- If you are viewing this course as a recorded course after the live webinar, you can use the scroll bar at the bottom of the player window to pause and navigate the course.
- This handout is for reference only. It may not include content identical to the PowerPoint. Any links included in the handout are current at the time of the live webinar, but are subject to change and may not be current at a later date.

EKG

Electrocardiography

EKG

Jamie Dyson, PT, DPT

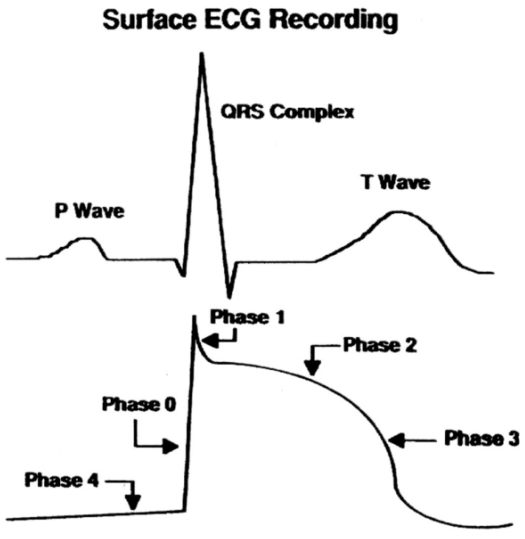
Learning Objectives

- Describe the electrophysiology of the heart.
- Describe EKG electrode placement and mechanics.
- Interpret patient rate, axis deviation and rhythm regularity from a 12 lead EKG.
- Identify supraventricular and ventricular dysrhythmias.
- Identify conduction blocks.
- Decide patient appropriateness for intervention based on EKG findings.

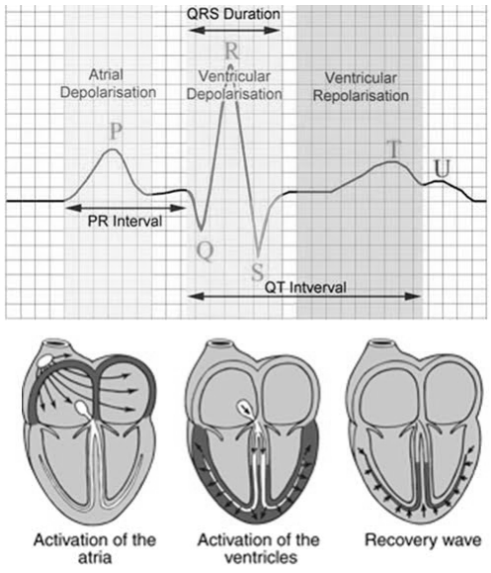
Cardiac Action Potential

- Phase 0- depolarization- Na+ channels open
- Phase 1-prolonged action potential due to slow and extended opening of Ca+ channels -repolarization begins.
- Phase 2-outward flow of K+ and prolonged opening of Ca lead to a plateau phase
- Phase 3- closure of Ca channels and opening of K channels completes repolarization.
- Phase 4- resting phase Na and Ca are pumper out K is pumped in.

