

# Beginning 12 Lead ECG Workshop



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California Association of Nurse Practitioners

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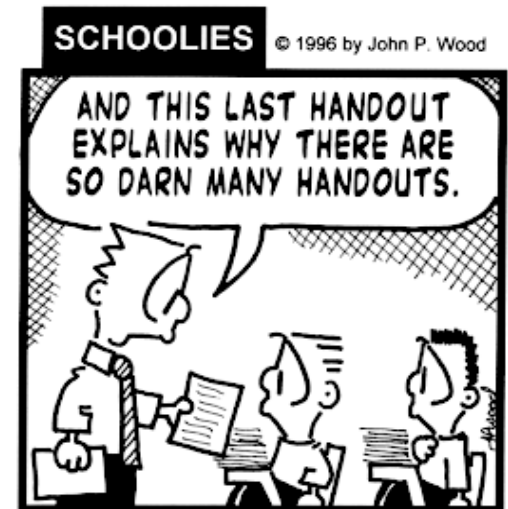
# Learning Objectives

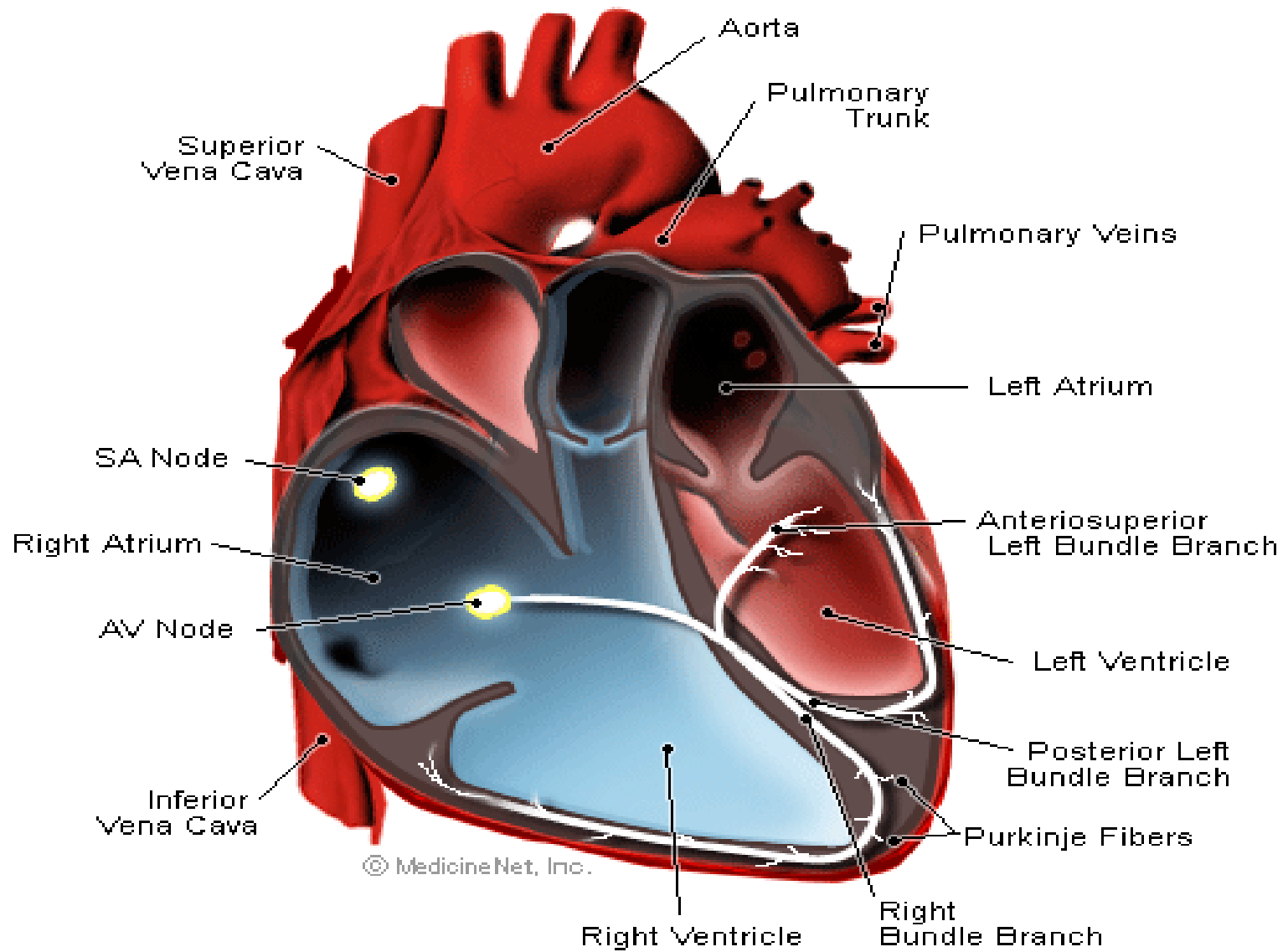


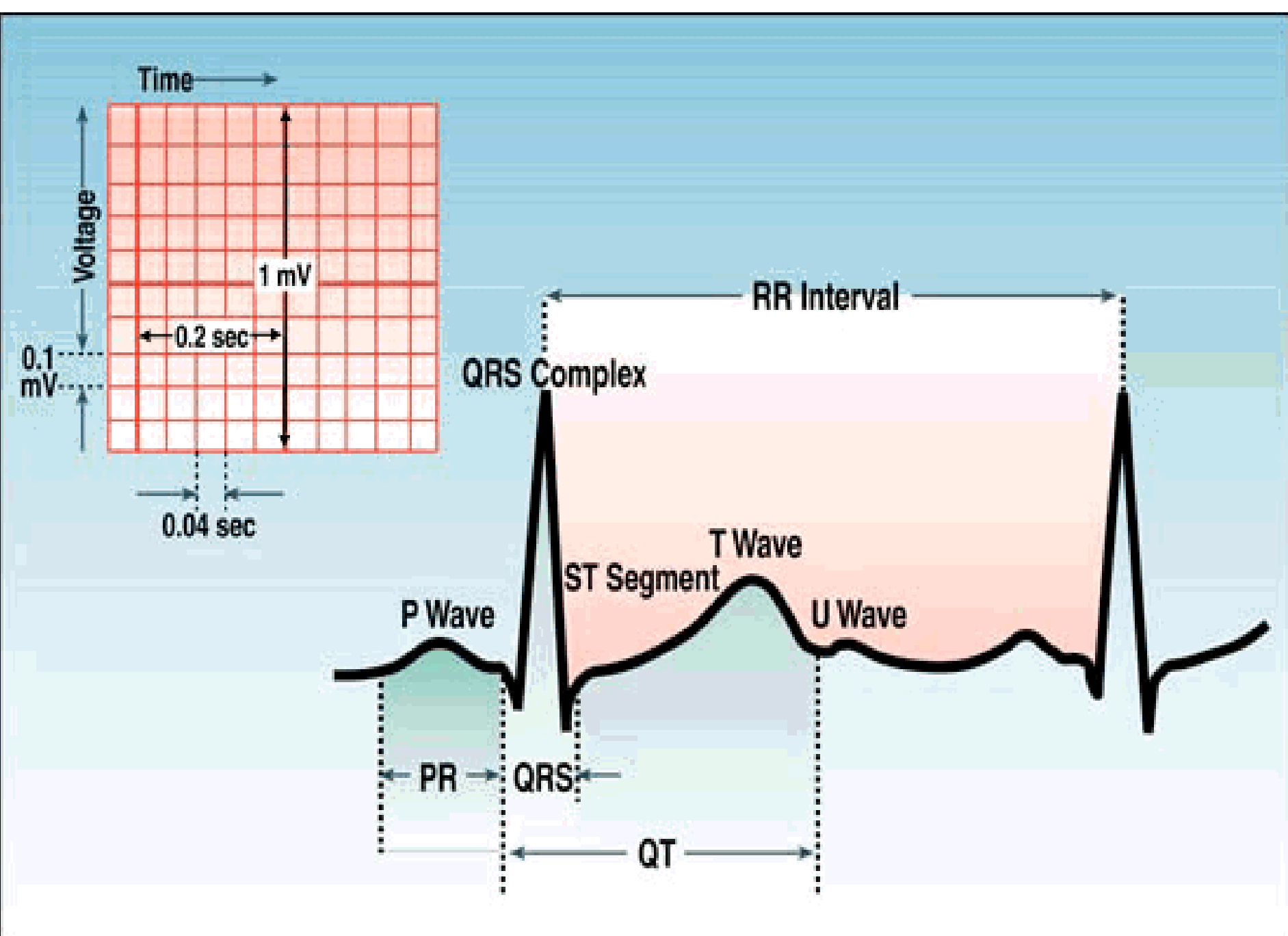
- Explain the purpose of a 12 lead ECG
- Identify the importance of proper lead placement and what the leads represent
- Identify axis deviation
- Recognize the wide variation in normal ECGs and how medications such as beta blockers and calcium channel blockers may influence the ECG

