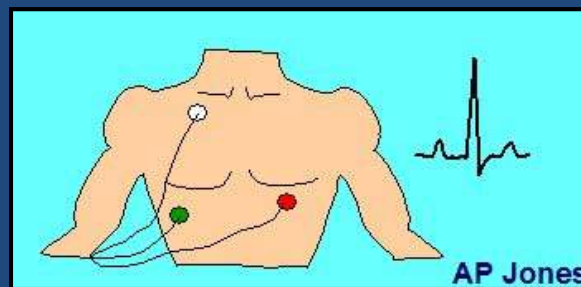


17

17

ECG Electrode Placement

- **Lead 2**
 - + under L pectoral
 - - under R clavicle

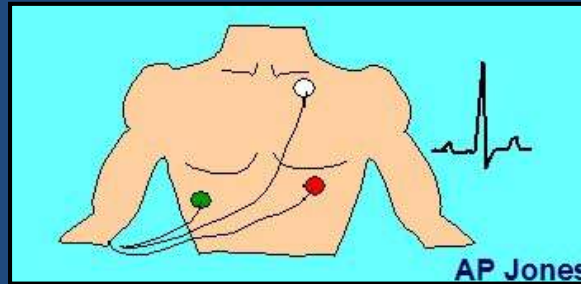


18

18

ECG Electrode Placement

- **Lead 3**
 - + under L pectoral
 - - under L clavicle

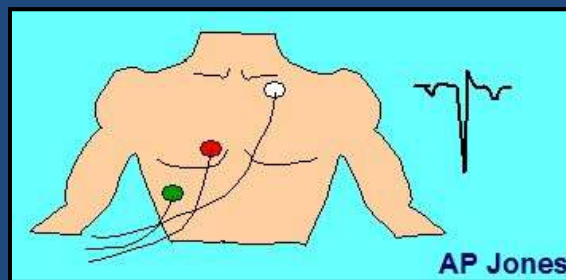


19

19

ECG Electrode Placement

- **MCL**
 - + R sternum 4th intercostal space
 - - under L clavicle



20

20

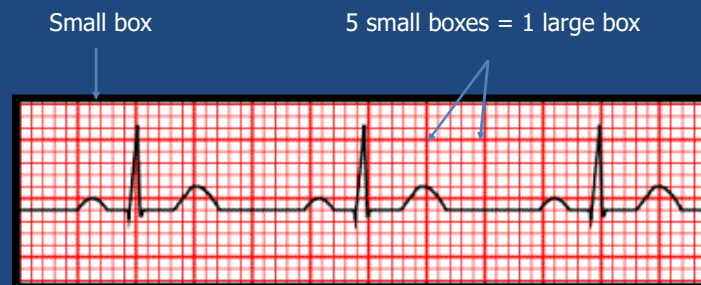
Rhythm Analysis

21

21

ECG Analysis Steps

- **Lead** – usually II or III
- **Rate** – 5 large boxes = 1 sec. @ paper speed of 25mm/sec

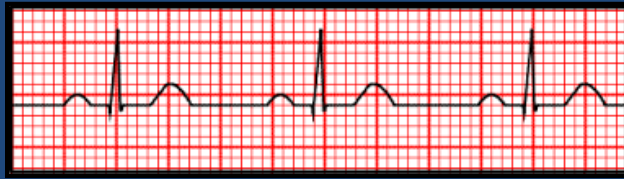


22

22

ECG Analysis Steps

- **Rate – 5 large boxes = 1 sec. @ paper speed of 25mm/sec**
- **Six second tracing & multiply R waves by 10**
- **Count large boxes between R waves and divide into 300**



HR = 300/4 or 75

23

23

ECG Analysis Steps

- **Regularity - compare distances between QRS complexes with calipers or marked scrap paper**