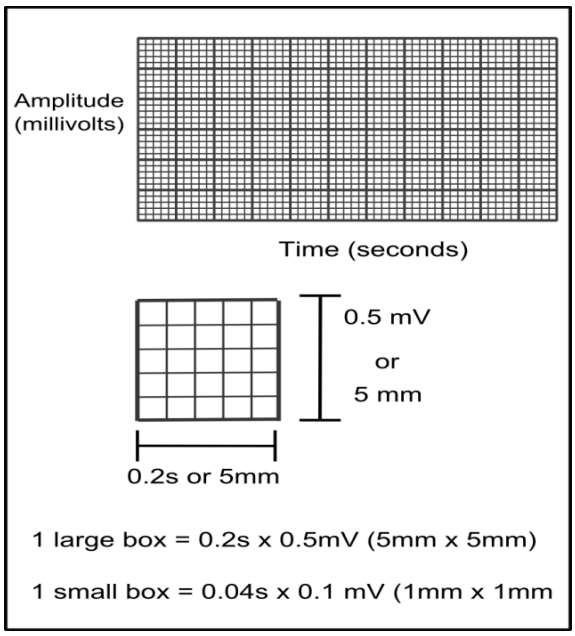
5



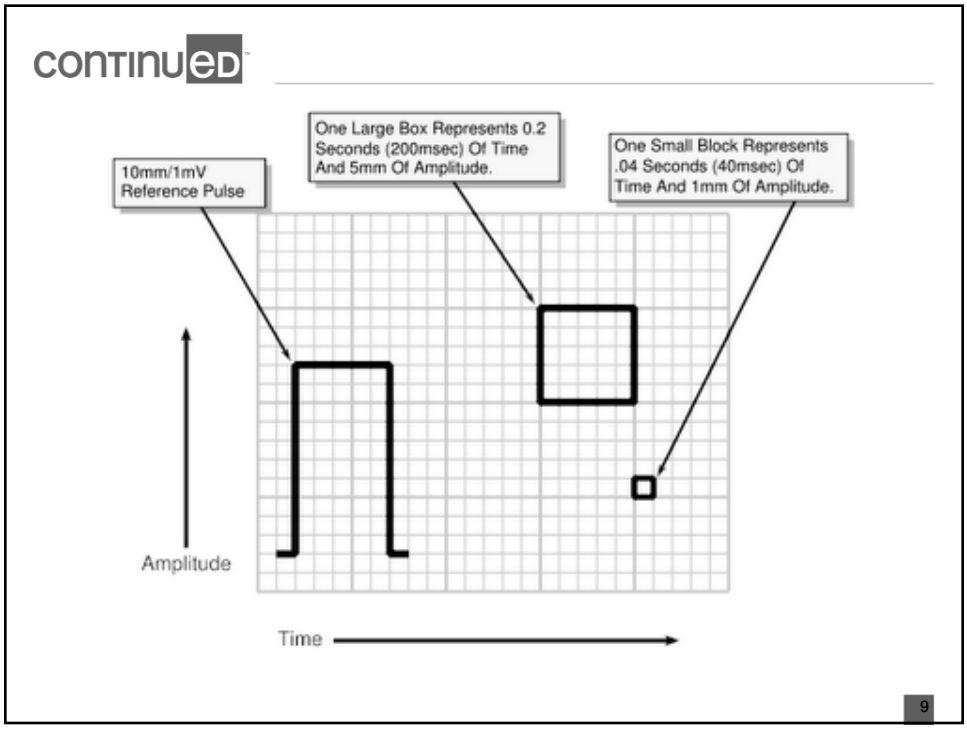
6

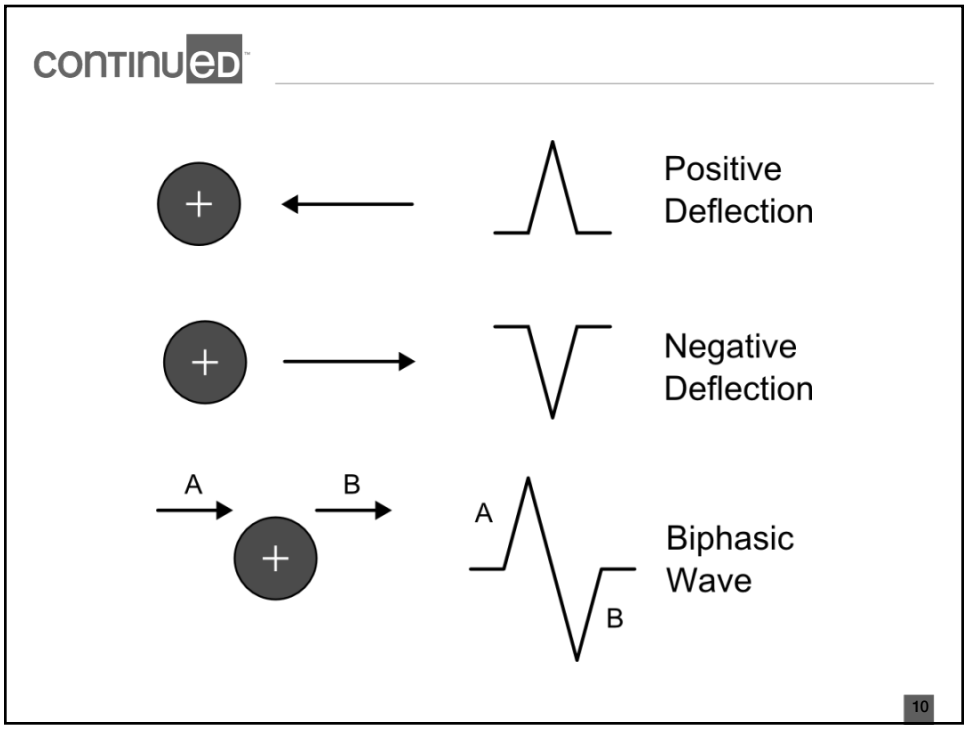

QRS Duration
R
Atrial Depolarisation
Ventricular Depolarisation
Ventricular Repolarisation
P
T
U
PR Interval
Q
S
QT Intverval
Activation of the atria
Activation of the ventricles
Recovery wave

7


Amplitude (millivolts)
Time (seconds)
0.5 mV
or
5 mm
0.2s or 5mm
1 large box = 0.2s x 0.5mV (5mm x 5mm)
1 small box = 0.04s x 0.1 mV (1mm x 1mm

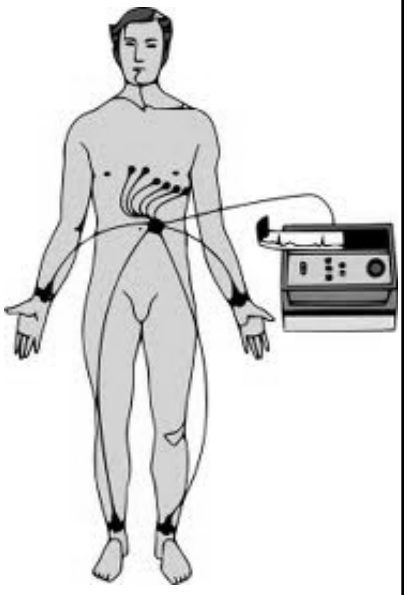
8


One Large Box Represents 0.2 Seconds (200msec) Of Time And 5mm Of Amplitude.
One Small Block Represents .04 Seconds (40msec) Of Time And 1mm Of Amplitude.
10mm/1mV Reference Pulse
Amplitude
Time
9


Positive Deflection
Negative Deflection
A
B
A
B
Biphasic Wave
10

EKG

- 12 Lead (view) of the heart
- Six Leads record frontal plane
- Six Leads record transverse plane



11

Frontal Plane Leads

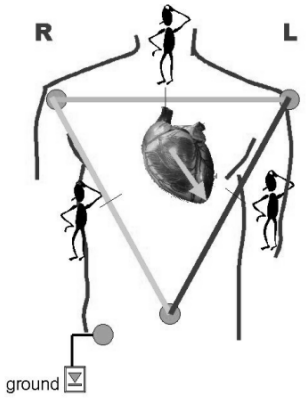
- 3 Bipolar limb leads I, II, III
  - Single positive and single negative electrode
- 3 augmented unipolar limb leads
  - aVR (right arm)
  - aVL (left arm)
  - aVF (left leg)

  Have single positive lead derive negative from a combination of other electrodes.