# In This Handout.....

- Color Coded Map of What Leads See
- Review of components of waveforms
- Summary of 12 Lead ECG Features
- 12 Lead ECGs







23-JAN-1963 (47 yr)

Male  
Room: ER16  
Loc: 201

Vent. rate 61 BPM  
PR interval 136 ms  
QRS duration 98 ms  
QT/QTc 390/392 ms  
P-R-T axes 46 74 36

\*\*\*age and gender specific ECG analysis\*\*\*

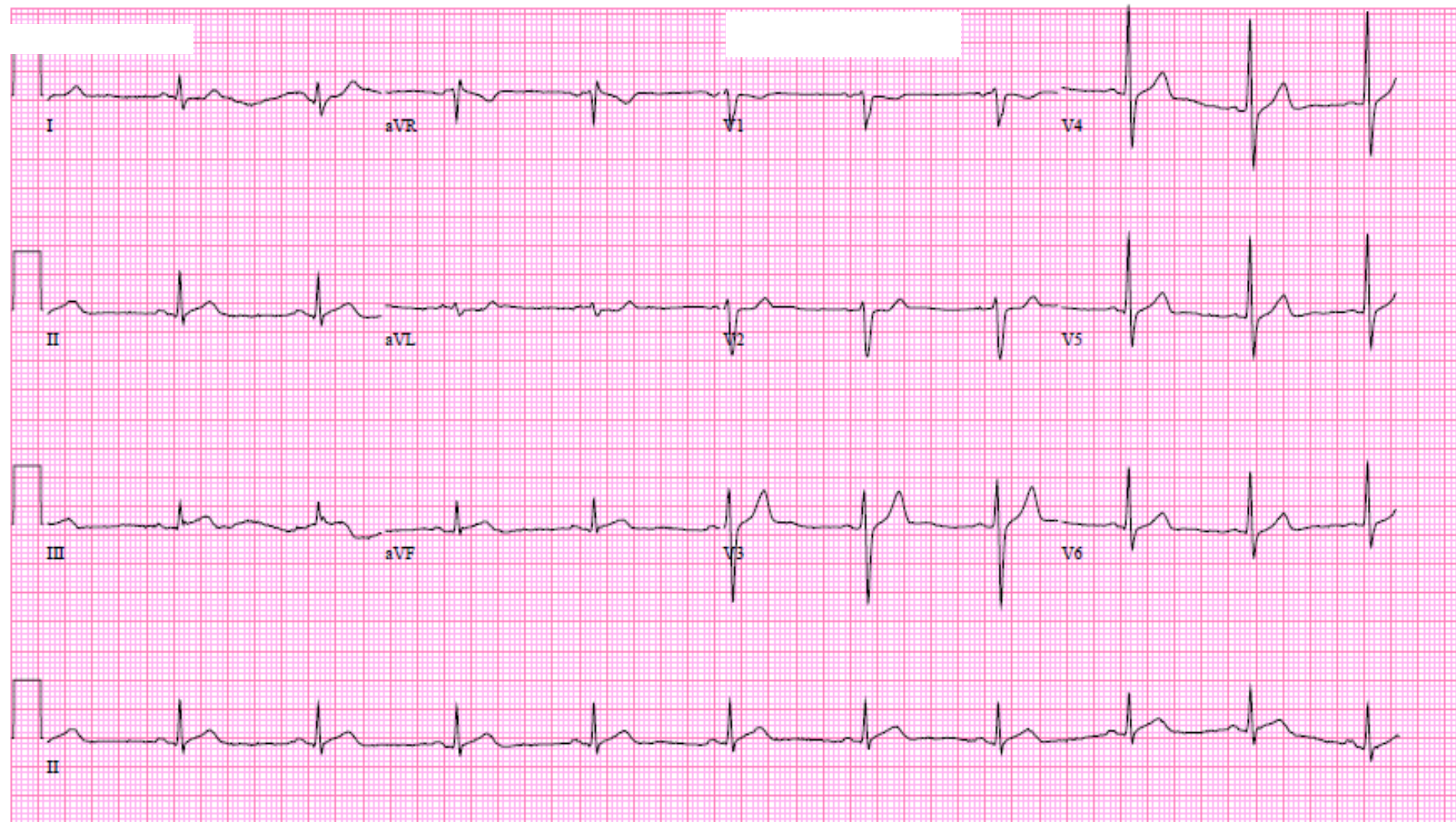
Normal sinus rhythm  
Normal ECG

Technician: BILL PORTER-ERT  
Test ind: STEMI

Referred by: DR ROSENGREEN  
NOTIFIED W: ROSENGREEN

Unconfirmed  
NOTIFIED T:

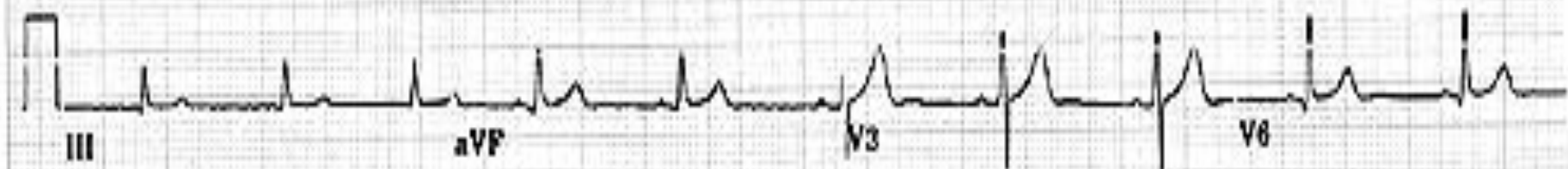
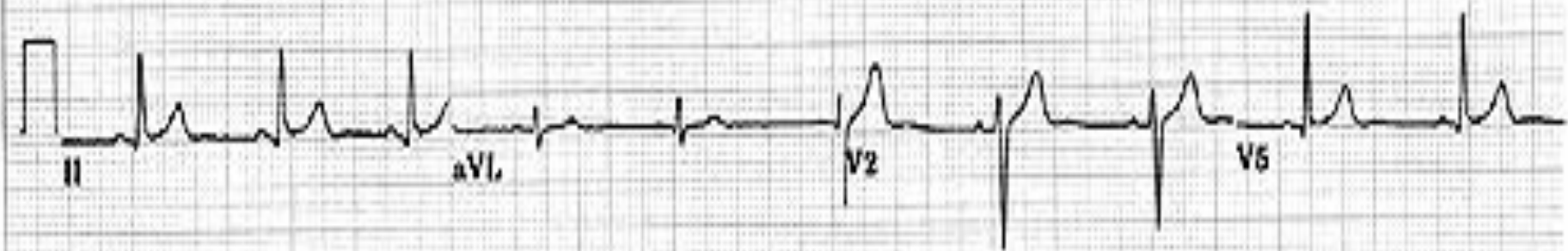
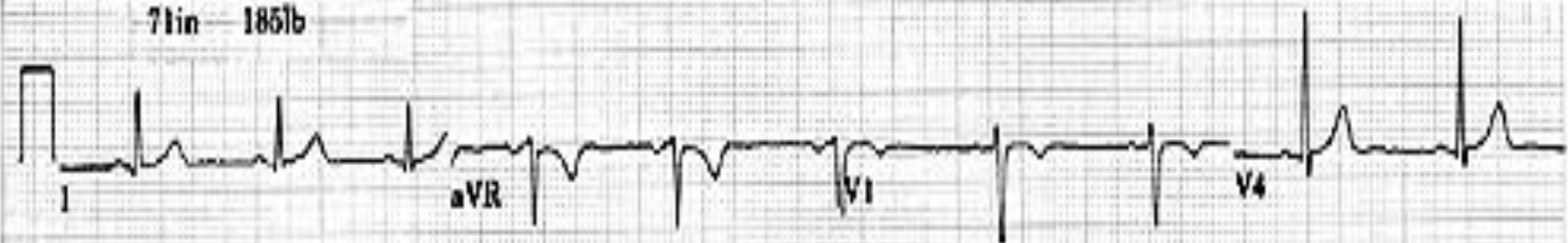
ACCOUNT #: 44849362



