PATIENT CARE THEORY 2

Unit 14 Part 2: Cardiac Rhythm Interpretation- Leads, HR calculation and Step by Step approach

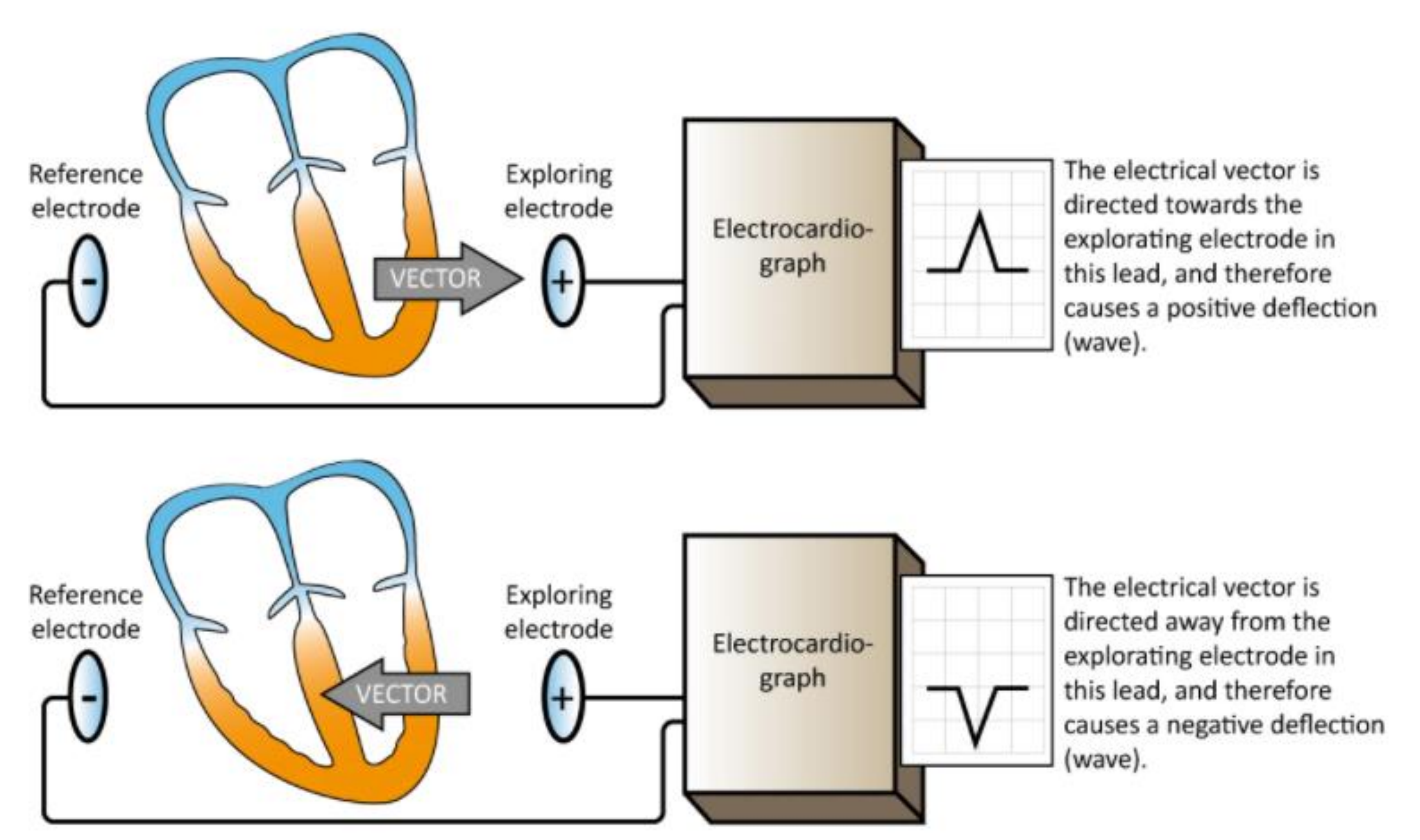
Learning Outcomes

- Differentiate between an electrode and a lead.
- Identify the bipolar leads and their limb placement.
- Identify the unipolar augmentation leads.
- Discuss augmentation as it applies to ECG interpretation.
- Explain Einthoven’s law.
- Discuss the morphology of an impulse travelling to and away from a positive electrode.
- Explain the delineations of ECG paper.
- Discuss and demonstrate the method for obtaining a 3or 4-lead ECG.
- Discuss and demonstrate the method for obtaining an accurate HR from ECG tracing
- Identify patient conditions for which cardiac monitoring is recommended
- Discuss the steps used to interpret an ECG

Electrodes vs Leads

- Electrode
  - The conductive pad that is placed on the patients skin in order to record a tracing of the electrical activity
- Leads
  - Are the graphical representation of electrical current in the heart
  - Measure the path of the current (created by depolarization) between 2 points
  - Vectors -> Positive deflection is seen as it travels away from the negative electrode to the positive electrode (and vice versa)
  - Must be placed symmetrically for proper tracing

Vectors


Reference electrode
VECTOR
Exploring electrode
Electrocardio-graph
The electrical vector is directed towards the exploring electrode in this lead, and therefore causes a positive deflection (wave).
Reference electrode
VECTOR
Exploring electrode
Electrocardio-graph
The electrical vector is directed away from the exploring electrode in this lead, and therefore causes a negative deflection (wave).

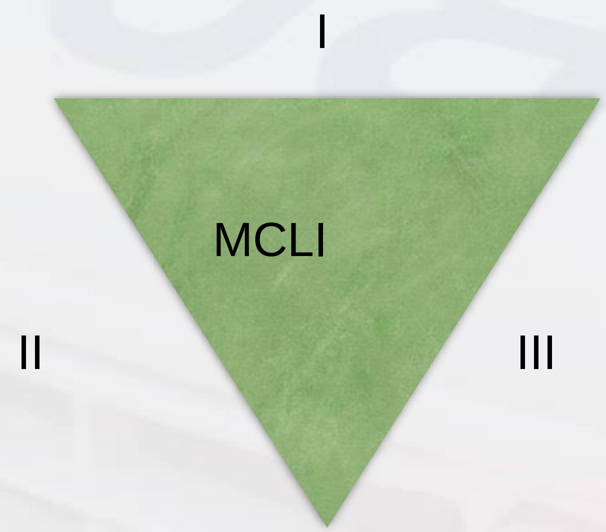
Electrophysiology

- Cardiac cells action potentials generate electrical current
- These currents are conducted all the way to the skin
- Electrodes conduct this current and the leads provide the graphical information

ECG Leads

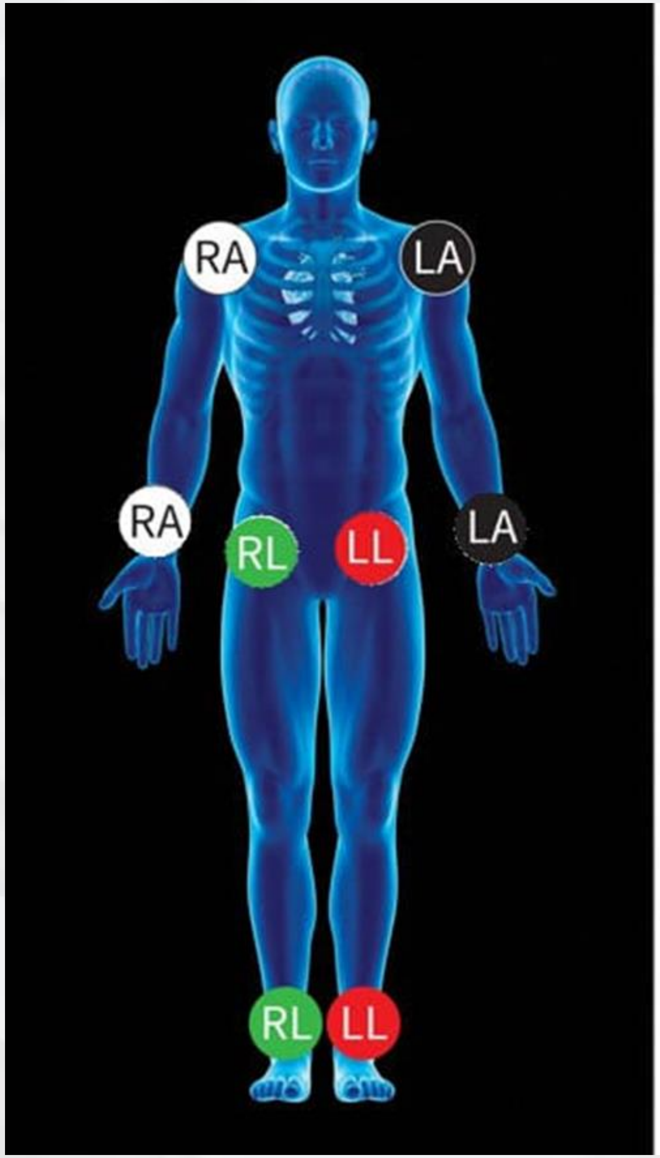
- Used to obtain an accurate picture of the electrical activity of the heart
- Limb leads and precordial leads

ECG Leads



Einthoven’s Triangle

Lead Placement – Limb Leads



RA Right Arm

LA Left Arm

The arm leads in a traditional approach are often placed on the wrists

The arm leads in a modified approach are often portrayed in the location of this image

While outside of the torso is correct, the most optimal location for modified arm leads is in line with the horizontal axis of V4