12

CONTINUED

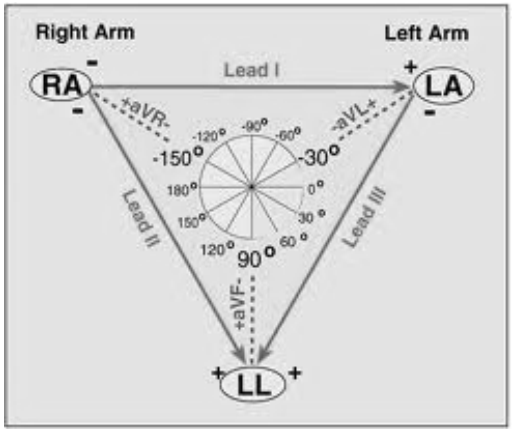
Einthoven's Triangle



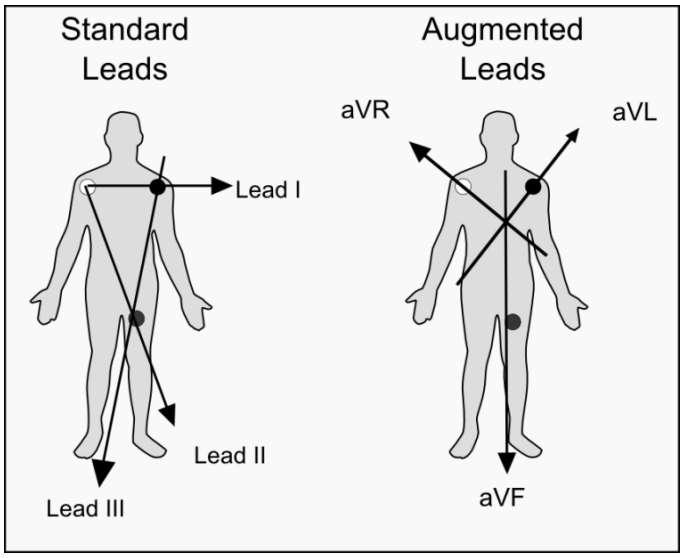
13

CONTINUED

Bipolar Leads

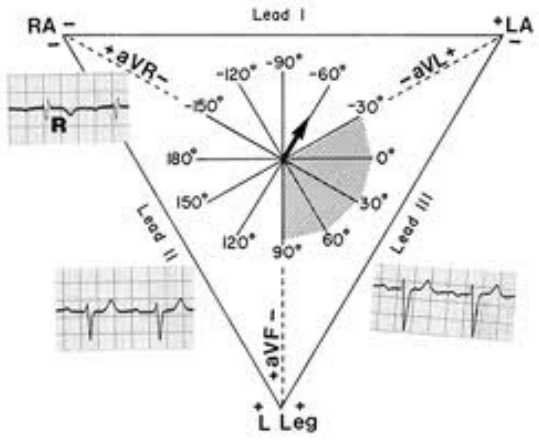


14



15

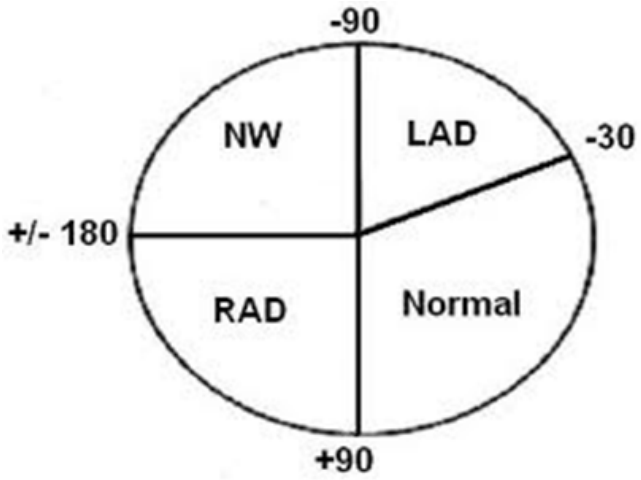
Axis Deviation



16

CONTINUED

Axis Deviation

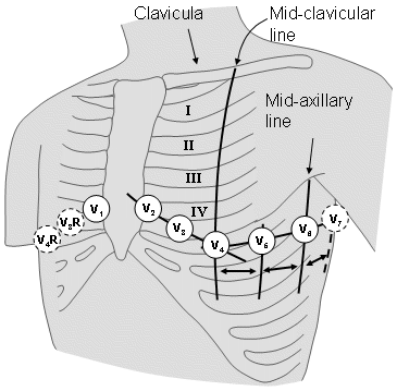


17

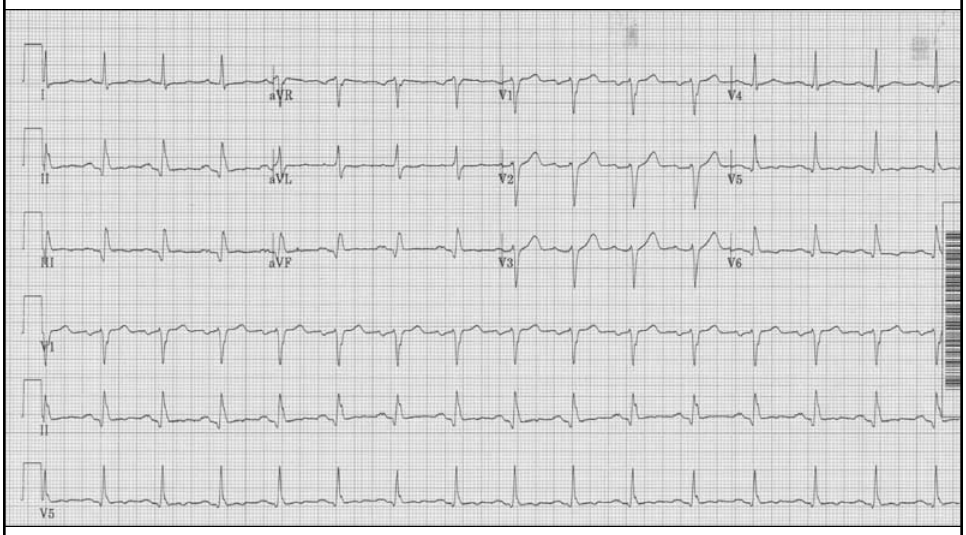
CONTINUED

Precordial (transverse plane) Leads

- V 1-6
- V1 and V2 look at R Ventricle
- V3 and V4 look at the intraventricular septum
- V5 and V6 look at L Ventricle



18



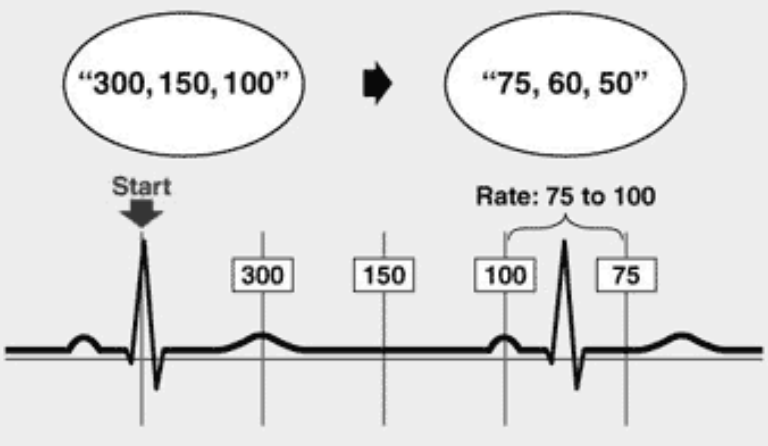
19

EKG Evaluation

- What is the rate and pattern (regularity) is R-R interval equal for each beat?
- Is the a P wave before each QRS? = atrial
- Is the a QRS after every P wave?= conduction of atria to the ventricles
- P-R interval? Normal= 0.12-0.2 seconds > 0.2 seconds= conduction delay or block
- QRS normal duration (0.1 sec) and shape?