08-NOV-1970 (25 yr)

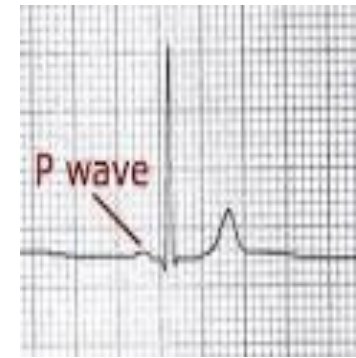
Male Caucasian

71in 185lb



11-MAR-1996 17:05

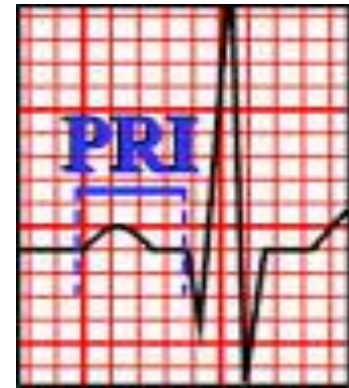
# P Wave



- Electrical
  - Atrial Depolarization- right and left sequential activation
- Mechanical
  - Blood is ejected from the atria through the Tricuspid Valve (RA) and the Mitral Valve (LA)
- Normally upright in I, II, aVF, V4-V6
- Duration < 0.12 seconds
- Amplitude < 2.5 mm
- May see notched or biphasic P waves in frontal plane

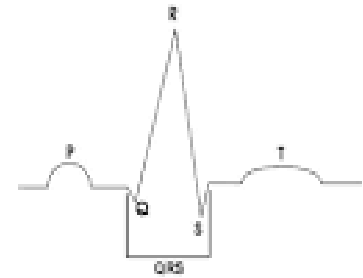


# PR Interval



- Electrical
  - The time it takes for the energy to spread through the atria and pass through the AV junction
- Mechanical
  - Ventricular filling time
- Normally .12-.20 seconds, isoelectric and consistent
- When longer than .20 seconds or not consistent, think about 1<sup>st</sup>, 2<sup>nd</sup> or 3<sup>rd</sup> degree AV blocks
  - Review medications (e.g. beta blockers, digoxin, calcium channel blockers)

# QRS Complex



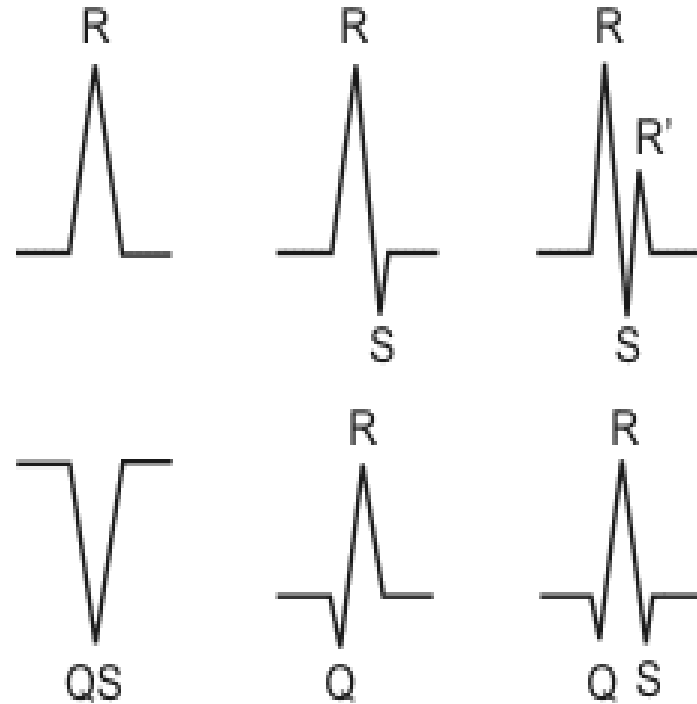
- Electrical
  - Ventricular depolarization- simultaneous activation of both
  - Energy passing through the Bundle of His, down Bundle Branches and out through Purkinje Fibers
- Mechanical
  - Blood is ejected out of the ventricles, through the semi lunar valves (Pulmonary RV and Aortic LV)
- Normally .06-.10 seconds
- Small, narrow Q wave in I, aVL, aVF, V5 and V6 normal

# QRS Complex

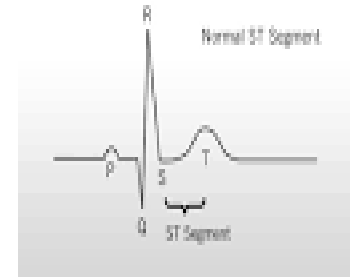
**Q WAVE**: The first negative deflection following the P wave, before the R wave.

**R WAVE**: first positive deflection following the P wave. A second positive deflection is R prime (R').

**S WAVE**: The second negative deflection following the P wave, or the first negative deflection after the R wave.

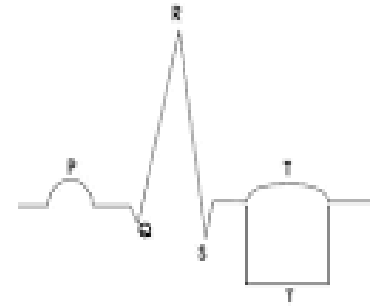


# ST Segment



- Electrical
  - Beginning of ventricular repolarization
  - Usually flat on the tracing
  - Refractory period for cells
- Mechanical
  - Passive filling of ventricle

# T wave



- Electrical
  - Part of the repolarization of the ventricles
  - Usually a positive deflection
  - Asymmetrical tent shape
- Mechanical
  - Passive refilling of the ventricles

# QT Interval



- Measured from onset of QRS complex to end of T wave: includes ventricular depolarization and repolarization
- Rule of thumb: QT is 1/2 of the preceding R-R for NSR
- QT interval length depends on rate, physiology and medications: normal is generally .36-.44
- QTc = QT Corrected
  - Males > .45 seconds is abnormal
  - Females > .47 seconds is abnormal
- If long, think about QT prolonging medications!

# COMBINED LIST OF DRUGS THAT PROLONG QT AND/OR CAUSE TORSADES DE POINTES (TDP)



Crediblemeds.org is your trusted partner providing reliable information on medicines. This is a composite list of drugs that CredibleMeds has concluded either 1) have a risk of TdP 2) prolong QT and therefore have a possible risk of TdP or 3) have a risk of TdP under certain conditions such as overdose, drugdrug interactions or when administered to certain high-risk individuals (e.g. congenital long QT syndrome).