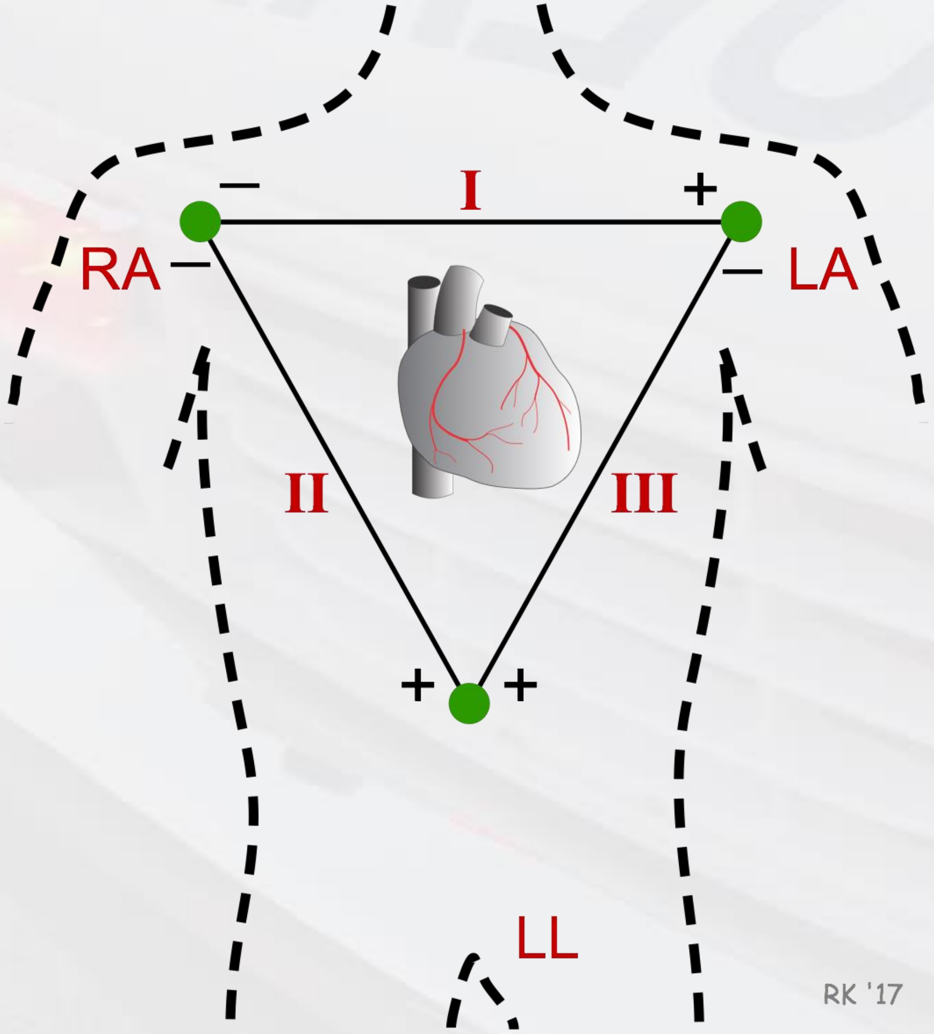
RL Right Leg

LL Left Leg

The leg leads in a traditional approach are often placed near the ankles

The leg leads in a modified approach should optimally be at least 8 cm below and 5 cm on either side of the navel

ECG Leads



Lead I

-ve electrode right arm

+ve electrode left arm

Lead II

-ve electrode right arm

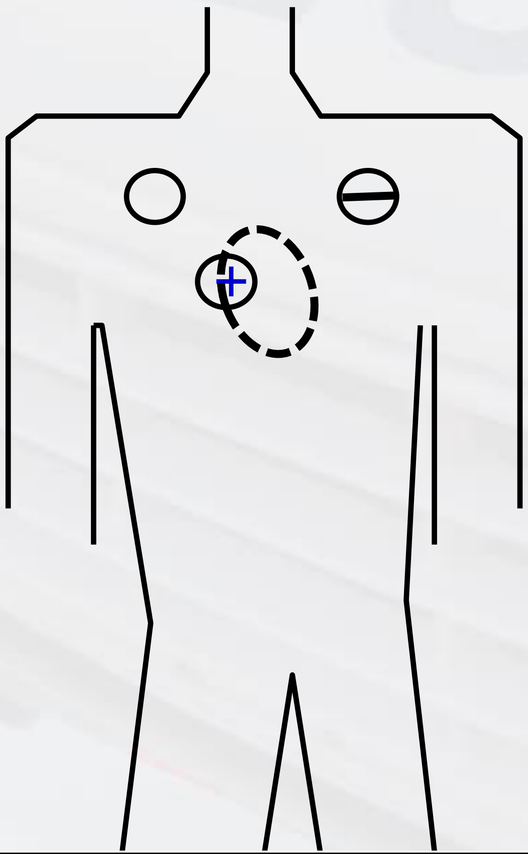
+ve electrode left chest

Lead III

-ve electrode left arm

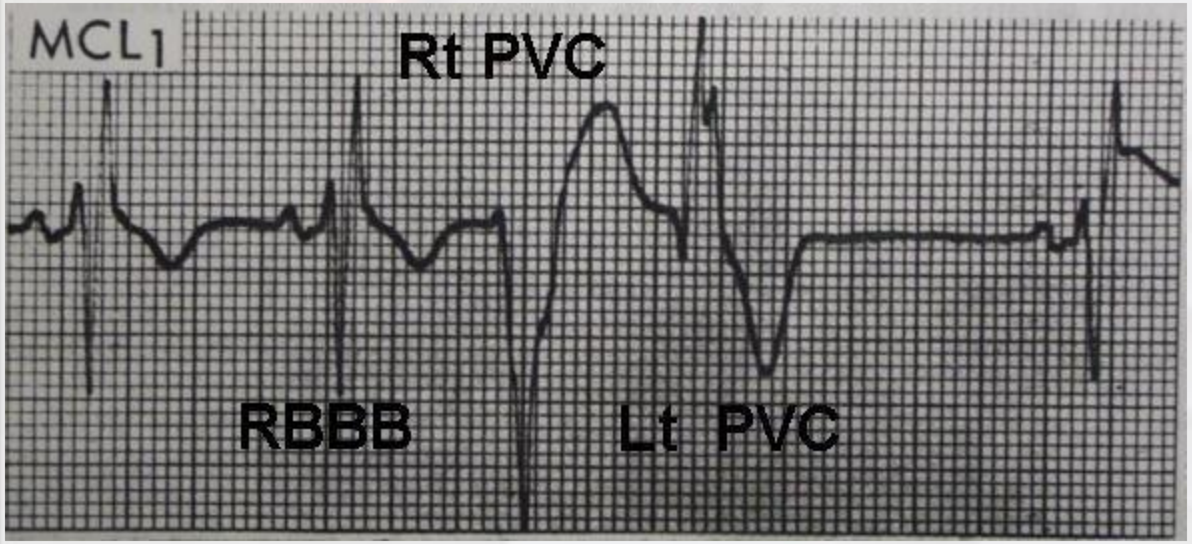
+ve electrode left chest

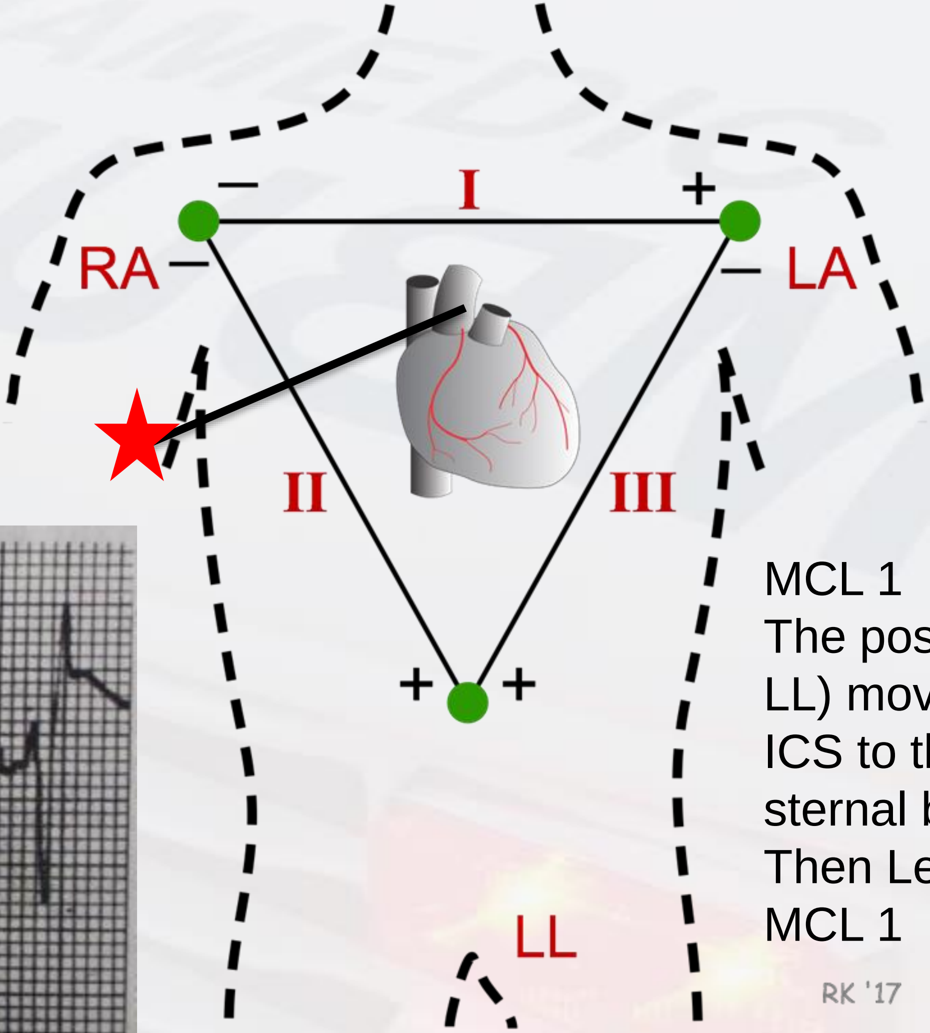
MCL I LEAD: A special Lead



- *+ve* electrode goes in the 4^{th} intercostal space at the right sternal border (left leg)
- it sits over the atria
- Good lead for highlighting atrial activity

Note: Select Lead III on the monitor so that the -ve electrode is on the left shoulder