24

24

ECG Analysis Steps

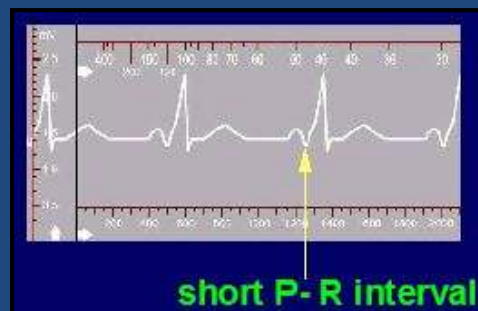
- **P wave**
 - **Absent**
 - Beats are ectopic
 - Rate is excessive
 - Atrial fibrillation
 - **Tall or wide** → atrial enlargement
 - **Inverted**
 - Junctional rhythm
 - Dextrocardia
 - Lead reversal

25

25

ECG Analysis Steps

- **PR interval**
 - **Prolonged (>0.2 sec)** → AV block
 - **Short (<0.12)** → Wolff-Parkinson-White (WPW) syndrome



26

26

ECG Analysis Steps

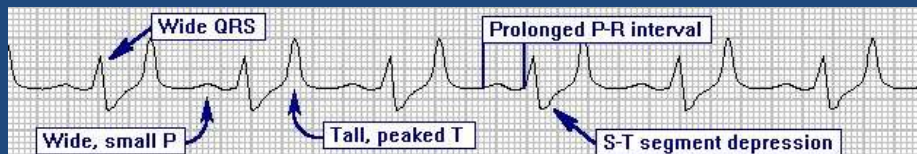
- PR relationship
 - More P than QRS →
 - AV block
 - Atrial flutter with block
 - Absent P wave →
 - Hidden by QRS complex
 - Ectopic rhythm
 - Fibrillation

27

27

ECG Analysis Steps

- QRS Complex
 - Interval > 0.12 →
 - Bundle branch block (notched QRS)
 - Hyperkalemia
 - Ventricular ectopic beat



28

28

ECG Analysis Steps

- S-T segment elevation → evolving transmural infarction



29

29

ECG Analysis Steps

- S-T segment depression →
 - Ischemia (often subendocardial)
 - Severe hypokalemia
 - digitoxicity



30

30

ECG Analysis Steps

- **T wave – should be in the same direction as the QRS**
 - Inversion → evolving infarction
 - Peaked → Hyperkalemia

31

31

ECG Analysis Steps

- **Interpret, with consideration to:**
 - Medical history
 - General clinical status
 - Electrolyte balance
 - Medications
 - Artifacts
 - Equipment calibration, adjustment, and application to patient

32

32

Dysrhythmias

33

33

Sinus Arrhythmias

- **Sinus bradycardia**
 - Beats originate in SA node
 - Normal wave configurations
 - Rate < 60/min

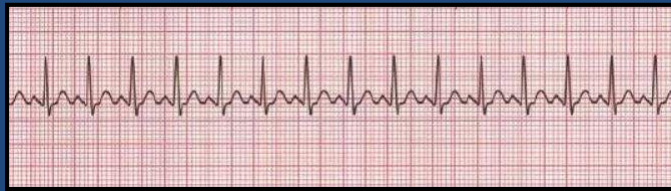


34

34

Sinus Arrhythmias

- **Sinus tachycardia**
 - Beats originate in SA node
 - Normal wave configurations
 - Rate > 100/min

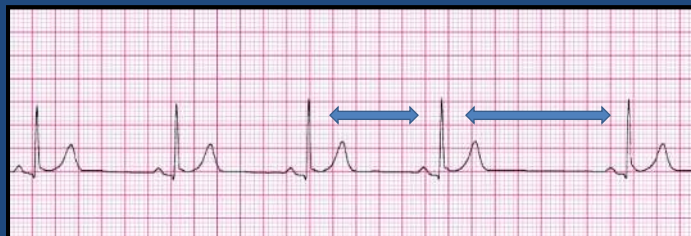


35

35

Sinus Arrhythmias

- **Sinus dysrhythmias**
 - Beats originate in SA node
 - Normal wave configurations
 - Irregular rhythm with breathing



36

36

Case Example #1

- 54 y/o male - pneumonia
- HR 120 bpm
- SpO2 88% on RA
- BP 136/82



37

37

Case Example #1

- **Interpretation**
 - Rhythm: Sinus tachycardia
 - Rate > 100
 - Normal P waves and PR interval
 - Regular rhythm