Generic Name	Brand Name
Alfuzosin	Uroxatral®
Amantadine	Symmetrel® and others
Amiodarone	Cordarone® and others
Amisulpride	Solian® and others
Amitriptyline	Elavil® (Discontinued 6/13) and others
Amoxapine	Asenden® and others
Anagrelide	Agrylin® and others
Apomorphine	Apokyn® and others
Aripiprazole	Abilify® and others
Arsenic trioxide	Trisenox®
Astemizole (Off US mkt)	Hismanal®
Atazanavir	Reyataz®
Azithromycin	Zithromax® and others
Bedaquiline	Sirturo®
Bepidil (Off US mkt)	Vascor®
Bortezomib	Velcade® and others
Bosutinib	Bosulif®
Chloral hydrate	Aquachloral® and others
Chloroquine	Aralen®
Chlorpromazine	Thorazine® and others
Ciprofloxacin	Cipro® and others
Cisapride (Off US mkt)	Propulsid®
Citalopram	Celexa® and others
Clarithromycin	Biaxin® and others
Clomipramine	Anafranil®
Clozapine	Clozaril® and others
Cocaine	Cocaine
Crizotinib	Xalkori®
Dabrafenib	Tafinlar®
Dasatinib	Sprycel®

Generic Name	Brand Name
Desipramine	Pertofrane® and others
Dexmedetomidine	Precedex® and others
Dihydroartemisinin+piperaquine	Eurartesim®
Diphenhydramine	Benadryl® and others
Disopyramide	Norpace®
Dofetilide	Tikosyn®
Dolasetron	Anzemet®
Domperidone (Not on US mkt)	Motilium® and others
Doxepin	Sinequan® and others
Dronedarone	Multaq®
Droperidol	Inapsine® and others
Eribulin	Halaven®
Erythromycin	E.E.S.® and others
Escitalopram	Cipraxel® and others
Famotidine	Pepcid® and others
Felbamate	Felbatol®
Fingolimod	Gilenya®
Flecainide	Tambocor® and others
Fluconazole	Diflucan® and others
Fluoxetine	Prozac® and others
Foscarnet	Foscavir®
Fosphenytoin	Cerebyx® and others
Furosemide (Frusemide)	Lasix® and others
Galantamine	Reminyl® and others
Gatifloxacin (Off US mkt)	Tequin®
Gemifloxacin	Factive®
Granisetron	Kytril® and others
Halofantrine	Halfan®
Haloperidol	Haldol® (US & UK) and others
Hydrochlorothiazide	Apo-Hydro® and others

Generic Name	Brand Name
Ibutilide	Corvert®
lloperidone	Fanapt® and others
Imipramine (mepipramine)	Tofranil®
Indapamide	Lozol® and others
Isradipine	Dynacirc®
Itraconazole	Sporanox® and others
Ivabradine (Not on US mkt)	Procoralan® and others
Ketoconazole	Nizoral® and others
Lapatinib	Tykerb® and others
Levofloxacin	Levaquin® and others
Levomethadyl (Off US mkt)	Orlaam®
Lithium	Eskalith® and others
Mesoridazine (Off US mkt)	Serentil®
Methadone	Dolophine® and others
Metronidazole	Flagyl® and many others
Mifepristone	Korlym® and others
Mirabegron	Myrbetriq®
Mirtazapine	Remeron
Moexipril/HCTZ	Uniretic® and others
Moxifloxacin	Avelox® and others
Nelfinavir	Viracept®
Nicardipine	Cardene®
Nilotinib	Tasigna®
Norfloxacin	Noroxin® and others
Nortriptyline	Pamelor® and others
Ofloxacin	Floxin®
Olanzapine	Zyprexa® and others
Ondansetron	Zofran® and others
Oxytocin	Pitocin® and others
Paliperidone	Invega® and others

# COMBINED LIST OF DRUGS THAT PROLONG QT AND/C



Crediblemeds.org is your trusted source for information on drugs that 1) prolong QT and 2) prolong QT and therefore have certain conditions such as overcertain high-risk individuals (e.g

Generic Name	Brand Name
Paroxetine	Paxil® and others
Pasireotide	Signifor®
Pazopanib	Votrient®
Pentamidine	Pentam®
Perflutren lipid microspheres	Definity®
Pimozide	Orap®
Pipamperone (Not on US Mkt)	Dipiperon (E.U) and others
Posaconazole	Noxafil® and others
Probucool (Off US mkt)	Lorelool®
Procainamide (Oral off US mkt)	Pronesty® and others
Promethazine	Phenergan®
Protriptyline	Vivactil®
Quetiapine	Seroquel®
Quinidine	Quinaglute® and others
Quinine sulfate	Qualaquin®
Ranolazine	Ranexa® and others
Rilpivirine	Edurant® and others
Risperidone	Risperdal®
Ritonavir	Norvir®
Roxithromycin (Not on US Mkt)	Rulide® and others
Saquinavir	Invirase®(combo)
Sertindole (Not on US mkt)	Serdolect® and others
Sertraline	Zoloft® and others
Sevoflurane	Ulane® and others
Solifenacin	VESIcare®

Generic Name	Brand Name
Sorafenib	Nexavar®
Sotalol	Betapace® and others
Sparfloxacin (Off US mkt)	Zagam®
Sulpiride (Not on US Mkt.)	Dogmatil® and others
Sunitinib	Sutent®
Tacrolimus	Prograf® and others
Tamoxifen	Nolvadex®(discontinued 6/13) and others
Telaprevir	Incivek® and others
Telavancin	Vibativ®
Telithromycin	Ketek®
Terfenadine (Off US mkt)	Seldane®
Tetrabenazine (Orphan drug in US)	Nitoman® and others
Thioridazine	Mellaril® and others
Tizanidine	Zanaflex® and others
Tolterodine	Detrol® and others
Toremifene	Fareston®
Trazodone	Desyre® (discontinued 6/13) and others
Trimethoprim-Sulfa	Sepra® and others
Trimipramine	Sumontil® and others
Vandetanib	Caprelsa®
Vardenafil	Levitra®
Vemurafenib	Zelboraf®
Venlafaxine	Effexor® and others
Voriconazole	VFend®
Vorinostat	Zolinza®
Ziprasidone	Geodon® and others



# Why Take a 12-LEAD ECG?

- Gold standard for the diagnosis of arrhythmias
- Guides therapy and risk stratification for patients with suspected myocardial infarction
- Helps detect electrolyte disturbances (e.g. hyperkalemia and hypokalemia)
- Allows for the detection of conduction abnormalities (e.g. right and left bundle branch block)
- Used as a screening tool for ischemic heart disease during a cardiac stress test
- Occasionally helpful with non-cardiac diseases (e.g. pulmonary embolism or hypothermia)