20

Calculating Rate



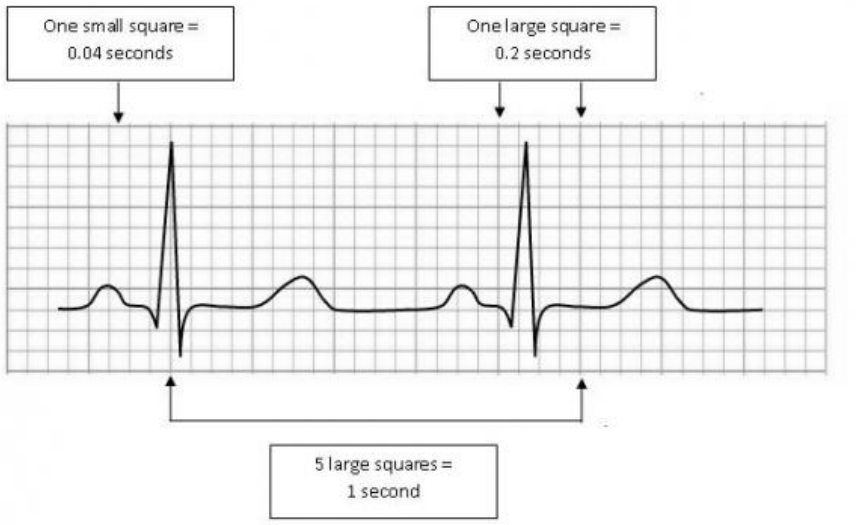
21

Calculating Rate

- Count the number of small boxes between two R waves and divide into 1500.
- Count the number of R waves in a six second strip and multiply by 10.

22

Lets try it



23

Sinus Rhythms

- Sinus Rhythm- 60-100 bpm
- Sinus Bradycardia- < 60 bpm
- Sinus Tachycardia- > 100 bpm
- These rhythms have normal P waves, PR int and QRS int

24

CONTINUED

Supraventricular Dysrhythmias

Atrial and Junctional Mechanisms

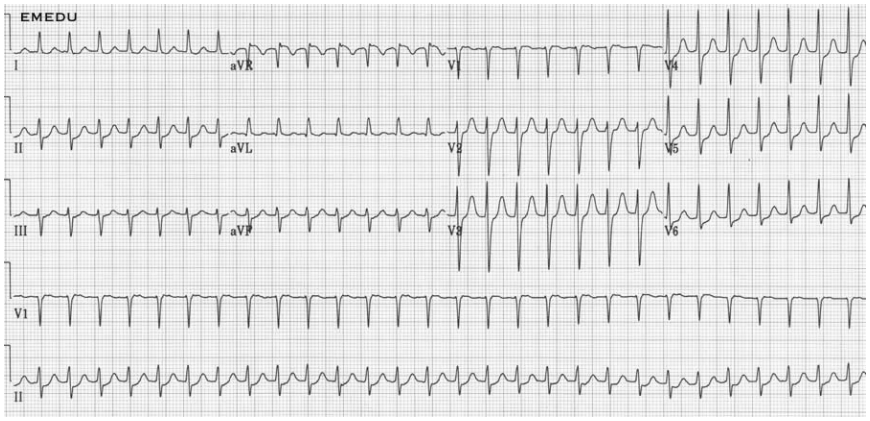
- Supraventricular tachycardia (SVT)
- Atrial tachycardia
- Atrial Flutter
- Atrial Fibrillation
- Junctional Rhythm

25

CONTINUED

SVT

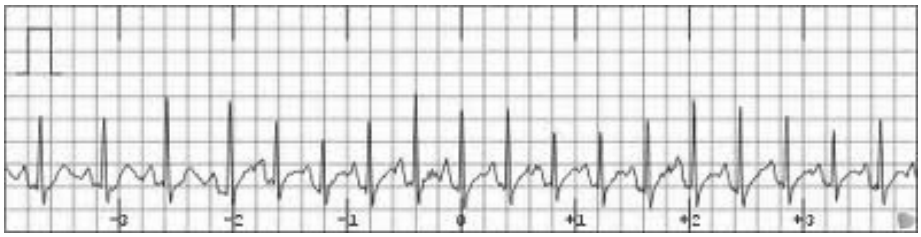
Rate- 150-250- regular rhythm- no visible P waves-
PR not measurable- QRS .12 or less



26

Atrial Tachycardia

Rate 150-250- regular- 1 P per QRS- PR may be shorter, QRS .12 or less



27

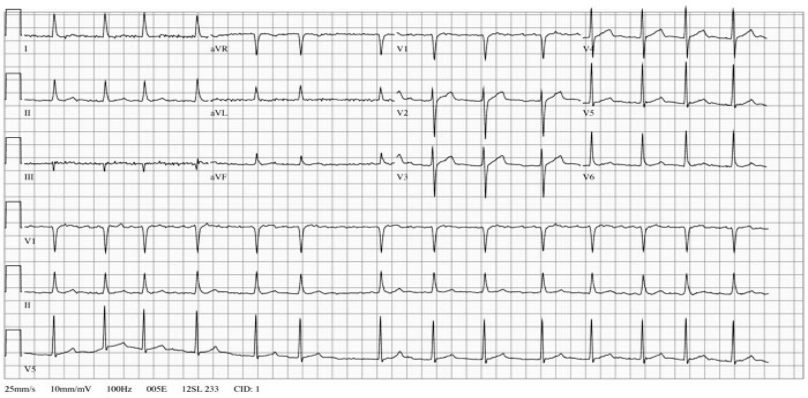
Atrial Flutter

Atrial rate 250-450- ventricular varies- Atrial is regular- ventricular can be irregular- P wave- saw tooth- PR not measurable- QRS <.12.

28

Atrial Fibrillation

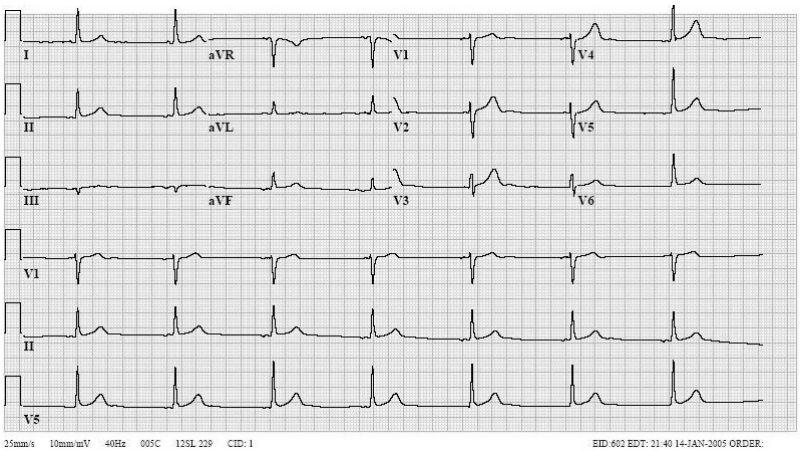
Rate can vary- Irregularly Irregular- P waves chaotic- PR not measured- QRS <.12.