38

38

Atrial Dysrhythmias

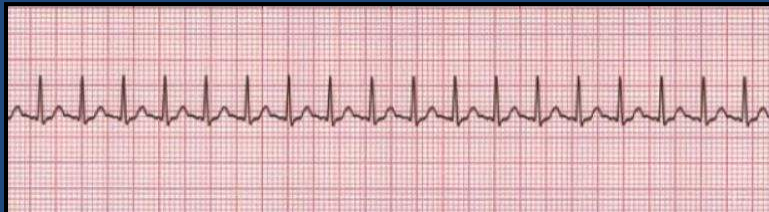
- **Paroxysmal atrial tachycardia** – ectopic atrial focus initiates beats
 - Sudden onset, rate > 150
 - Spontaneous termination
 - Type of PSVT

39

39

Atrial Dysrhythmias

- **Atrial tachycardia**



40

40

Atrial Dysrhythmias

- **Atrial flutter**
 - Saw tooth atrial waves
 - Associated with pulmonary disease
 - Promotes thrombus formation
 - Atrial rate 180-300/min
 - Often multiple flutter waves per QRS (commonly 4:1, but 2:1, 3:1, or variable conduction may occur).

41

41

Atrial Dysrhythmias

- **Atrial flutter**



Saw tooth P waves

42

42

Atrial Dysrhythmias

- **Atrial fibrillation**
 - Non-discernible P waves
 - Promotes thrombus formation



43

43

Case Example #2

- **68 y/o female – COPD & pulmonary hypertension**
- **HR 75 bpm**



44

44

Case Example #2

- **Interpretation:**
 - Rhythm: Atrial flutter
 - Atrial rate ≈ 300
 - 4:1 AV conduction
 - Ventricular rate controlled by AV block



45

45

Atrial Dysrhythmias

- **Premature atrial complex (PAC)**
 - Normal beat inserted between other beats
 - Normal waves and configuration

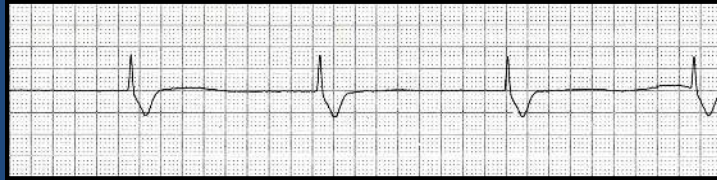


46

46

Junctional (Nodal) Dysrhythmias

- **Junctional bradycardia**
 - SA node suppression
 - Absent P waves



47

47

Junctional (Nodal) Dysrhythmias

- **Junctional tachycardia**
 - **Causes:**
 - Digitalis toxicity
 - Recent cardiac surgery
 - Acute myocardial infarction
 - Medications; e.g. beta adrenergics
 - P waves absent, inverted, after QRS

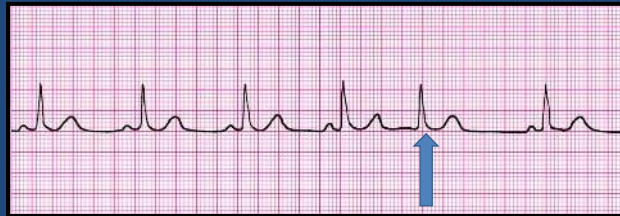


48

48

Junctional (Nodal) Dysrhythmias

- **Premature junctional complexes**
- **Most common causes:**
 - Heart disease
 - Digitalis toxicity
- **P waves absent, inverted, after QRS**



49

49

Case Example #3

- **72 y/o male – Post cardiac surgery**
- **HR 48 bpm**
- **BP 118/70**



50

50

Case Example #3

- **Interpretation:**
 - **Rhythm: Junctional bradycardia**
 - **Rate 40-60 bpm**
 - **Absent or retrograde P waves**



51

51

Ventricular Dysrhythmias

- **Premature ventricular complexes (PVCs)**
 - **Ectopic beats**
 - **P wave is absent**
 - **Wide QRS complex**
 - **Compensatory pause before next regular beat**