ASSESSMENT	LOOK AT	LOOK FOR
<b>Context</b>	Patient, Chart	<ul style="list-style-type: none"> <li>Clinical condition</li> <li>Changes over time</li> </ul>
<b>Rhythm and Rate</b>	Rhythm Strip (Lead II)	<ul style="list-style-type: none"> <li>Arrhythmias</li> <li>Threats to perfusion</li> </ul>
<b>Ischemia/Infarction</b>	All Leads <ul style="list-style-type: none"> <li>V<sub>1</sub>-V<sub>4</sub> (anterior)</li> <li>V<sub>5</sub>-V<sub>6</sub>, aVL, I (lateral)</li> <li>II, III, aVF (inferior)</li> </ul>	<ul style="list-style-type: none"> <li>ST changes</li> <li>T wave changes</li> <li>Q waves</li> <li>Loss of R waves</li> </ul>
<b>Axis</b>	Leads I and aVF	<ul style="list-style-type: none"> <li>QRS upright in I and aVF (normal axis)</li> <li>QRS up in I, down in aVF (LAD)</li> <li>QRS down in I, up in aVF (RAD)</li> <li>QRS down in I and aVF (ERAD)</li> </ul>
<b>Chamber Enlargement</b>	Atrial Enlargement V <sub>1</sub> —	<i>Diphasic P:</i> <ul style="list-style-type: none"> <li>Initial deflection is larger (RAE)</li> <li>Terminal deflection is larger (LAE)</li> </ul>
	II—	<i>Unusual P Morphology:</i> <ul style="list-style-type: none"> <li>Tall, peaked P wave (RAE)</li> <li>Notched P wave (LAE)</li> </ul>
	Ventricular Enlargement V <sub>1</sub> —	<i>High-Amplitude QRS Complexes:</i> <ul style="list-style-type: none"> <li>R wave longer than S (RVE)</li> <li>Extremely deep S (LVE)</li> </ul>
	V <sub>6</sub> —	<ul style="list-style-type: none"> <li>S wave larger than R (RVE)</li> <li>Extremely tall R (LVE)</li> </ul>
<b>Intraventricular Conduction Defects</b>	V <sub>1</sub> —	<i>Wide QRS:</i> <ul style="list-style-type: none"> <li>Notched R wave (RBBB)</li> <li>Deep, slurred S wave (LBBB)</li> </ul>
	V <sub>6</sub> —	<ul style="list-style-type: none"> <li>Broad S wave (RBBB)</li> <li>Broad notched R wave (LBBB)</li> </ul>
<b>Miscellaneous Abnormalities</b> • Hyperkalemia	All Leads	<ul style="list-style-type: none"> <li>Tall, peaked T waves</li> <li>Wide, flat P waves</li> <li>Widening of QRS</li> <li>Disappearing ST segment</li> <li>Merging QRS and T</li> </ul>
• Hypokalemia	All Leads	<ul style="list-style-type: none"> <li>Flat T waves</li> <li>Increasingly prominent U waves</li> </ul>
• Hypercalcemia	All Leads	<ul style="list-style-type: none"> <li>Prolonged QT interval (for rate)</li> </ul>
• Hypocalcemia	All Leads	<ul style="list-style-type: none"> <li>Short QT interval (for rate)</li> </ul>
• Digitalis Toxicity	All Leads	<ul style="list-style-type: none"> <li>Sloping ST segment</li> <li>ST depression</li> <li>Diphasic or inverted T wave</li> <li>Short QT interval</li> </ul>
• Pericarditis	All Leads	<ul style="list-style-type: none"> <li>Elevated, concave ST segment</li> <li>Diffuse ST changes not correlated to coronary vessels</li> </ul>

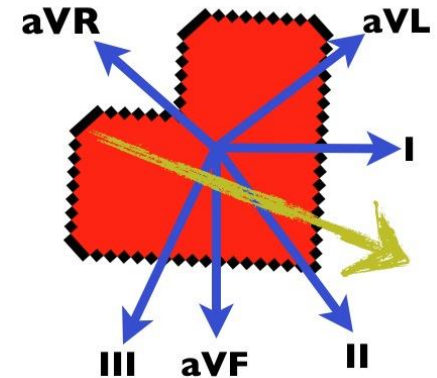
# What Does Each Lead “See”?

I Lateral	aVR	V1 Septal	V4 Anterior
II Inferior	aVL Lateral	V2 Septal	V5 Lateral
III Inferior	aVF Inferior	V3 Anterior	V6 Lateral

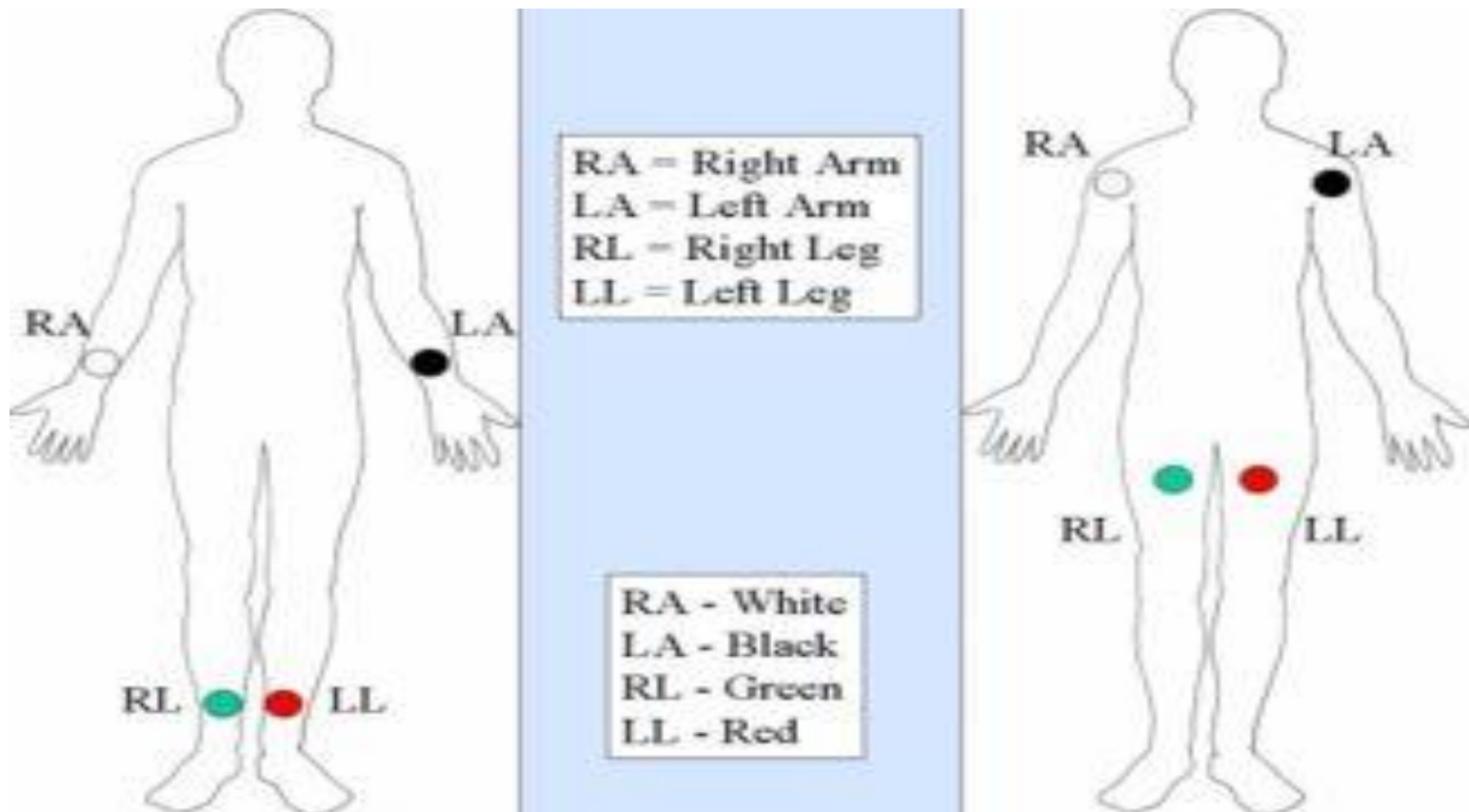
<http://www.ivline.org/2010/05/quick-guide-to-ecg.html>

# 12-LEAD ECG

- There are only 10 electrodes that take 12 pictures of the heart!
  - 4 LIMB LEADS WHICH CREATE 6 PICTURES
    - I, II, III
    - aVR, aVL, aVF
  - 6 CHEST LEADS WHICH CREATE 6 PICTURES
    - V1-V6