29

Junctional Rhythm

Rate- 40-60- regular- P waves inverted-before or after QRS or absent- PR if present <.12- QRS .12 or less.



30

Ventricular Dysrhythmias

Premature Ventricular Contraction (PVC)
- Bigeminy
- Ventricular couplet
- Multifocal PVC (>1 ectopic focus)

Ventricular Tachycardia

Ventricular Fibrillation

31

PVC

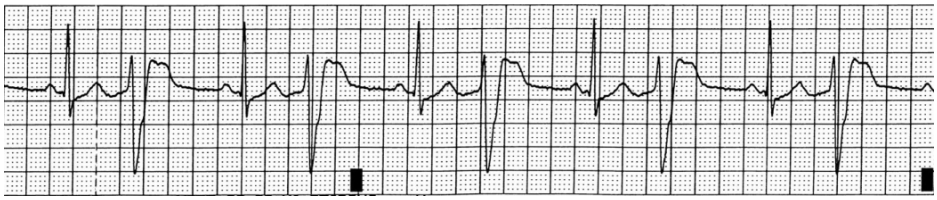
Rate varies- Can be regular or irregular- P wave will be absent- unmeasurable PRI- QRS >.12.

32

CONTINUED

Bigeminy

1 PVC every other beat- regular-irregular rhythm

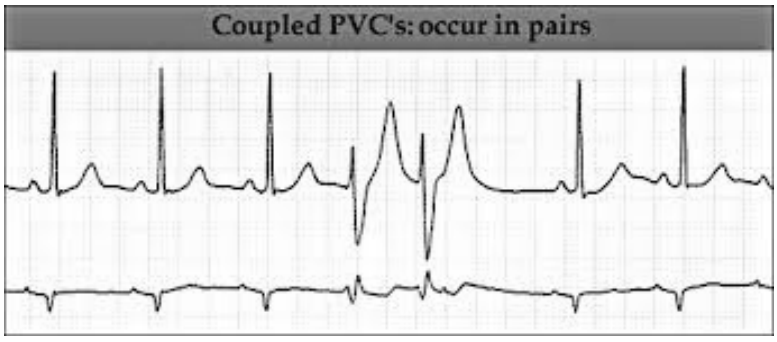


33

CONTINUED

Ventricular Couplet

PVC occurs twice

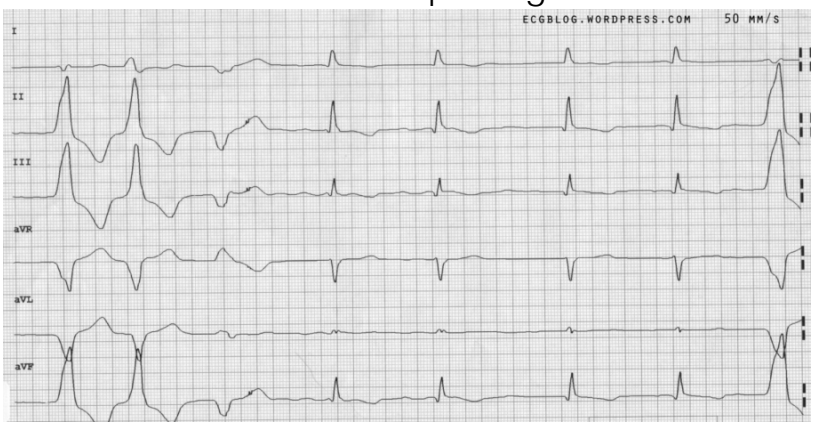


34

CONTINUED

Multi-Focal PVC

Can be both positive and negative since there are different ectopic origins



35

CONTINUED

Ventricular Tachycardia

3 or more PVC with rate >100 bpm- patient can be asymptomatic- symptomatic or unconscious and pulseless.