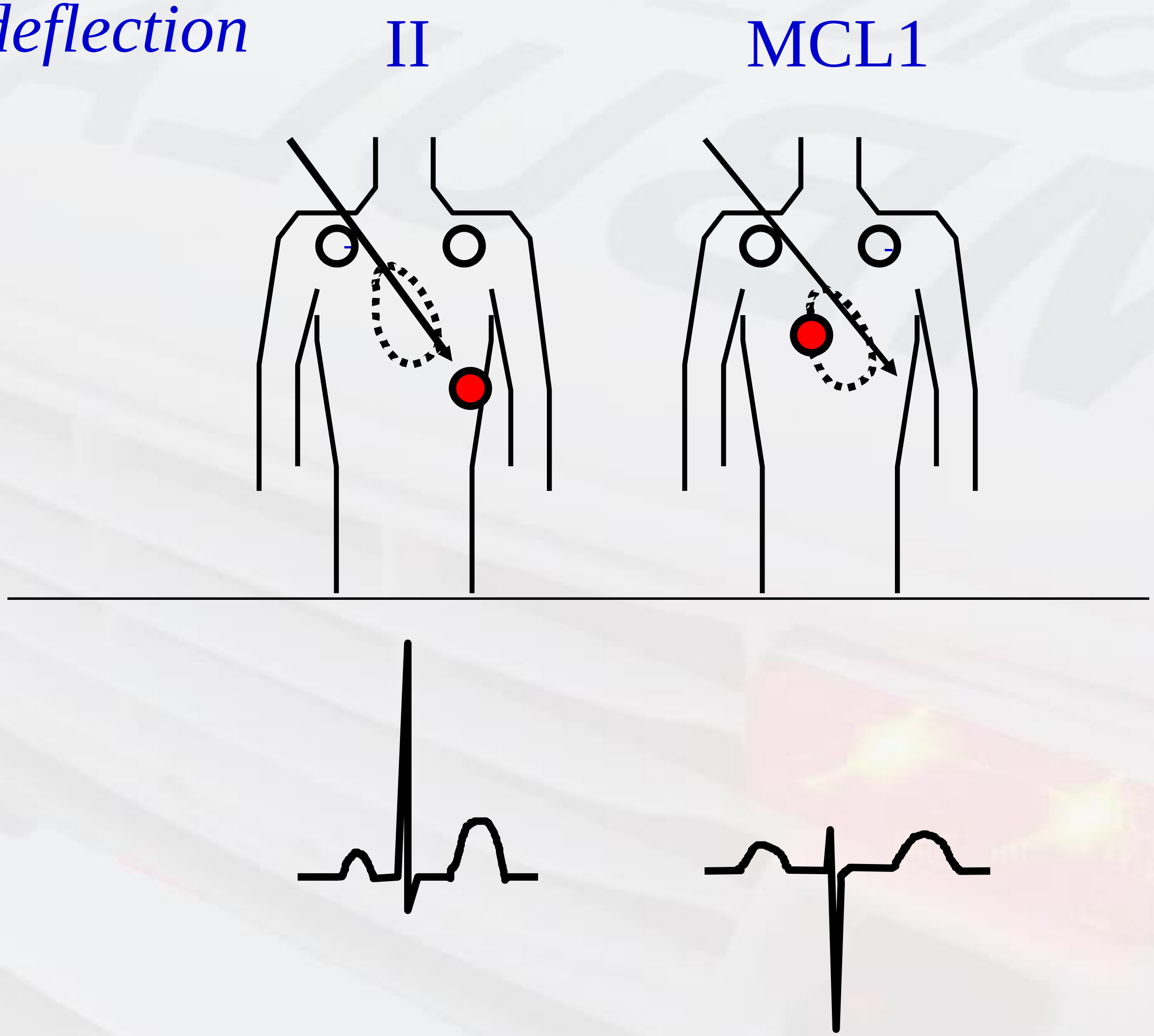
MCL 1
The positive lead (from LL) moves up to the 4th ICS to the right of the sternal border
Then Lead III becomes MCL 1

RK '17

Electrode Placement

- Ensure that skin is dry
  - Can use an alcohol swab if necessary
- Inspect electrode and ensure that conductive surface gel is not dry
- Attach the electrode to the lead
- Remove the protective cover and apply the electrode to the prepared skin surface ensuring that the adhesive surface fully contacts the skin
  - Avoid bony protuberances and large muscle mass
  - Do not place overtop of pacemakers/defibrillators

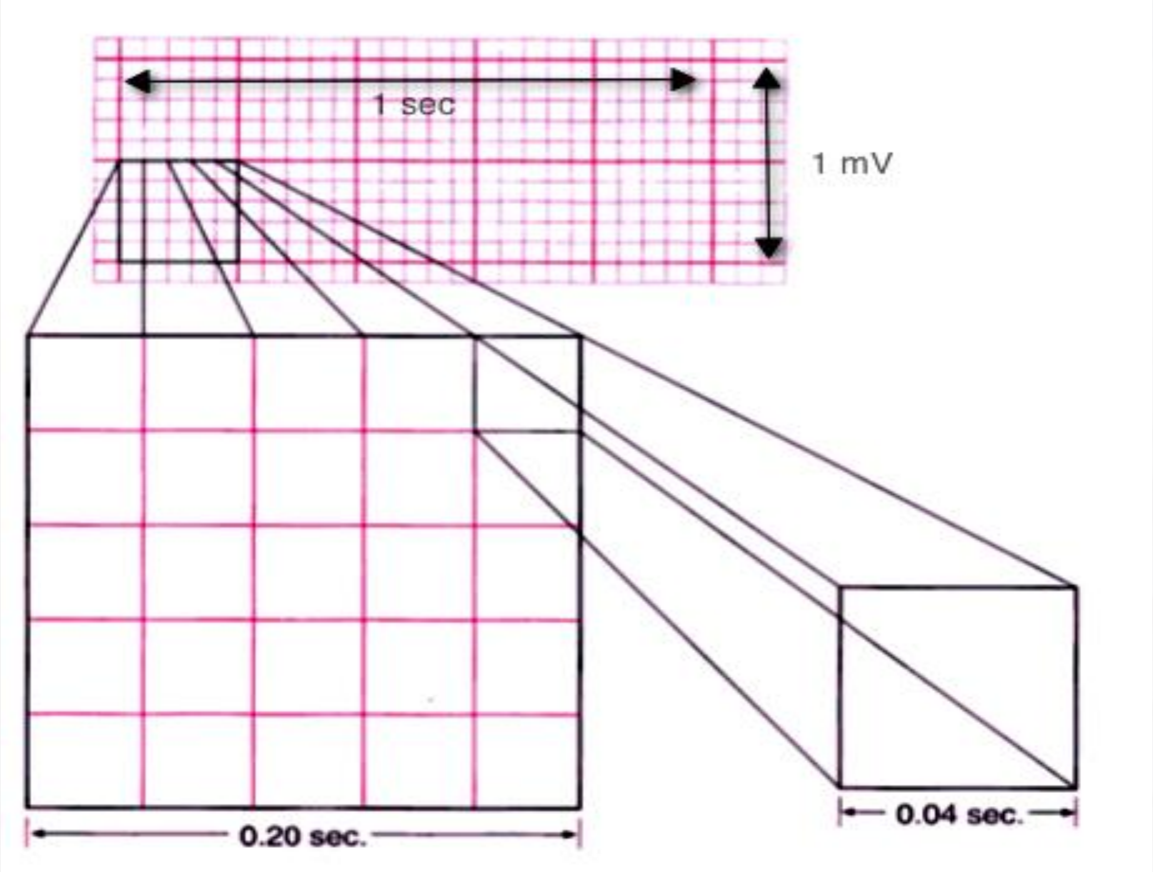
QRS deflection



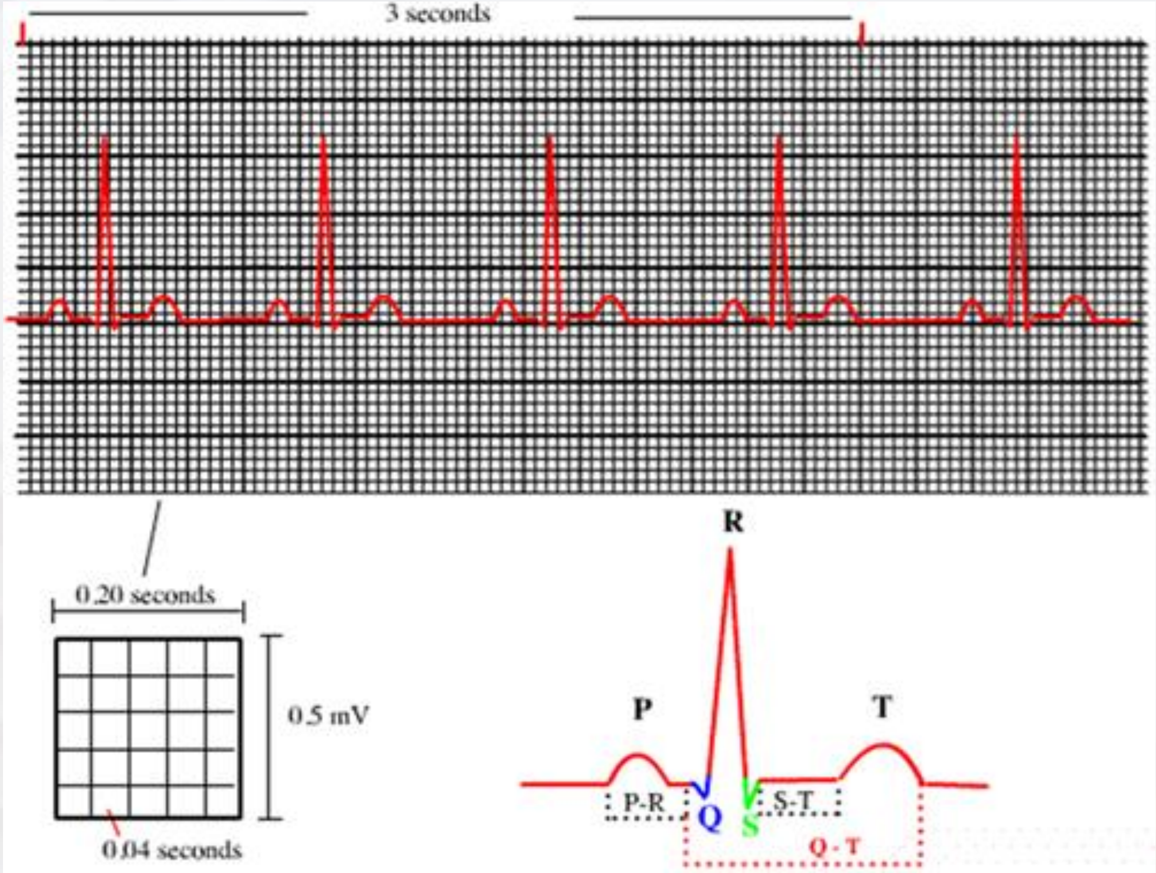
How Do ECG Leads Present?

- ECG paper
  - present one diagram for each lead shown
  - Consists of small boxes within large boxes
  - Typically runs at a speed of 25mm/second
    - This speed corresponds with the expected time frames for each square

ECG paper



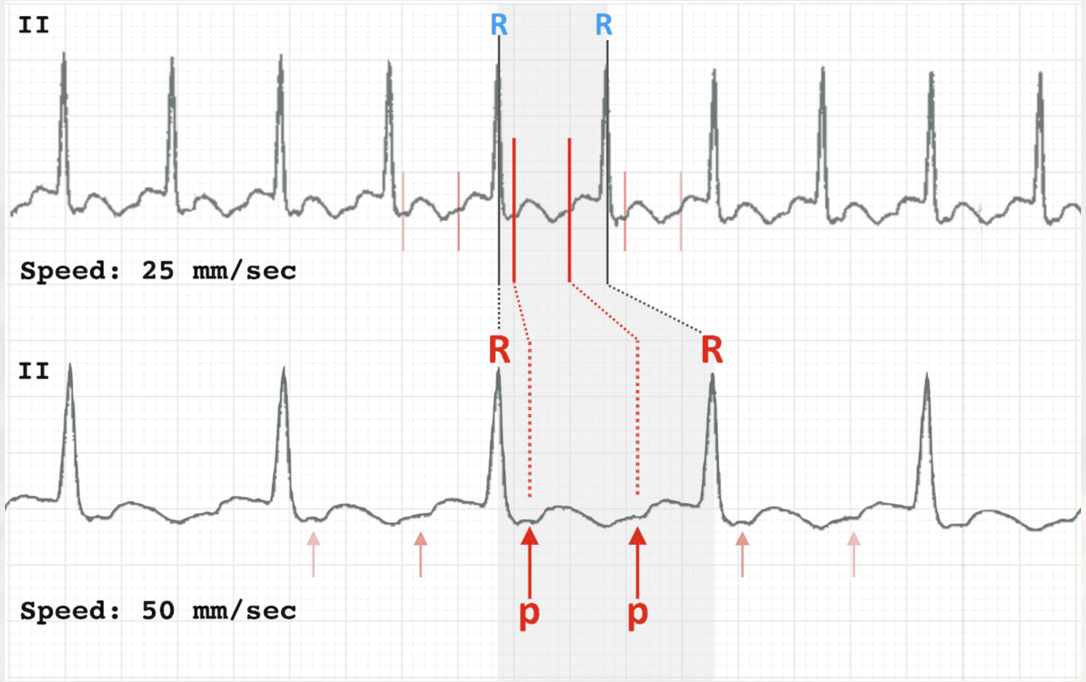
1 sec
1 mV
0.20 sec.
0.04 sec.