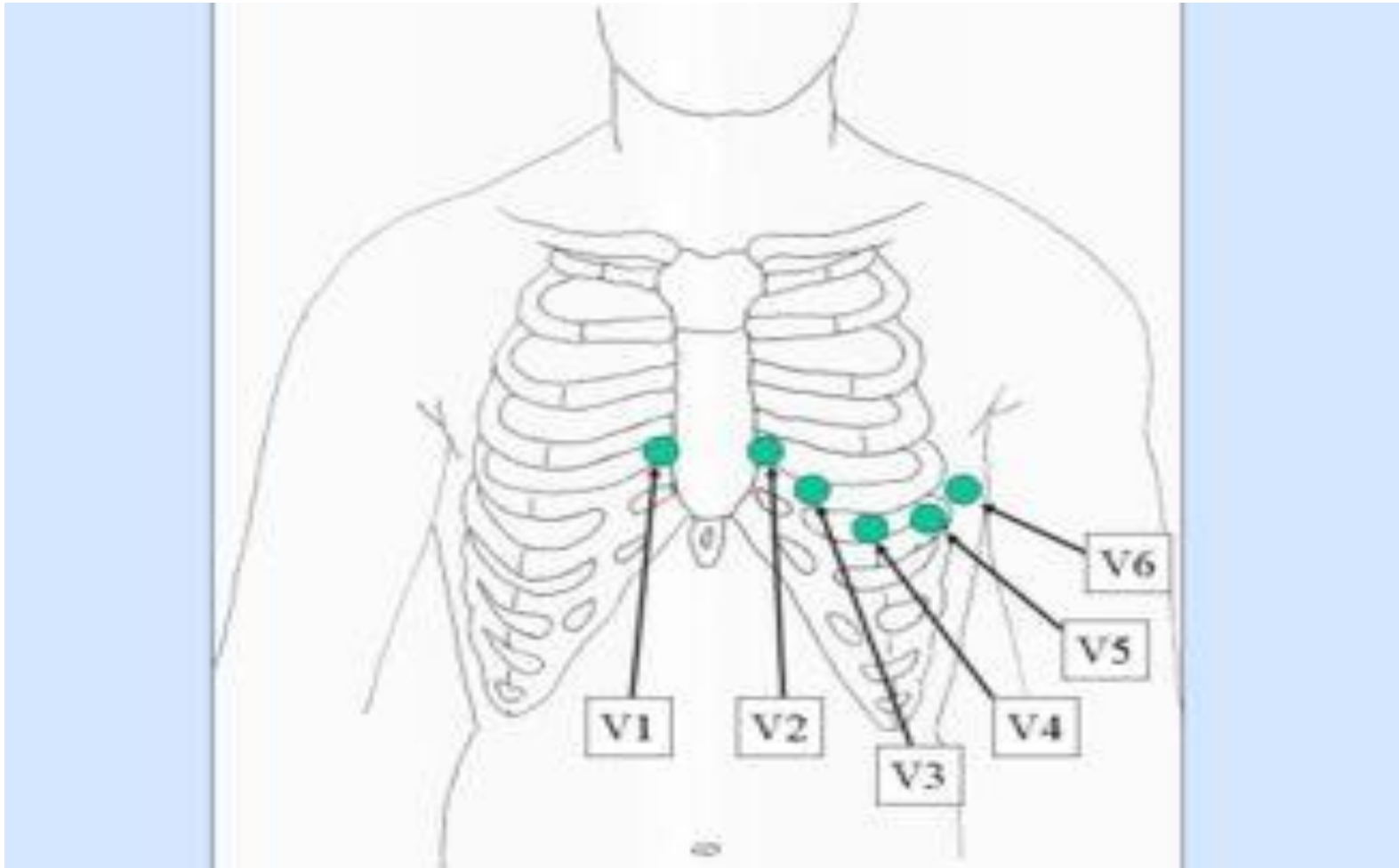


# 12-Lead ECG- Limb Lead Placement



***WHITE TO THE RIGHT, SMOKE OVER FIRE! GREEN IS GROUND.***

# 12-Lead ECG: Chest Lead Placement

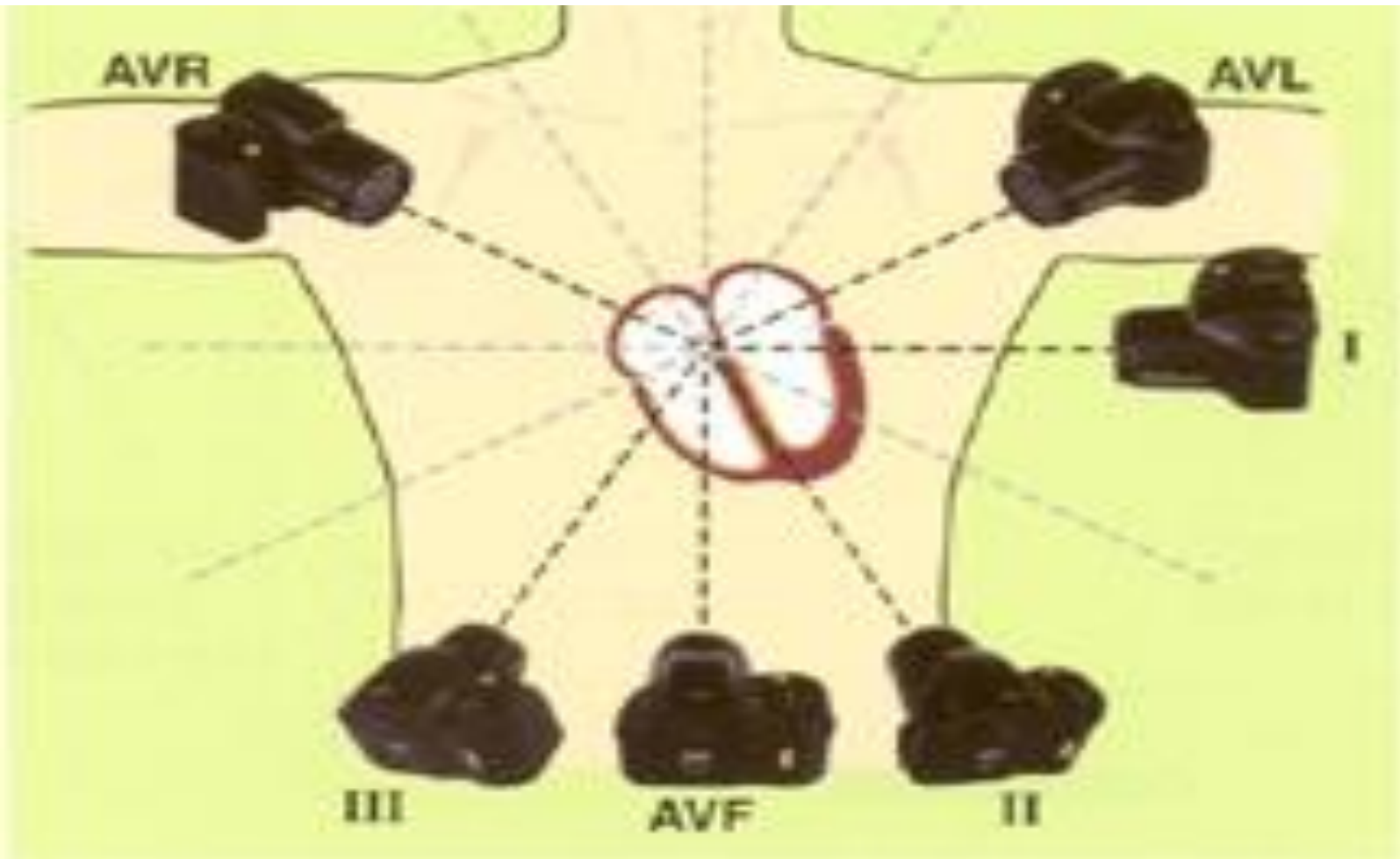


# 12-Lead ECG: Chest Lead Placement

**The electrodes for the chest leads MUST go in the standard positions:**

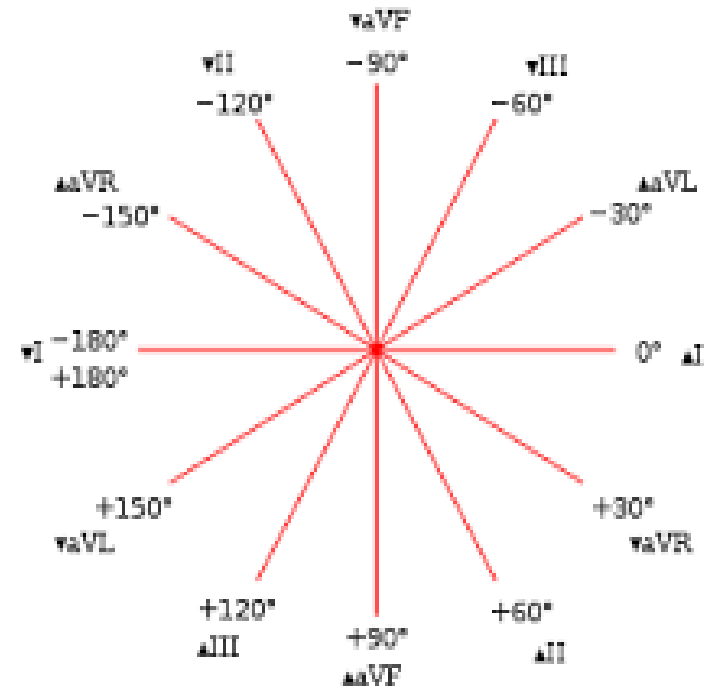
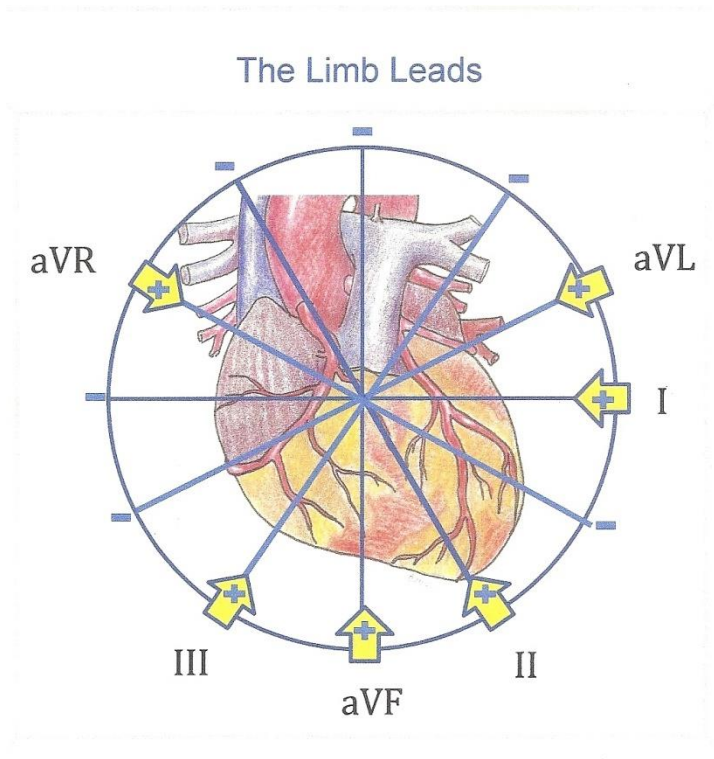
- V1 - Fourth intercostal space, right sternal border.
- V2 - Fourth intercostal space, left sternal border.
- V3 - Midway between V2 and V4.
- V4 - Fifth intercostal space, left midclavicular line.
- V5 - Level with V4, left anterior axillary line.
- V6 - Level with V4, left mid axillary line.