52

52

PVCs

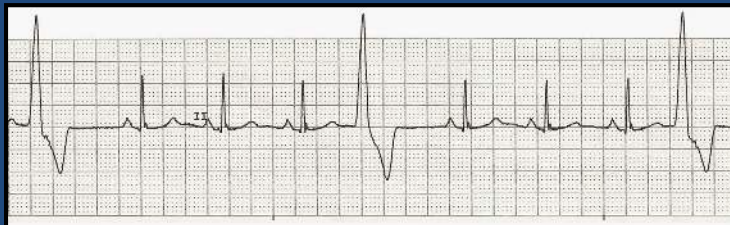
- **Unifocal – similar configurations → one originating site**
- **Multifocal – variable configurations → more than one originating site**

53

53

Unifocal PVCs

- **Unifocal – similar configurations → one originating site**

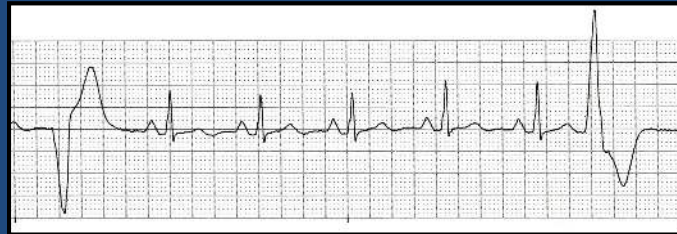


54

54

Multifocal PVCs

- **Multifocal – variable configurations → more than one originating site**



55

PVC Categories

- **Frequency**
 - Isolated
 - Every third – trigeminy
 - Every other – bigeminy
 - Couplet = two, triplet = three
 - Every – ventricular tachycardia

56

56

Couplet PVCs

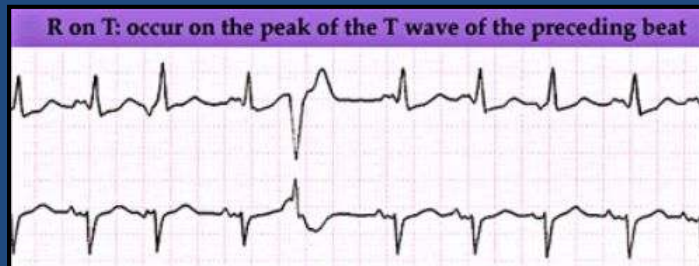


57

57

PVCs - Frequency

- Increased frequency → increased risk for R on T → V-Tach



58

58

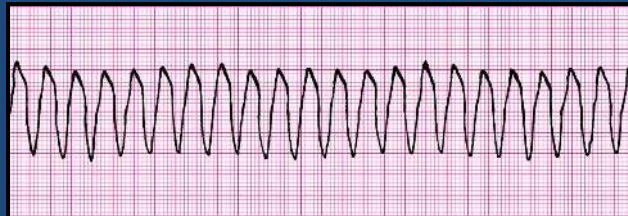
Ventricular Tachycardia

- All beats originate in ventricle
- Wide QRS complexes
- P waves are absent
- Torsades des Pointes – type of VT
 - Caused by hypomagnesemia
 - Common in alcoholics
 - No response to defibrillation – must restore Mg^{++}

59

59

Ventricular Tachycardia



60

60

Torsades des Pointes



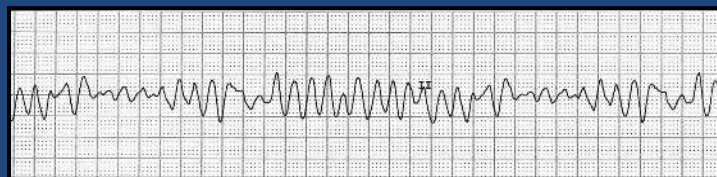
Wandering baseline

61

61

Ventricular Fibrillation

- **Rapid irregular rhythm**
- **Coarse-to-fine complexes**



62

62

Idioventricular Rhythm

- Failure of all upper pacemakers
- Rate 20-40/min
 - Absent P waves
 - Widened QRS
- Causes:
 - Myocardial ischemia/infarction
 - Pacemaker failure