3 seconds
0.20 seconds
0.5 mV
0.04 seconds
R
P
T
P-R
Q
S
S-T
Q - T

ECG Paper

- Some monitors allow a change in paper speed (50mm/second)
- This can be used to “draw out” the complexes giving it a wider appearance
- Atrial abnormalities become easier to see



Calculating Heart Rate

- Regular Rhythms
  - 300 Method
    - Count the number of FULL LARGE [each large box contains 5 small boxes] and divide that number into 300
  - 1500 Method
    - Most accurate
    - Count the total number of small boxes between 2 R waves and divide into 1500

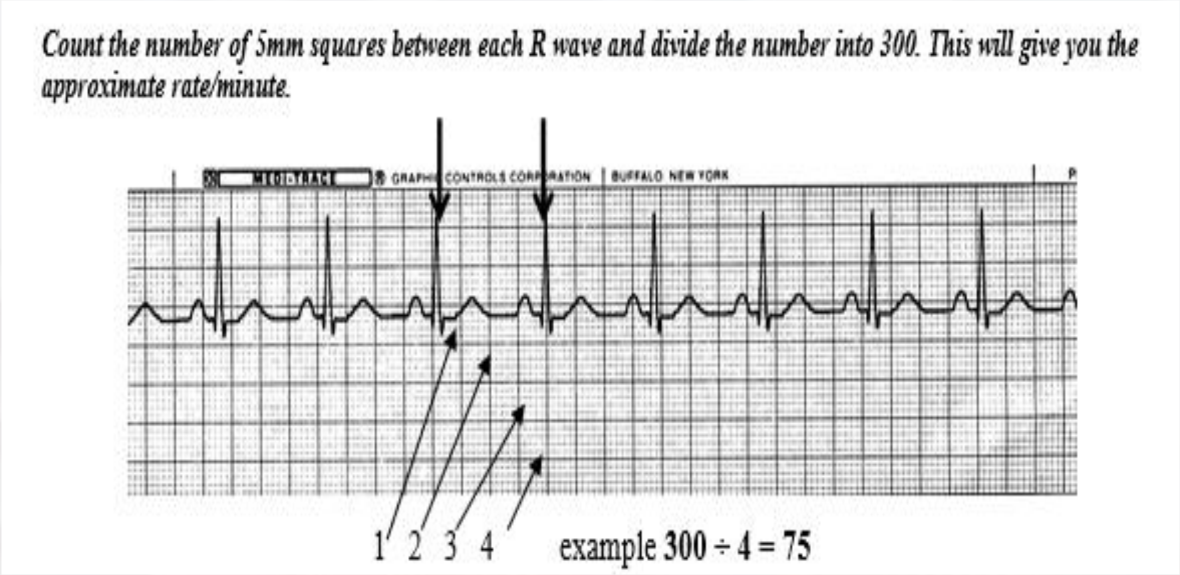
HR Calculations – Regular Rhythms

0.2

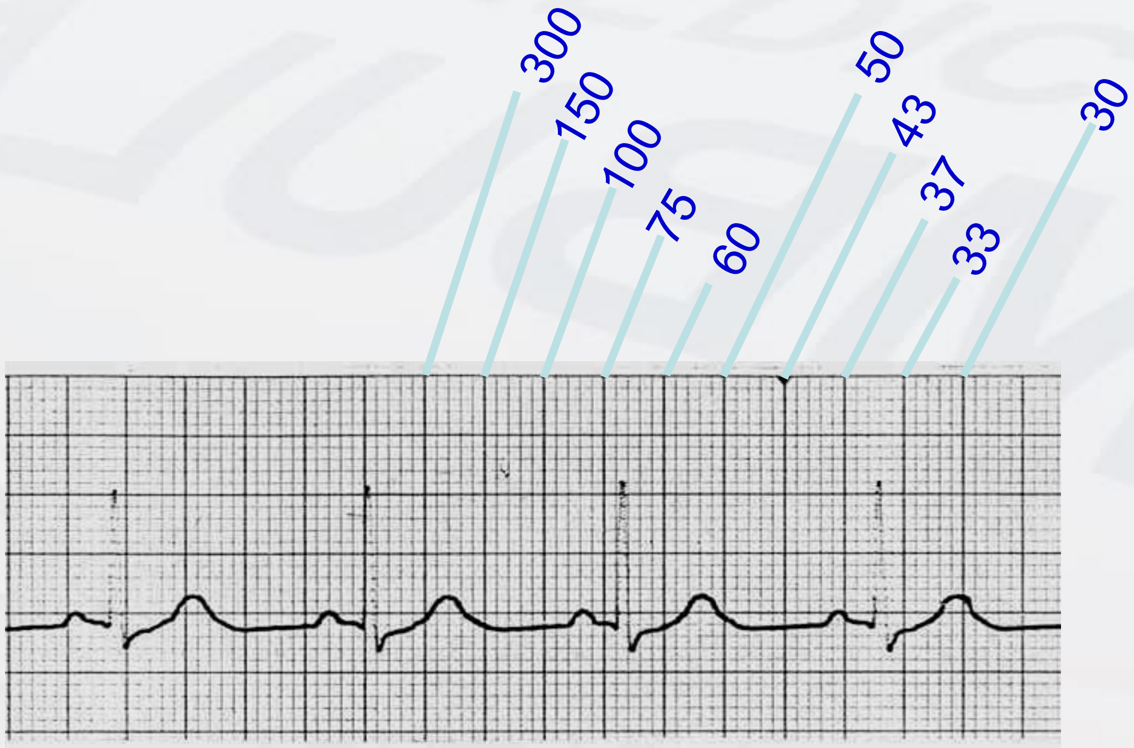
0.4

1500 Method

300 Method



Heart rate calculation – Memorization /R-R Interval



Method

1. Find an R wave that falls on a dark line.
2. Count the number of dark lines between neighboring R waves and divide into 300.
3. More accurate than 6 sec x10 method

This is essentially memorization of the factors in the 300 method

Irregular Rhythm HR calculation

What if the R to R cycles Vary?
Use the 6-Second Method

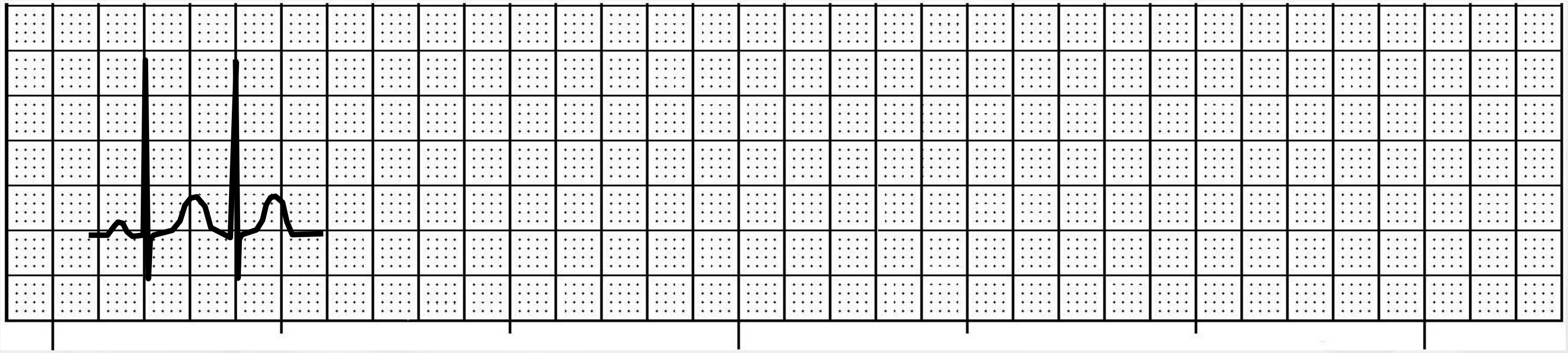
6 (QRS complexes) x 10 = 60 b/min

Simply count the number of complete QRS complexes in a 6 second strip (multiply by 10).

How many large boxes in a 6 sec strip? 30

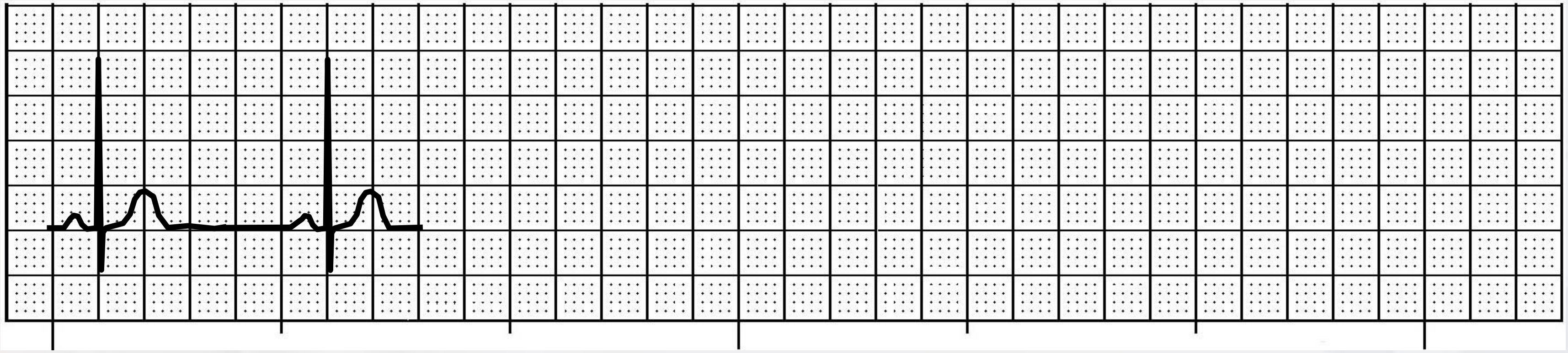
Rhythm must vary by 4 small boxes (.16 sec) anywhere on the rhythm strip.