36

Ventricular Fibrillation

No organized rhythm- needs immediate defibrillation

37

Atrioventricular Blocks

First Degree AV Block

Second Degree AV Block

- Mobitz Type 1- Wenckebach
- Mobitz Type 2

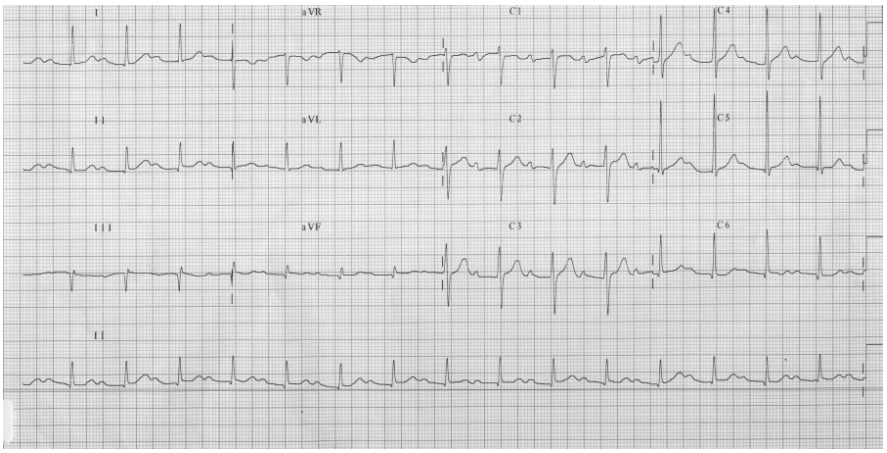
Third Degree AV Block

38

CONTINUED

First Degree Heart Block

PR interval > .20s

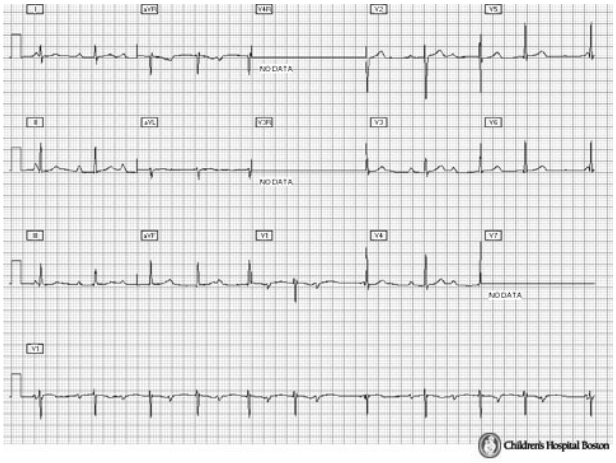


39

CONTINUED

Mobitz Type 1

PR interval progressively get longer than QRS drops



40

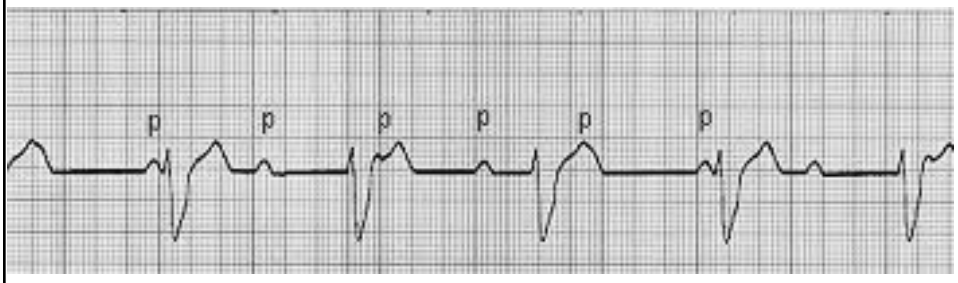
Mobitz Type 2

Regular dropped QRS every 2nd third or 4th P wave- consistent PR interval

41

Third Degree Heart Block

No conduction between A and V- both will have regular rates- Ps can be hidden in QRS



42

CONTINUED

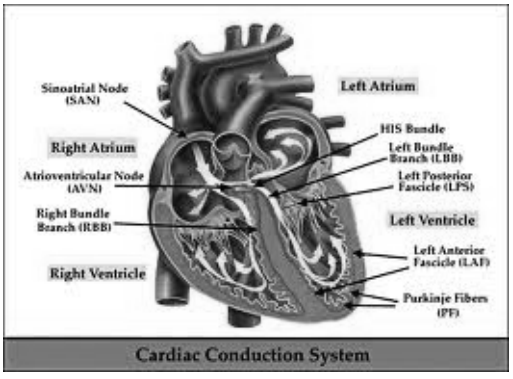
Story of the AV block Family

43

CONTINUED

Bundle Branch Blocks

- Right Bundle Branch Block RBBB
- Left Bundle Branch Block LBBB

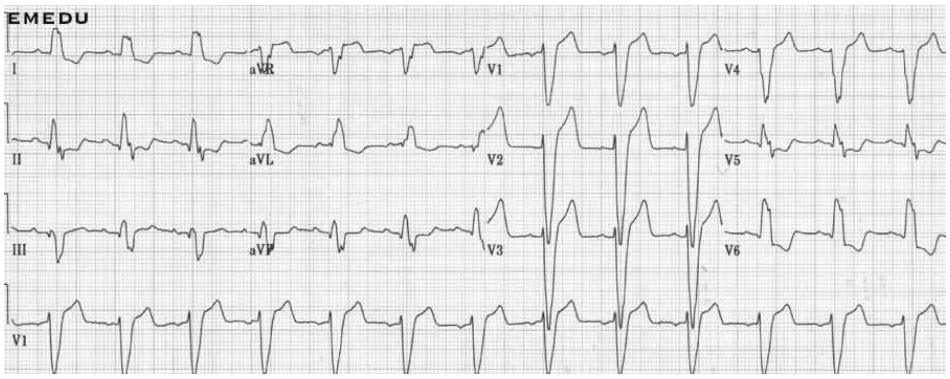


44

Left Bundle Branch Block

- Increased QRS >.10s
- Once a widened QRS > 0.10s is identified, we look at leads closest to the LV to identify a LBBB.
  Leads V5,V6, I, and aVL are in close proximity to the left ventricle, and as such, are the best location to identify a LBBB.
- Characterized by an RSR segment or notched QRS

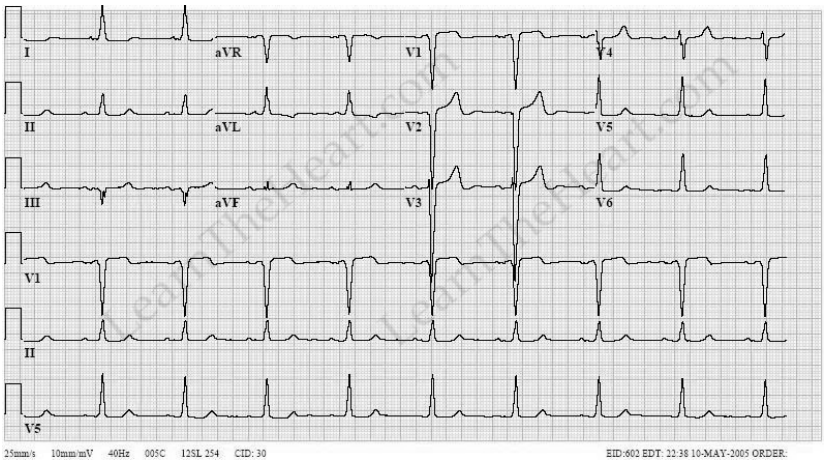
45



46

Right Bundle Branch Block

Look at Right chest Leads V1 and V2



47

Myocardial Infarction

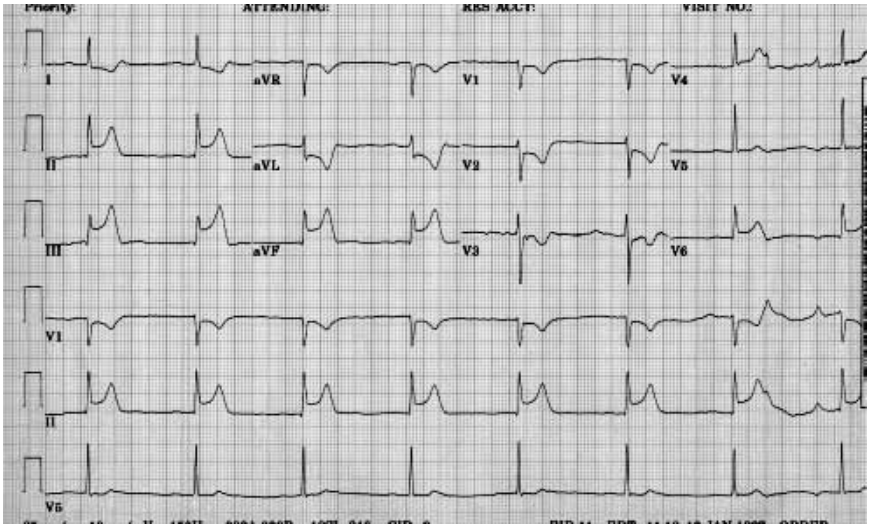
- ST segment elevation
- ST segment depression
- Inverted T wave