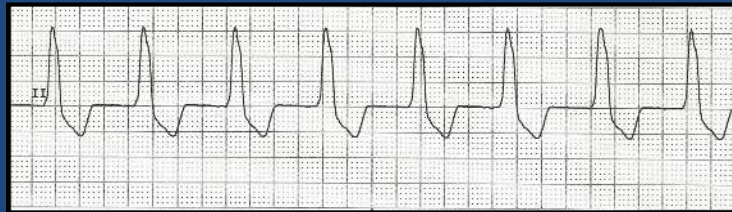


63

63

Accelerated Idioventricular Rhythm

- Looks like VT, but slower and non-lethal
- Causes:
 - Spinal anesthesia
 - Heart disease, e.g. M.I.
 - Reperfusion
 - Drugs, e.g. digitalis

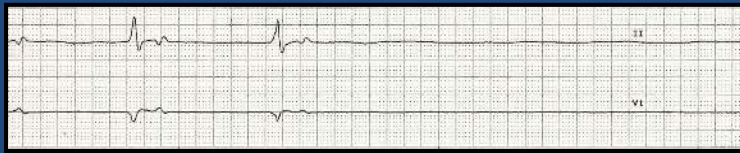


64

64

Agonal Rhythm

- **Slow, irregular rhythm**
- **Wide ventricular complexes**
- **Varying morphology**
- **Unsuccessful resuscitation**



65

65

Heart Blocks

- **Blockage of conduction between atria and ventricles at:**
 - **Lower atrial tissue**
 - **AV junction**
 - **Bundle of His**
 - **Bundle branches**

66

66

Heart Blocks

- **Causes:**
 - Enhanced vagal tone
 - Congenital heart defects
 - Myocardial ischemia/infarction
 - Congestive heart failure
 - Cardiomyopathy
 - Cardiac surgery
 - Medications, e.g. digitalis, antidysrhythmics

67

67

First Degree Heart Block

- **Benign**
- **P-R interval > 0.20 sec.**



68

68

Second Degree Heart Block Type 1

- AKA Wenckebach, Mobitz Type I
- Progressive lengthening of PR, then dropped beat

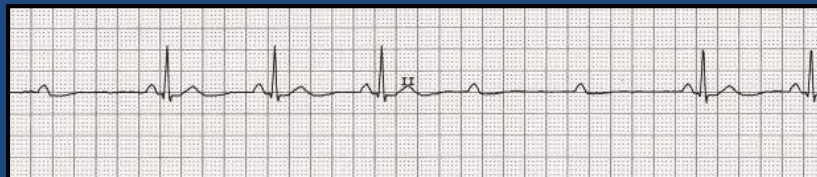


69

69

Second Degree Heart Block Type 2

- AKA Mobitz Type II
- Constant PR intervals
- QRS dropped at fixed ratio



70

70

Third Degree (Complete) Heart Block

- Very slow ventricular rate
- No consistent association between P wave and QRS complex

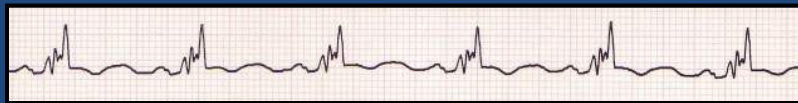


71

71

Bundle Branch Block

- Conduction blocked at one of the branches, left or right
- Wide, (sometimes) notched QRS complex
- May be seen at any heart rate.

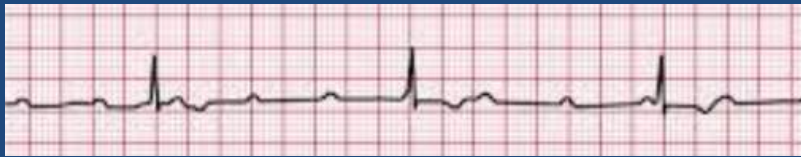


72

72

Case Example #4

- 80 y/o male – Dizziness
- HR 38 bpm
- BP 90/50

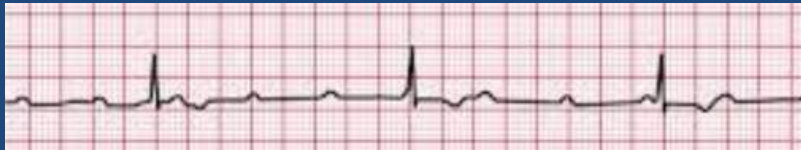


73

73

Case Example #4

- **Interpretation**
 - Rhythm: Third-degree (complete) heart block
 - No relationship between P waves and QRS
 - Ventricular escape rhythm