1. Based on the following R-R interval, what is the heart rate?



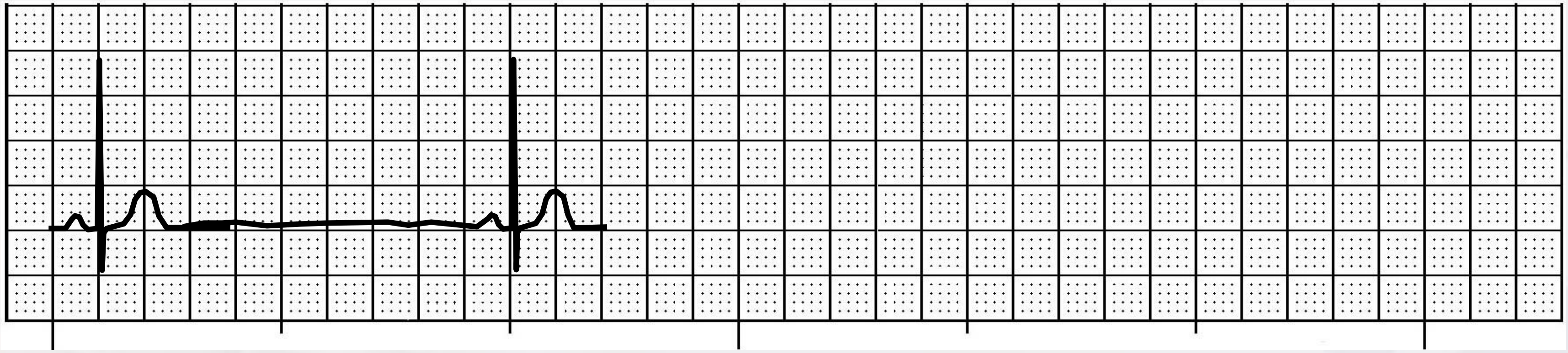
HR: 150

2. Based on the following R-R interval, what is the heart rate?



HR: 60

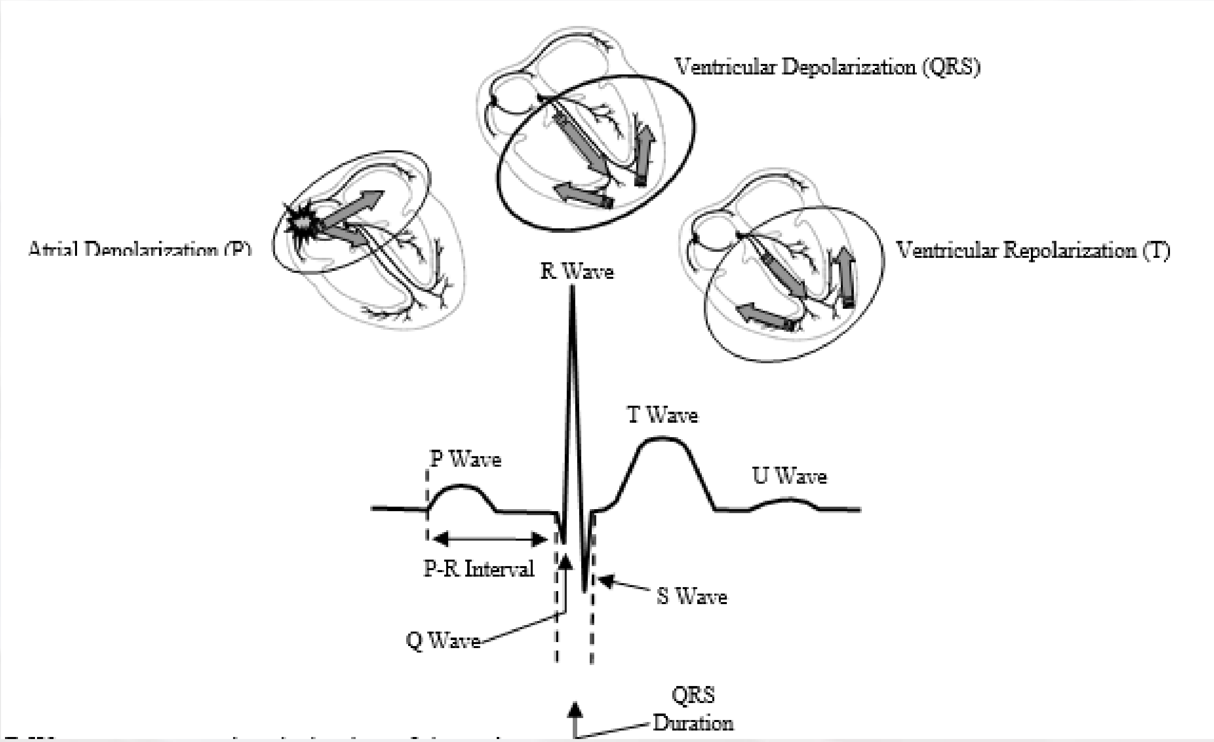
3. Based on the following R-R interval, what is the heart rate?



HR: 33

Step by Step Approach to Interpretation

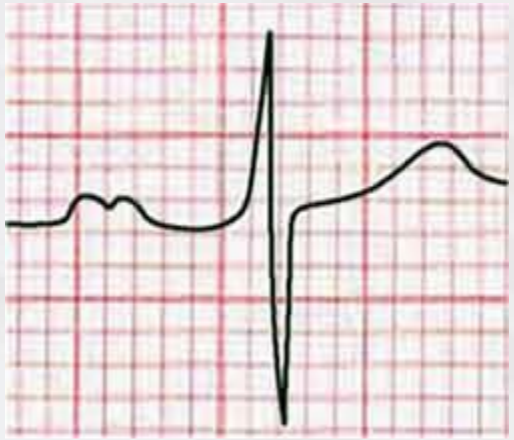
- Interpretation requires identification of normal vs. abnormal
- Interpretation of ECG is only looking at the electrical activity
  - Treat the patient, NOT the monitor!
- Waves, complexes, intervals and duration, ratios and rhythm



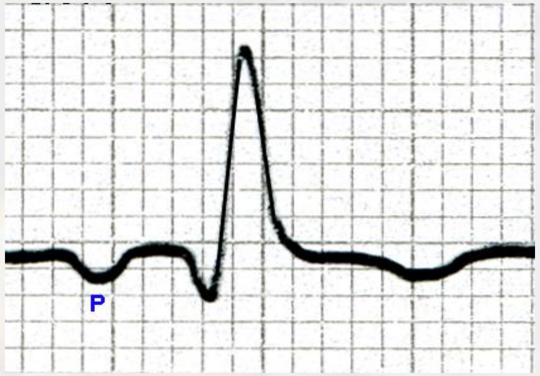
P Wave

repolarization isn't
visble for atrium

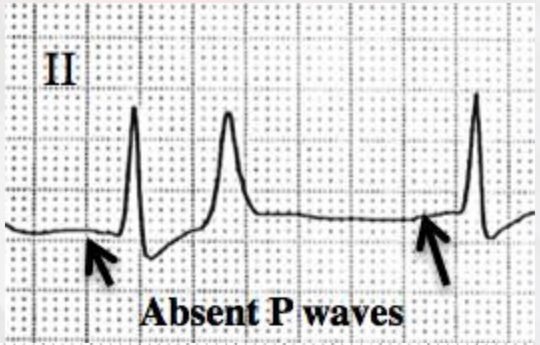
- Represent depolarization of the atria
- Normally from SA node
- Upright (normally) in leads I, II and III
- Similar size shape represent a sinus rhythm
- Can be contoured, notched or biphasic



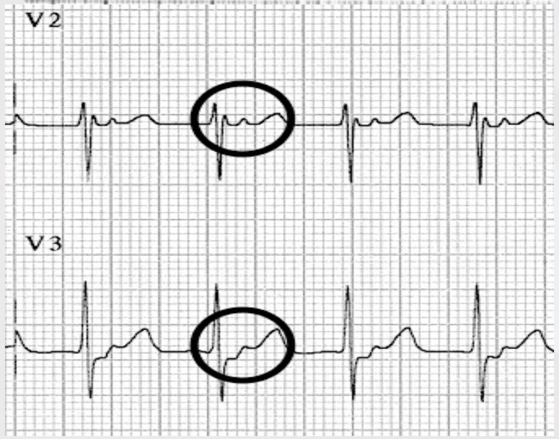
Junctional P waves (not Sinus)



Inverted P waves – with a short PR interval suggest a junctional Rhythm



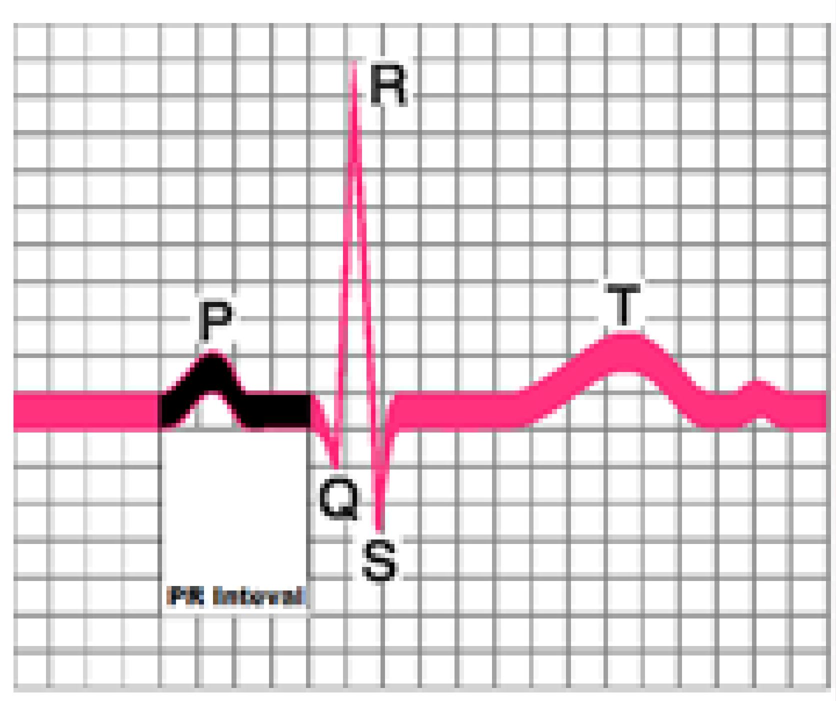
Absent P waves – followed by a narrow QRS complex suggest a junctional rhythm