48

ST segment elevation

- Transmural MI
- Use precordial leads to localize

49

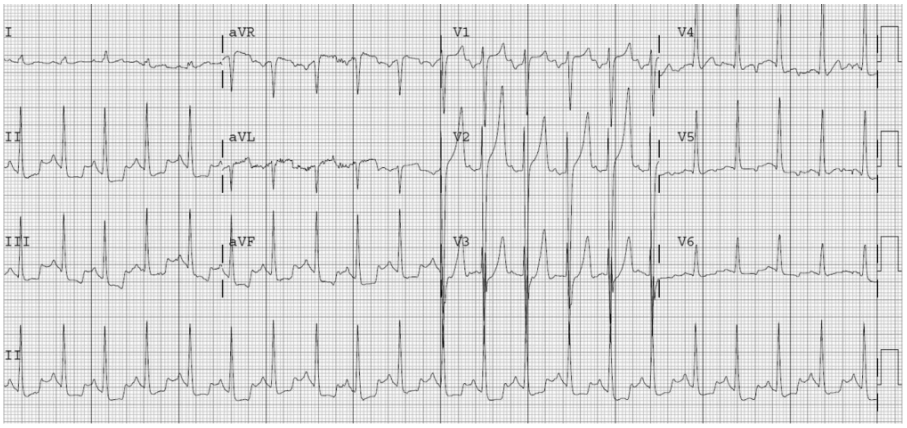


50

ST segment depression

- Myocardial ischemia- can be diagnostic during exercise

51



52

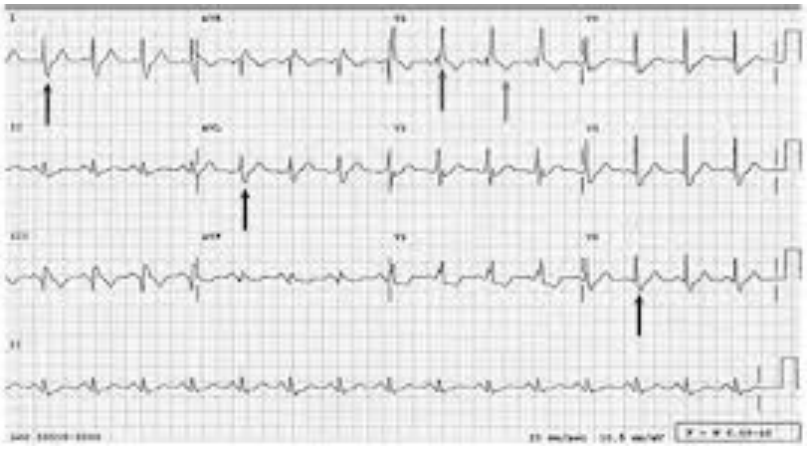
CONTINUED

Inverted T wave

- Myocardial ischemia (can be old)