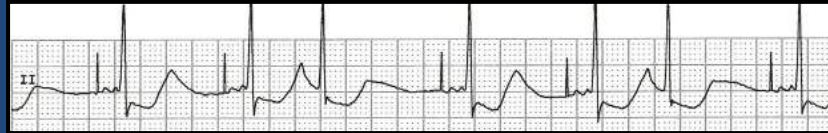


74

74

Artificial Pacemaker

➤ Atrial pacemaker



75

75

Artificial Pacemaker

➤ Atrial-ventricular pacemaker



76

76

Artificial Pacemaker

- Pacemaker capture failure



77

77

Heterotopic Heart Transplant

- Two hearts → Two ECG patterns

78

78

Dextrocardia

- Heart located on right
- Leads should be reversed for patients with dextrocardia

79

79

Artifacts

- Patient tremors
- Caregiver activities
- External devices
- Treacherous technician syndrome
 - Reversal of leads by technician
 - Most common cause of false positive diagnosis of dextrocardia

80

80

Dysrhythmias: Recognition vs Treatment (RT Perspective)

- **Why meds matter**
 - Hypoxemia
 - Hypercapnia
 - Acidosis
 - Electrolytes
- **Treat cause first**

81

81

Dysrhythmias: Recognition vs Treatment (RT Perspective)

- **Medication categories**
 - Rate control
 - Rhythm control
 - AV nodal blockers
 - Electrolytes – magnesium & potassium

82

82

Dysrhythmias: Recognition vs Treatment (RT Perspective)

- **A-Fib/Flutter**
 - Often rate controlled, not converted
 - Oxygen & ventilation
- **Ventricular ectopy**
 - Hypoxemia
 - Acidosis
 - Ischemia
- **Torsades**
 - Magnesium & QT prolongation
- **Digitalis toxicity**

83

83

Dysrhythmias: Recognition vs Treatment (RT Perspective)

- **New rhythm after hypoxemia**
- **Rhythm change after suctioning or NIV failure**
- **Bradycardia after vagal stimulation**
- **Wide QRS + electrolyte abnormality**
- **Rhythm change after beta-agonist**

84

84

Dysrhythmias: Recognition vs Treatment (RT Perspective)

- **Treat the patient – not the monitor**

85

85

Review and Summary

- **ECG is result of electrical conduction through the heart**
- **ECG comprised of waves and intervals**
- **ECG leads**
- **Systematic analysis of ECG**
 - **Rate**
 - **Regularity**
 - **Waves, intervals**

86

86

Review and Summary

- **Sinus Dysrhythmias**
 - Bradycardia
 - Tachycardia
 - Dysrhythmias
- **Atrial Dysrhythmias**
 - Atrial tachycardia, PAT
 - Atrial flutter
 - Atrial fibrillation
 - Premature atrial contractions

87

87

Review and Summary

- **Junctional Dysrhythmias**
 - Junctional bradycardia
 - Junctional tachycardia
 - Premature junctional complex
- **Ventricular Dysrhythmias**
 - Premature ventricular contractions
 - Ventricular tachycardia
 - Ventricular fibrillation
 - Idioventricular rhythm

88

88

Review and Summary

- **Heart block – conduction defects**
 - First degree
 - Second degree, Mobitz I
 - Second degree, Mobitz II
 - Third degree (complete)
 - Bundle branch
- **Pacemaker beats**
 - Atrial
 - Atrioventricular
 - Failure to capture

89

89

Review and Summary

- **Unusual conditions**
 - Heterotopic transplants
 - Dextrocardia
- **Artifacts**
 - Tremors, movements
 - TTS

90

90

Final Thought

91

91

References

- American Heart Association. *Electrocardiogram (ECG) Interpretation and Rhythm Recognition. Advanced Cardiovascular Life Support (ACLS) Provider Manual.*
- Brown KR, Jacobson S. *Mastering Dysrhythmias*
- Marriott HJL, Wagner GS. *Practical Electrocardiography*
- Dubin D. *Rapid Interpretation of EKGs*
- Wilkins RL, et al. *Clinical Assessment in Respiratory Care*

92

92

The End



93