Retrograde P waves (appear after the QRS) – suggest a junctional rhythm

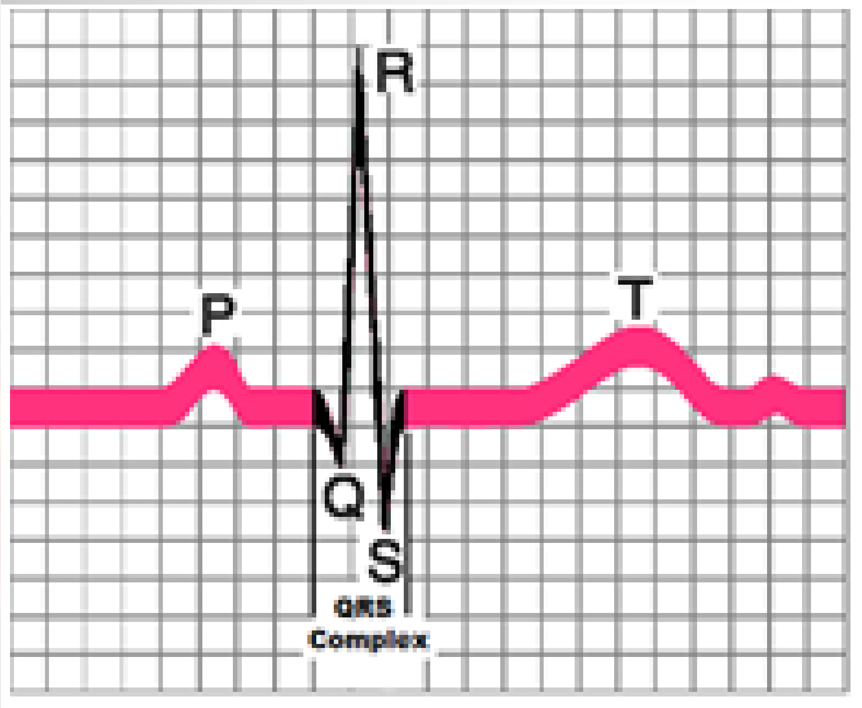
PR Interval (PRI)

- Impulse conduction from the SA node through the AV node
- Measured from the start of the P wave -> start of the QRS complex
- Normal time is 3-5 small squares (0.12 – 0.20 secs)



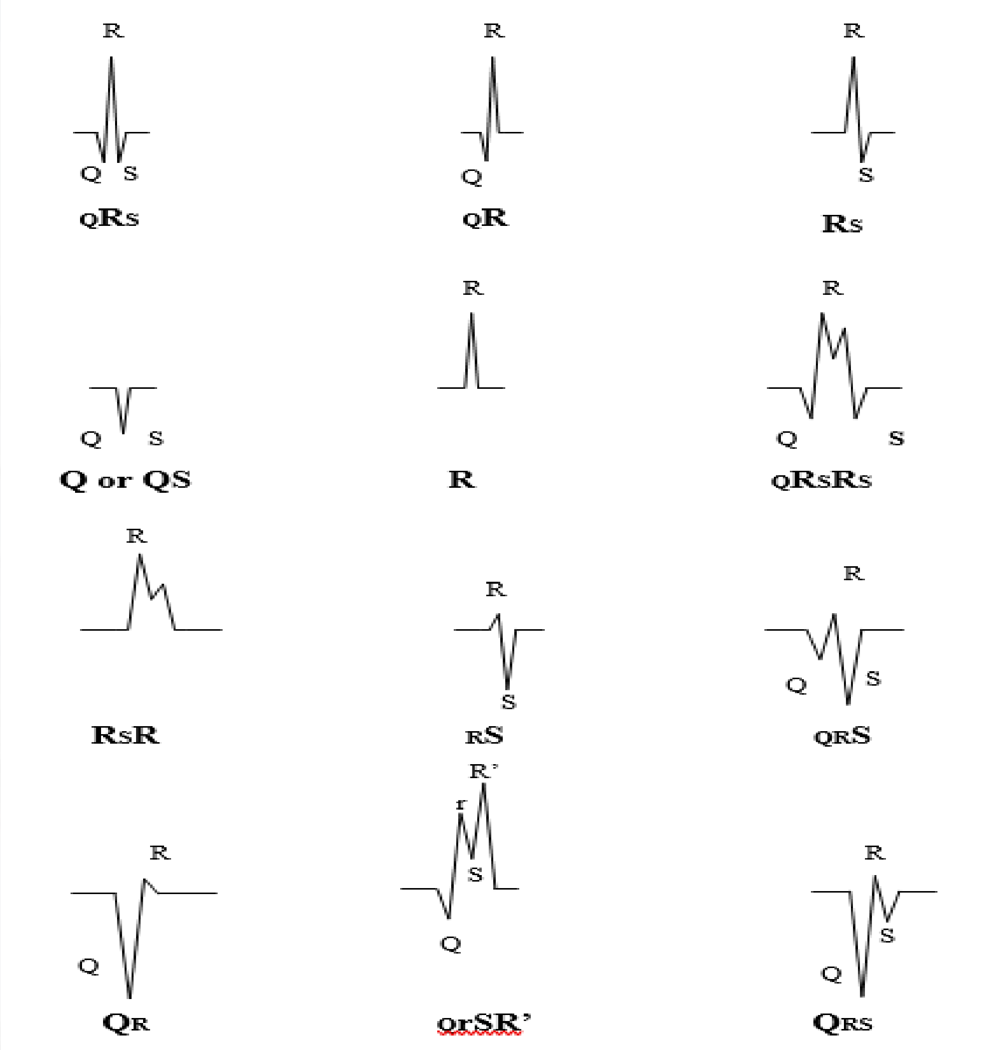
QRS Complex

- Represents Ventricular Depolarization
- Normal Duration is 0.08 – 0.10 or <0.12 (< 3 small squares)
- Large amplitude as a result of the large ventricular muscles
- Q wave – septal wall depolarization (first negative/downward deflection)
- R wave – Ventricular wall depolarization (first positive/upward deflection)
- S wave – Lateral wall depolarization (second negative deflection)
- All 3 waves may not be seen



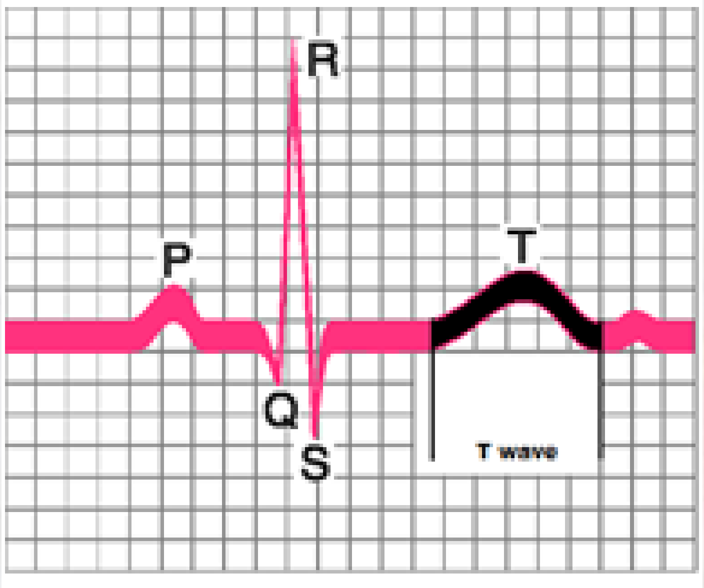
QRS Complex – Morphology (shape)

- Varies depending on the lead being viewed, the patient or abnormal pathology



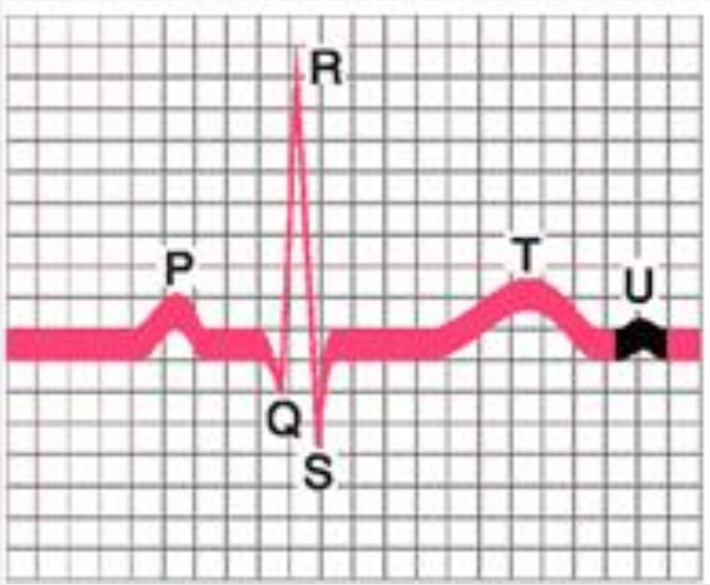
T Wave

- Ventricular Repolarization
- Morphology, or deflection is not important for basic rhythm interpretation



U wave

- Small wave that sometimes follows the T wave
- May represent late purkinje fiber repolarization
- Frequently seen in Hyperkalemia
- May also suggest cardiomyopathies, diabetes, LVH, other electrolyte imbalances



Steps for Interpretation

Blocks and delays typcally occur at PR interval, betweenatrial depolarization and ventricles.

Step 1. Rate

- < 60 Bradycardia
- 60-99 Normal
- ≥ 100 Tachycardia

SA rythm. That's why it's called sinus.

- These are calculated using the previous described methods (300, 1500, memorization R-R method, 6 second strip)

Steps for Interpretation

Step 2. P Waves

- Present? Regular? Same size and shape?
- If P waves are inverted, absent or retrograde = junctional
- Fibrillation or Flutter waves
  - An irregularly irregular with indiscernible or fibrillating P waves indicates atrial fibrillation
  - Flutter waves are characterized by a “saw tooth” appearance and represent a single foci that is not the SA node

at AV junction

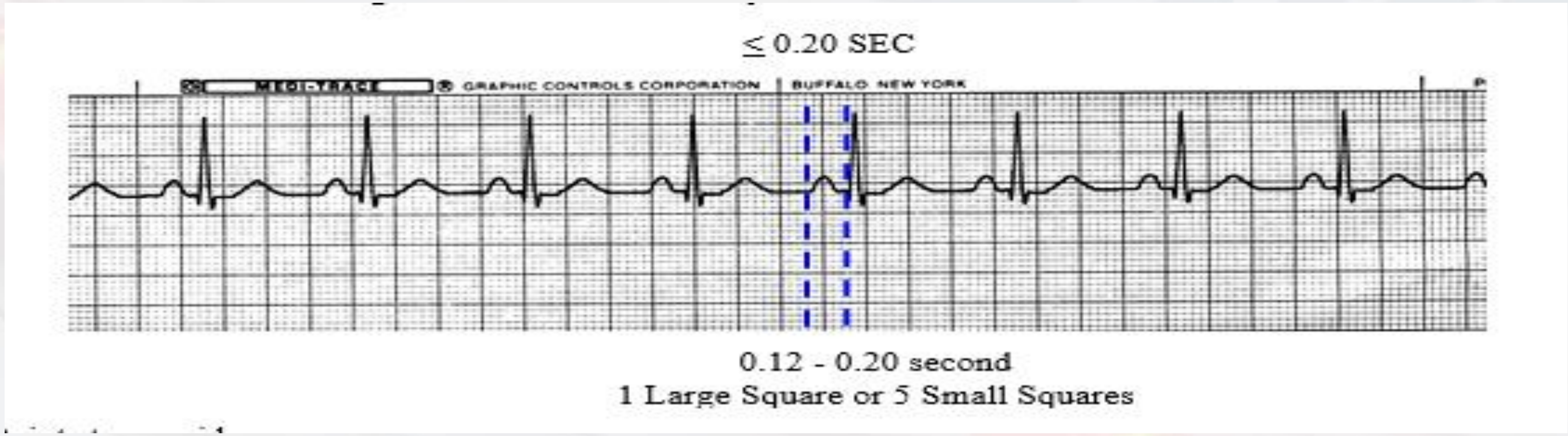
3 kinds of bad heart rythms:

Regular bad rythm = somewhat normal shape over and over, like saw tooth
Regularly irregular = weird shape that's repeating
irregularly irregular = no discernable pattern in irreularities (afib)

Steps for Interpretation

Step 3. P-R Interval

- 0.12-0.20 second (3-5 small squares)



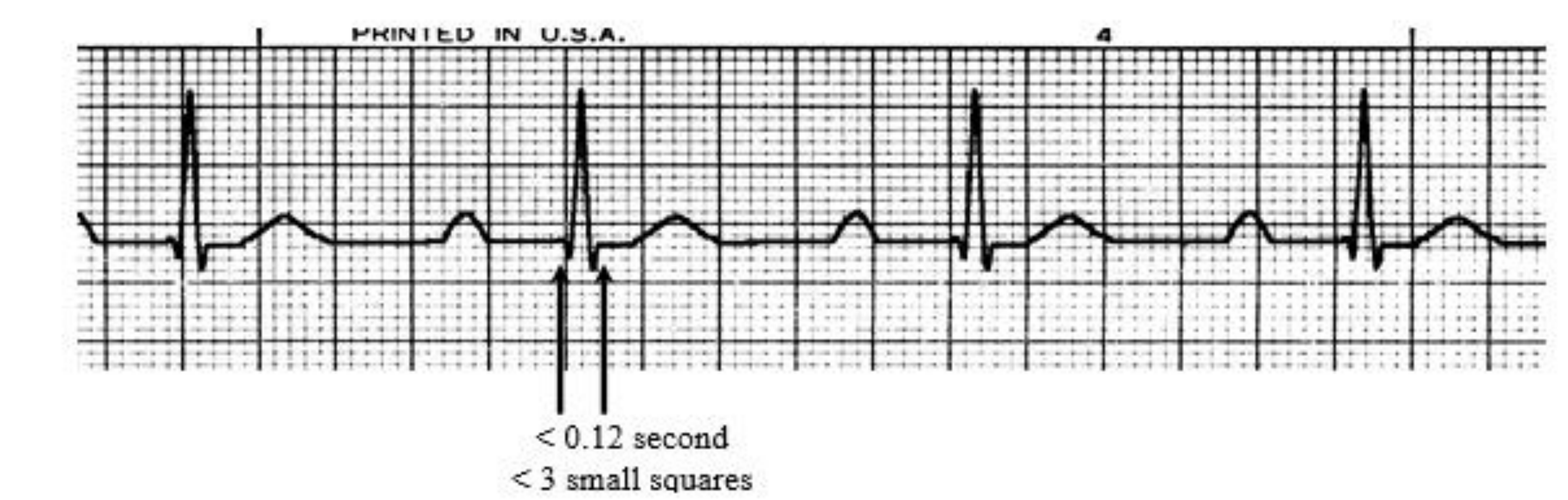
- Measured in the same place regardless of morphology
- Any delay greater than 0.20 secs represents a significant conduction delay

Steps for Interpretation

for it to be narrow, it must travel from above the ventricle and down both bundle branches at the same time

Step 4. QRS complex

- Narrow (0.08-0.10) or wide ($\geq$ 0.12)?
- > 0.12 indicates impulses originating from below the AV junction or has delayed conduction through the BB or aberrant conduction due to damage, drug effect etc.

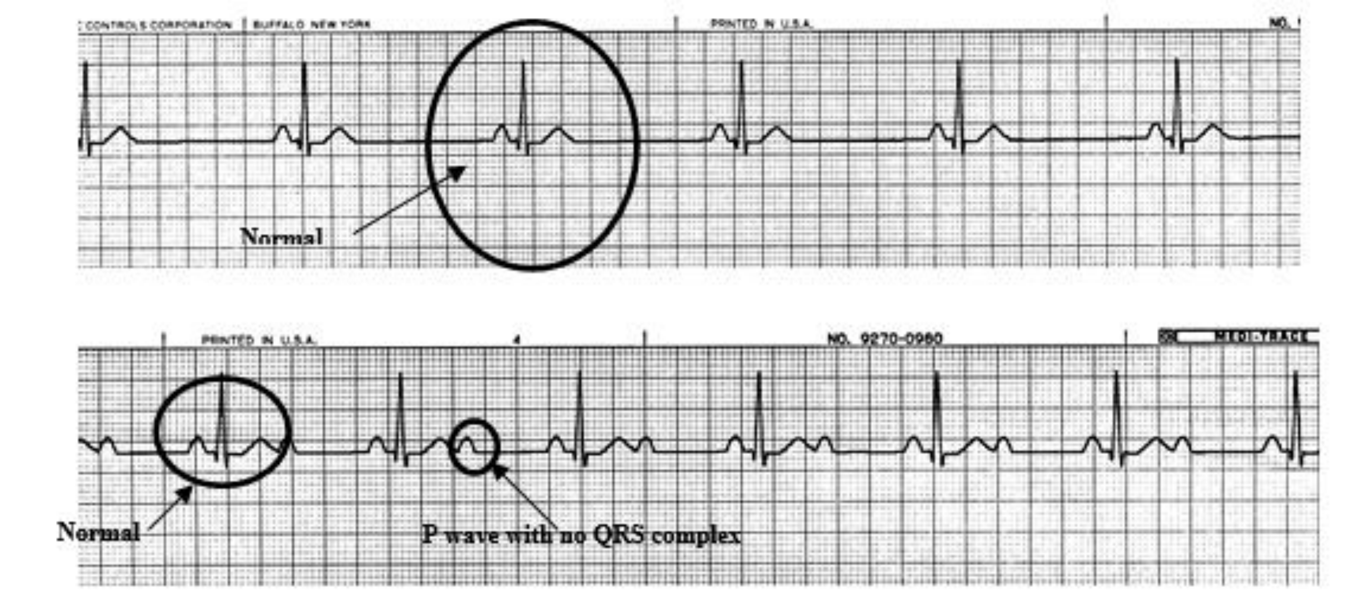


Steps for Interpretation

Step 5. Ratio

- Is there one P wave for each QRS complex (1:1 ratio) or is there more than one? (2:1, 3:1 etc.)
- There are no P waves and therefore ratio does not apply?
  - P waves with no corresponding QRS or QRS with no associated P wave signals a heart block or ectopic beat
  - Tachy rhythms may "lose" the P wave in the preceding T wave

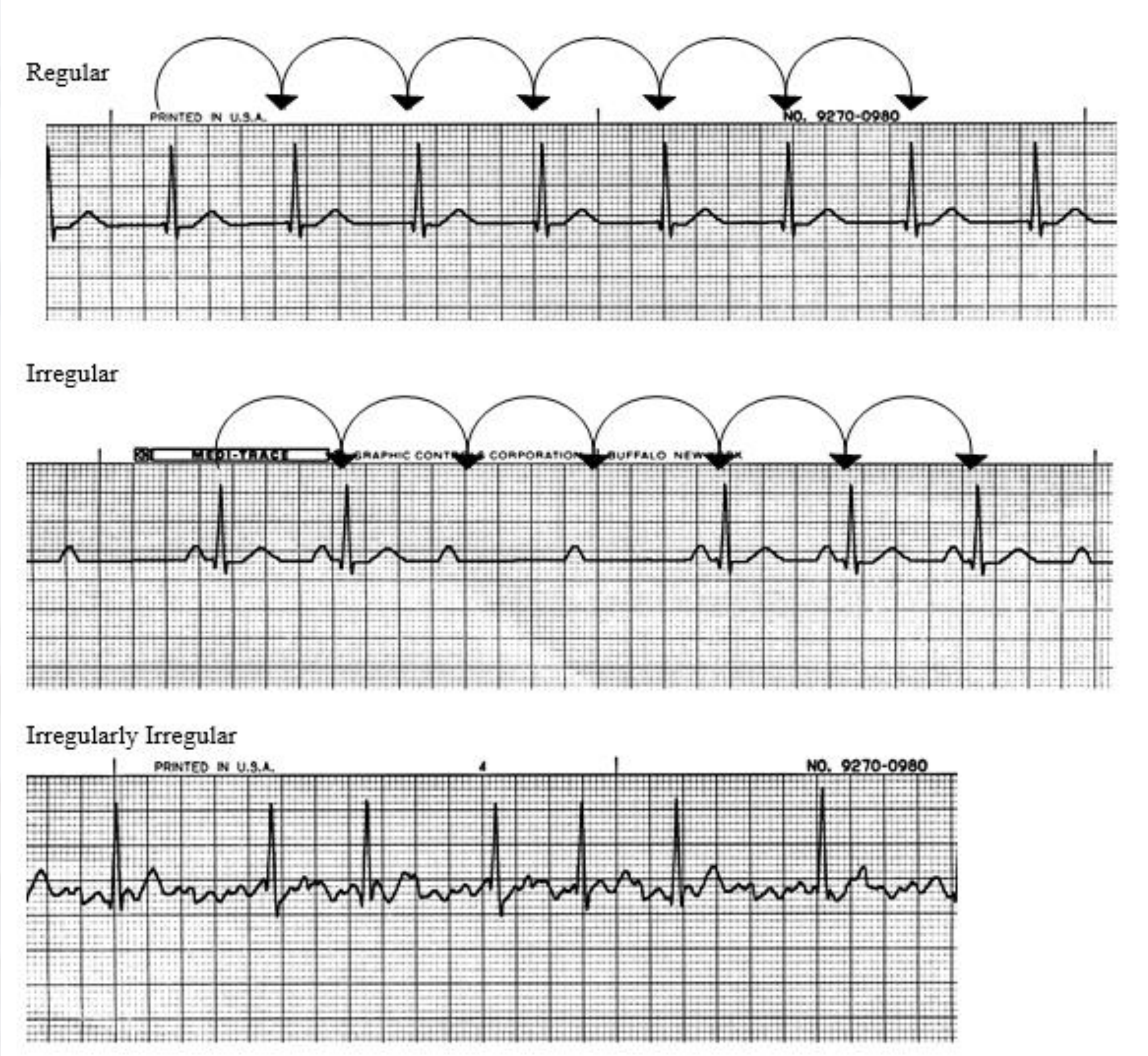
SA node is firing, but not travelling to the ventricles.CC