53

CONTINUED

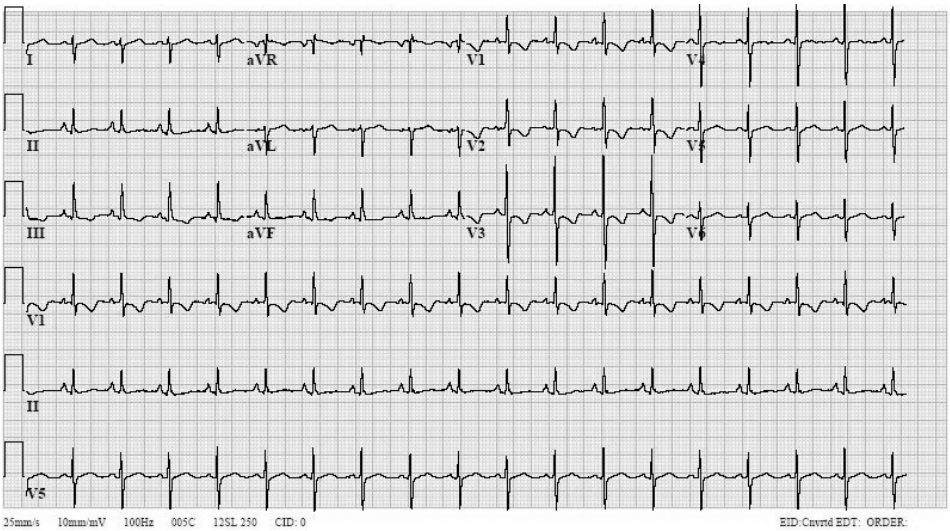


54

EKG Lab

55

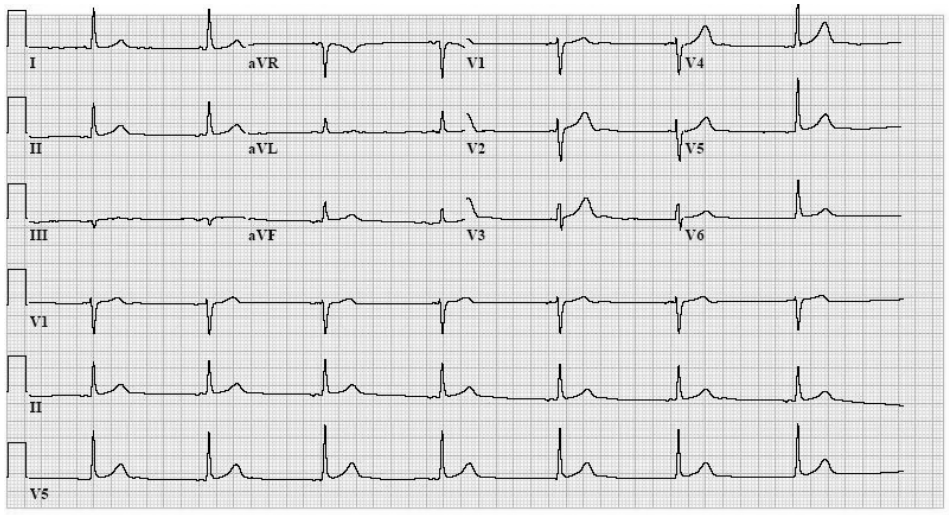
Case 1



56

CONTINUED

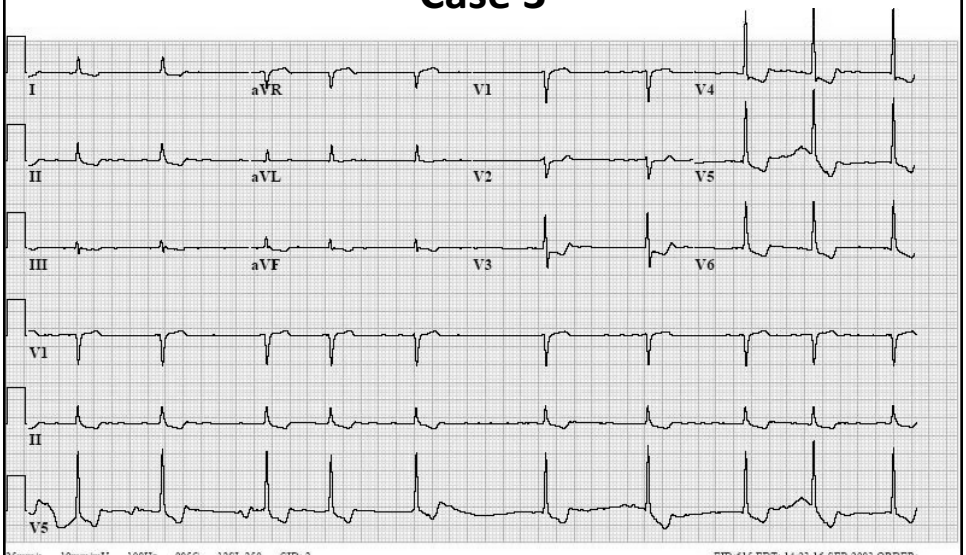
Case 2



57

CONTINUED

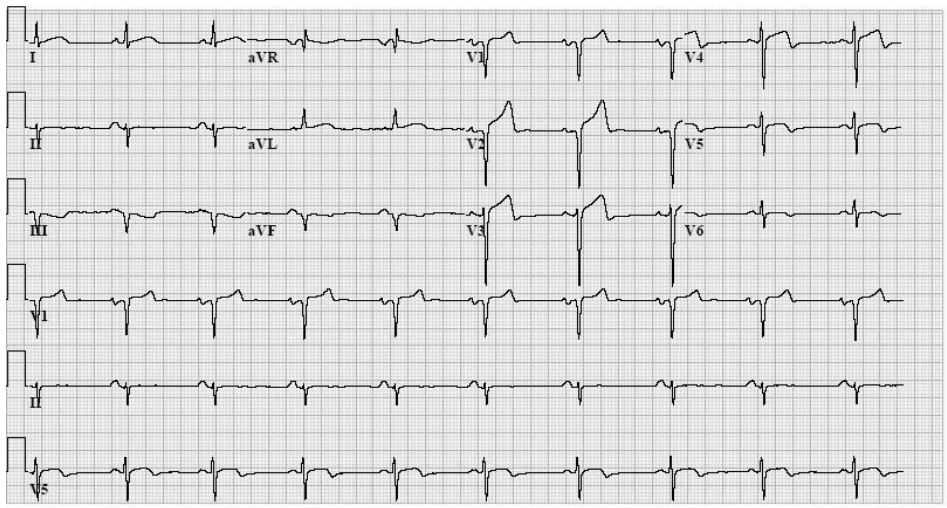
Case 3



58

CONTINUED

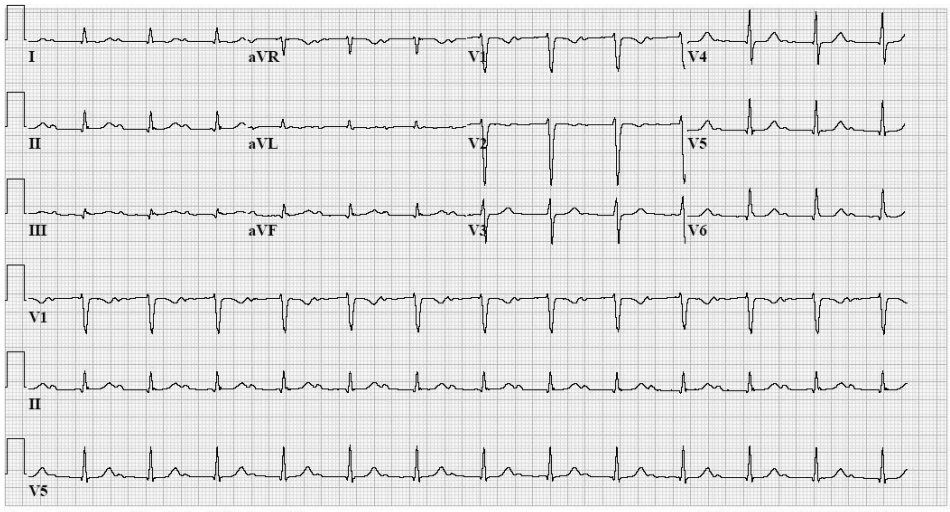
Case 4



59

CONTINUED

Case 5



60

References

Daamen, M. A. M. J., Brunner-la Rocca, H. P., Tan, F. E. S., Hamers, J. P. H., & Schols, J. M. G. A. (2017). Clinical diagnosis of heart failure in nursing home residents based on history, physical exam, BNP and ECG: Is it reliable?. *European Geriatric Medicine*, *8*(1), 59-65.

Askandar, S., Bob-Manuel, T., Singh, P., & Khouzam, R. N. (2017). Shorter Door-To-Balloon ST-Elevation Myocardial Infarction Time: Should There Be a Minimum Limit?. *Current Problems in Cardiology*, *42*(6), 175-187.

Lyell, D., & Coiera, E. (2016). Automation bias and verification complexity: a systematic review. *Journal of the American Medical Informatics Association*, *24*(2), 423-431.

Matuskowitz, A. J., Carr, C. M., Jennings, L., Hall, G. A., & Saef, S. H. (2016). 107 How Good are Paramedics and Emergency Physicians at Diagnosing a STEMI by EKG Compared to Cardiologists?. *Annals of Emergency Medicine*, *68*(4), S43.

Bartlo, P., Brooks, G., & Cohen, M. (2015). Toward entry-level competencies in cardiovascular and pulmonary physical therapy. *Cardiopulmonary Physical Therapy Journal*, *26*(4), 99-107.

61