Steps for Interpretation

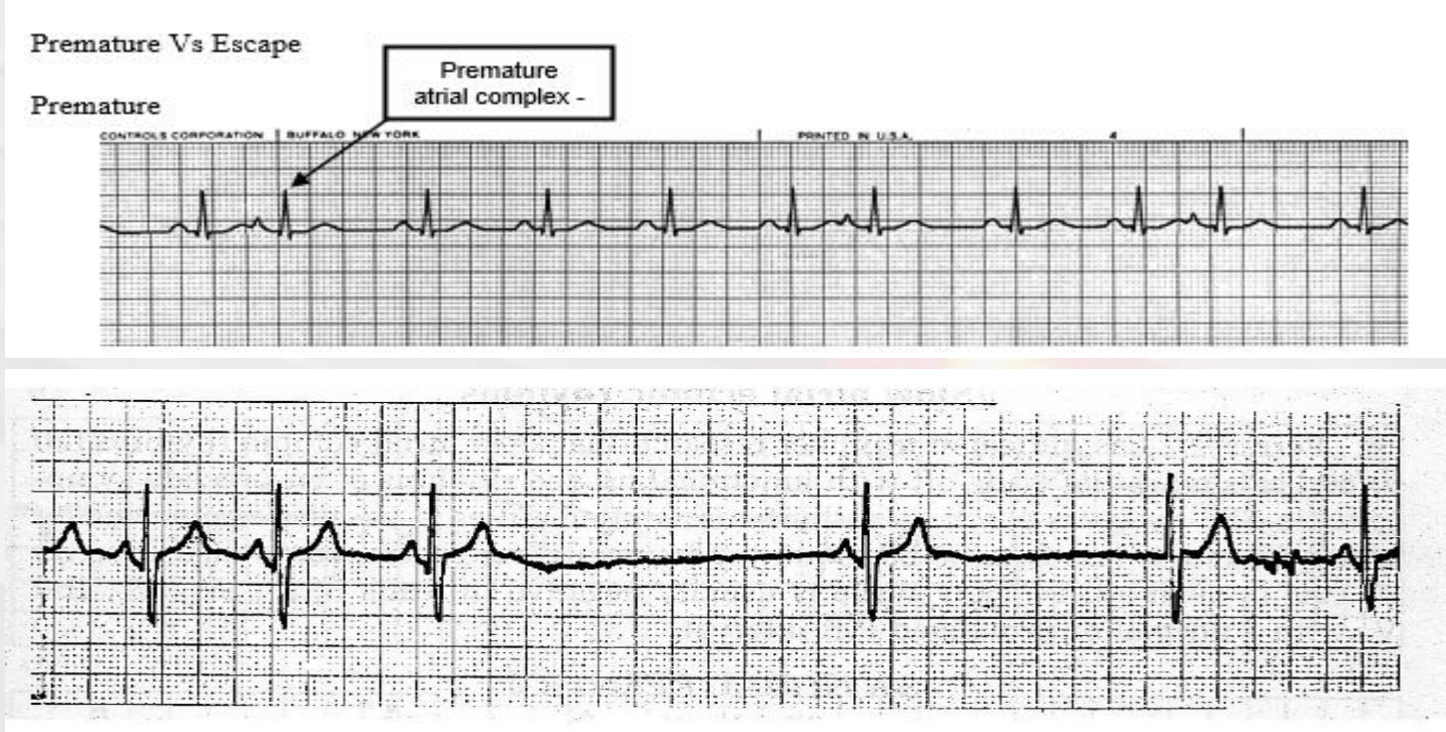
Step 6. Rhythm

- Is it regular? Irregular, regularly irregular



Steps for Interpretation

- Step 7. Missing or Added Beats>
  - This is an unofficial step that can help with the over all interpretation
  - Premature beats (come before expected) or escape beats (come after expected)

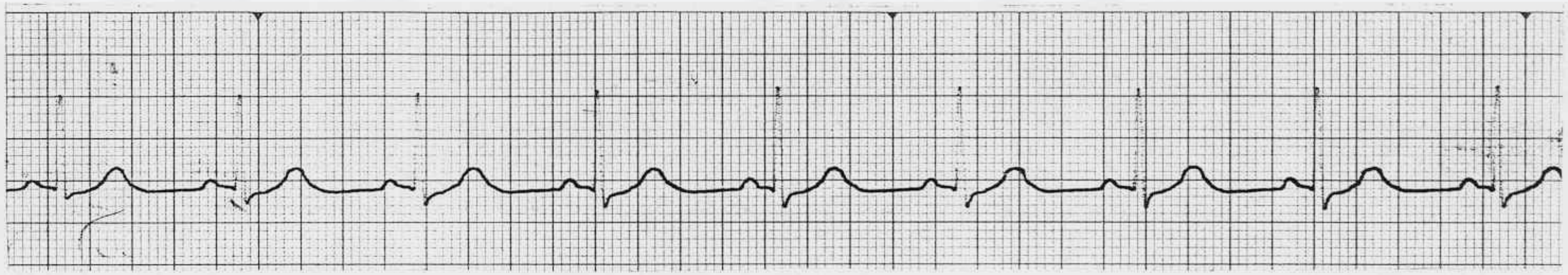


Steps for Interpretation

- Once you have answered all the previous questions you can put it all together
- Underlying rhythm, rate, any disturbances
  - Normal sinus rhythm, 82 beats/min with PAC’s

She wants this interpretation strucure:
Rythm name, rythm rate, followed by ratio

Normal Sinus Rhythm (NSR)

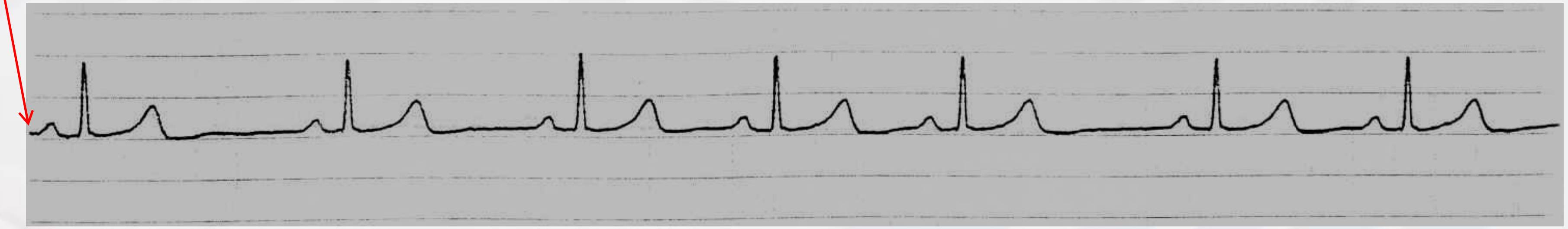


- Rate: Heart rate is between 60 - 99
- P waves: Are present and upright in leads I, II and III
- PR: Normal, i.e. ≤ 0.20 second
- QRS: Is *usually* narrow, i.e. < 0.12 second
- Ratio: 1:1
- Rhythm: Regular

Sinus Arrhythmia

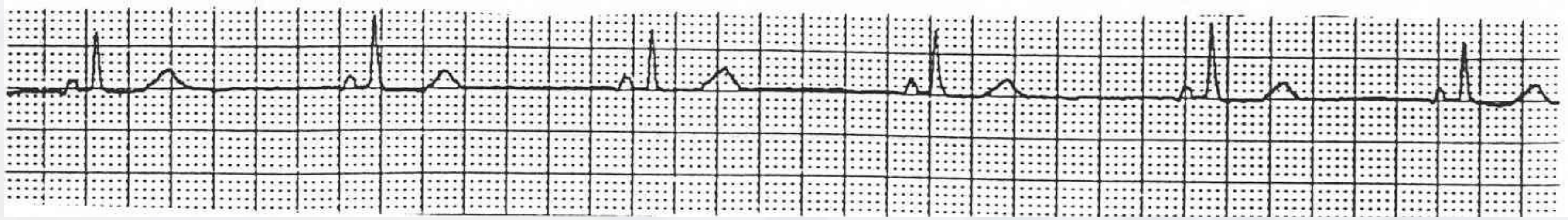
P waves normal, so it's originating from SA node

This is based on breathing pattern, speeding up during inhalation, slowing down during exhalation. Normal pattern, more obvious in kids (due to sensitive vagus nerve



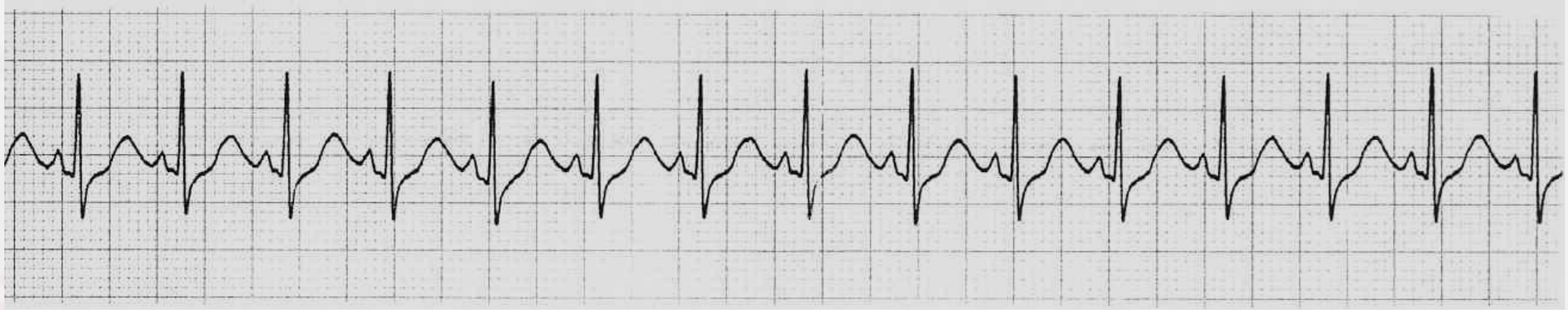
- Within normal range and sometimes below rates of 60 *The rate increases slightly with inspiration and slows with expiration*
- ✓ P waves: Normal
- ✓ PR: Normal. < 0.20 second
- ✓ QRS: Usually narrow. < 0.12 second
- ✓ Ratio: 1:1
- ✓ Rhythm: *Regularly irregular.* Rhythm coincides with breathing pattern

Sinus Bradycardia



- Rate: *Less than 60*
- P waves: Normal
- PR: Normal. $\leq$ 0.20 second
- QRS: Usually narrow
- Ratio: 1:1
- Rhythm: Regular

Sinus Tachycardia



- Rate: *100 or greater*. In adults, rates higher than 160 are rarely sinus in origin
- P waves: Normal
- PR: Normal
- QRS: Usually narrow
- Ratio: 1:1
- Rhythm: Regular

Questions???

References

- Cardiac Muscle and Electrical Activity – Anatomy and Physiology (opentextbc.ca)
- Clinical electrocardiography and ECG interpretation – ECG & ECHO (ecgwaves.com)
- Theriault, R. (2016). Cardiac Dysrhythmia Interpretation (PowerPoint slides).