# Bipolar and Augmented Leads

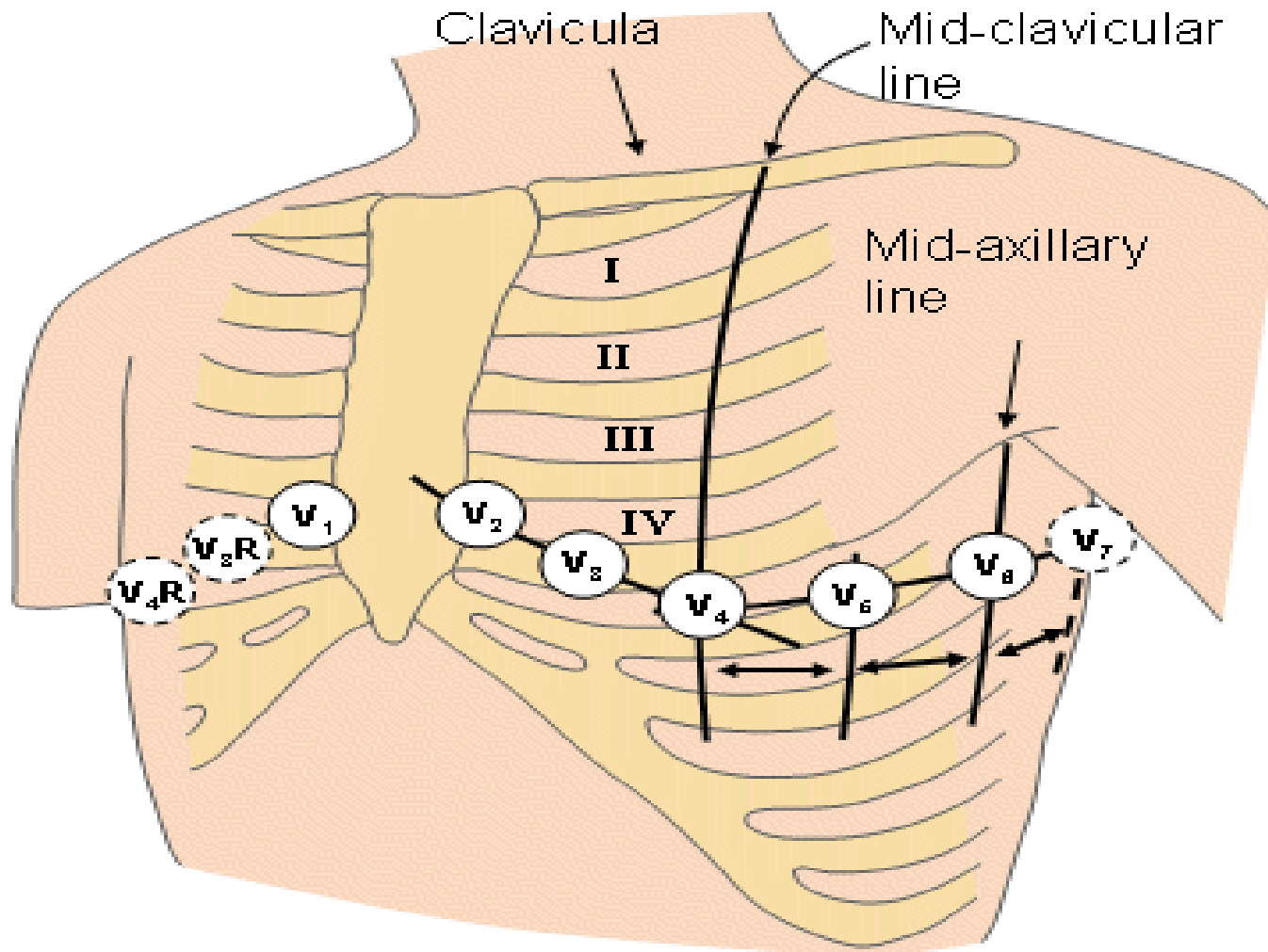




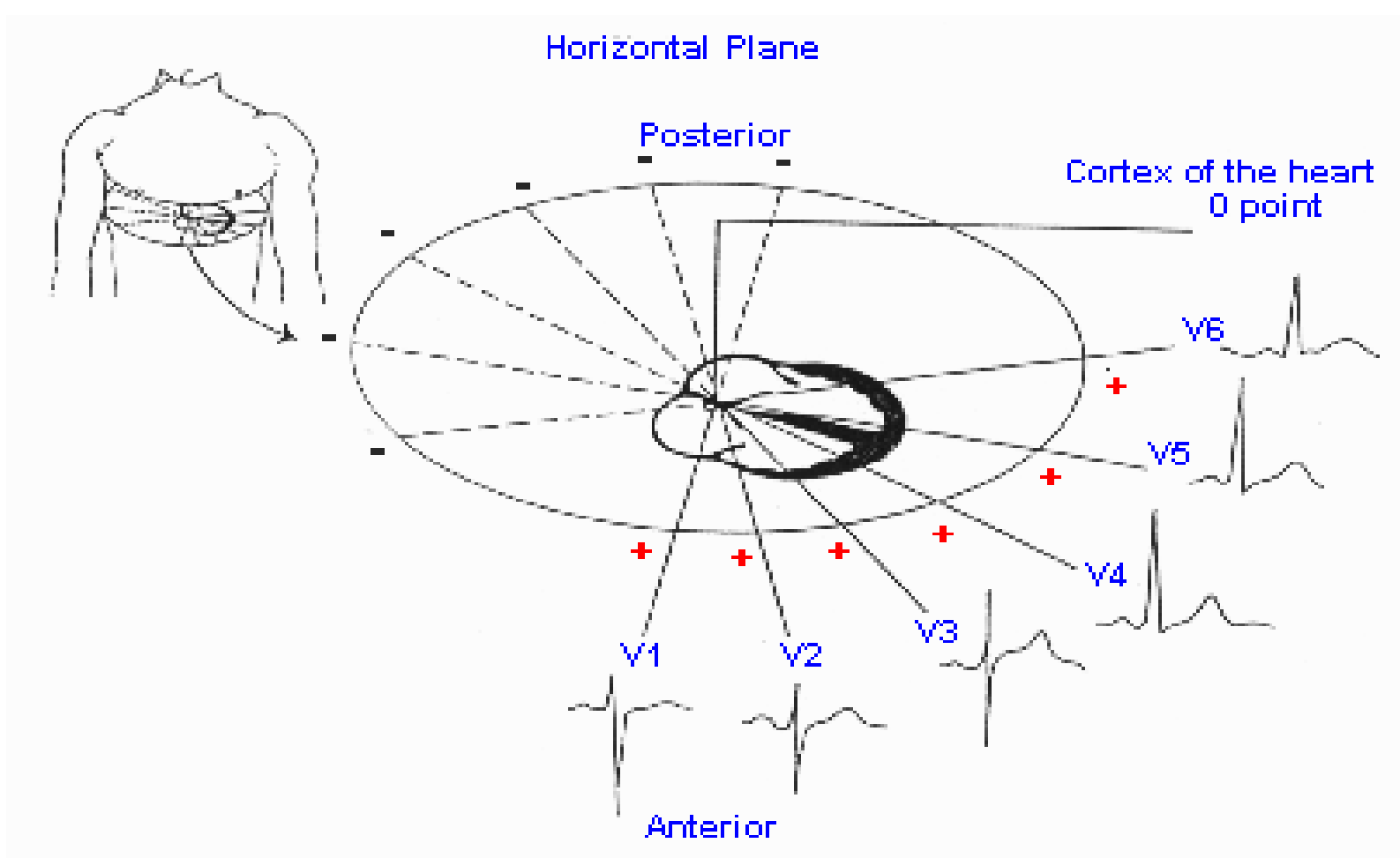
# Frontal Plane- Hexaxial Diagram



# Horizontal Plane



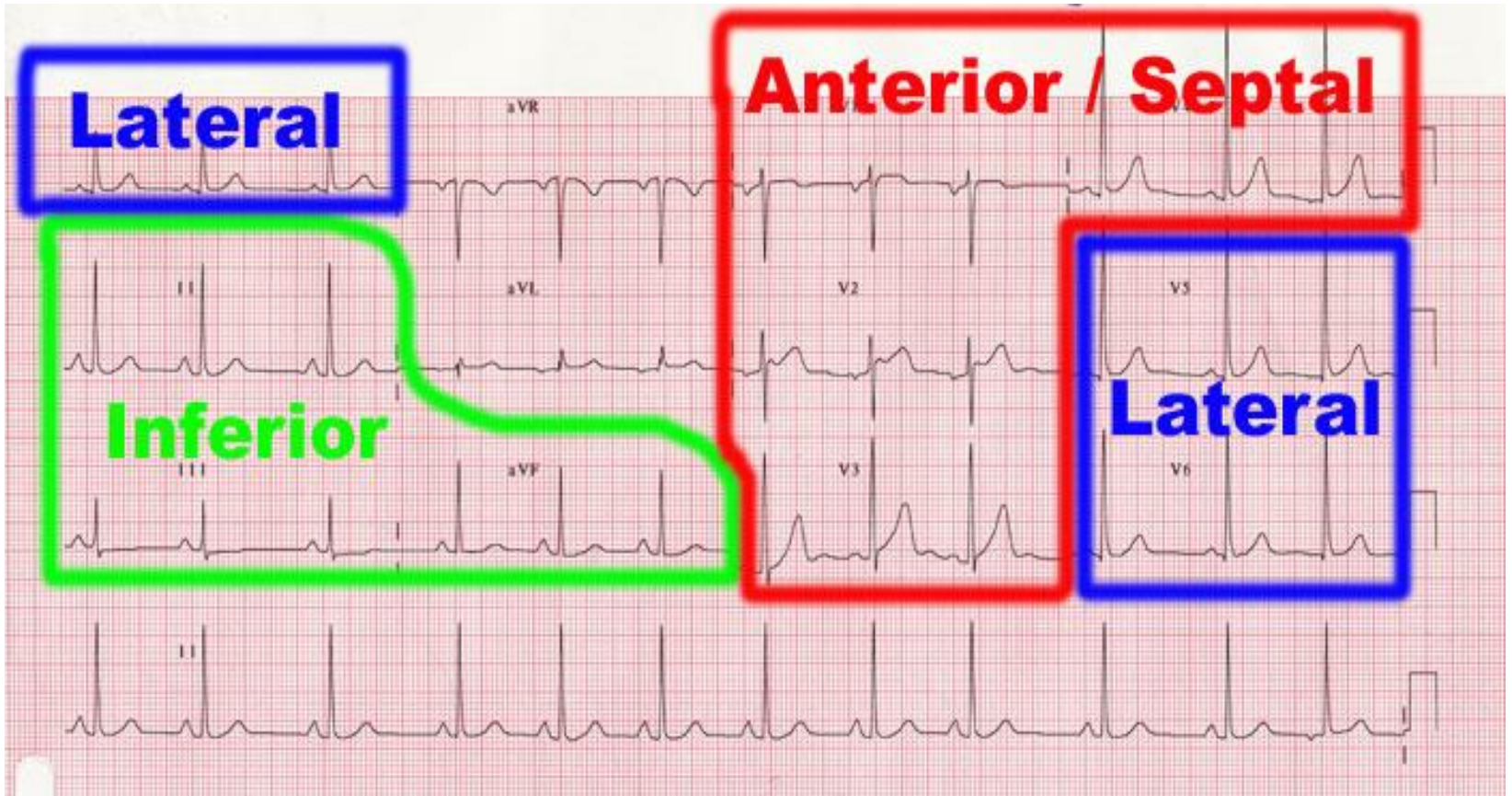
# Horizontal Plane



# What Does Each Lead “See”?

<b>LEADS</b>	<b>VIEW</b>
<b>II, III, aVF</b>	<b>INFERIOR</b>
<b>V1, V2</b>	<b>SEPTAL</b>
<b>V3, V4</b>	<b>ANTERIOR</b>
<b>V5, V6, I, aVL</b>	<b>LATERAL</b>

# What Does Each Lead “See”?



# Taking a good picture

- II & aVF should look similar
- aVR is upside down (negative deflection)
- Precordial R wave progression
  - V1 is mostly negative
  - As you look through the V leads from 1 – 6, the R wave will continually become more positive
- ECG's are a snapshot of the electrical workings of the heart at that moment and can change in seconds. Be a good photographer and QC your work before showing it to the physician. (Don't be afraid to tell a technician or USNA to repeat an ECG if you think the quality is poor.)

# ECG Leads

- Each ECG Lead has a different orientation to the heart
- Vectors of ventricular depolarization produce a different deflection in each lead
- Also true of ventricular repolarization and atrial depolarization

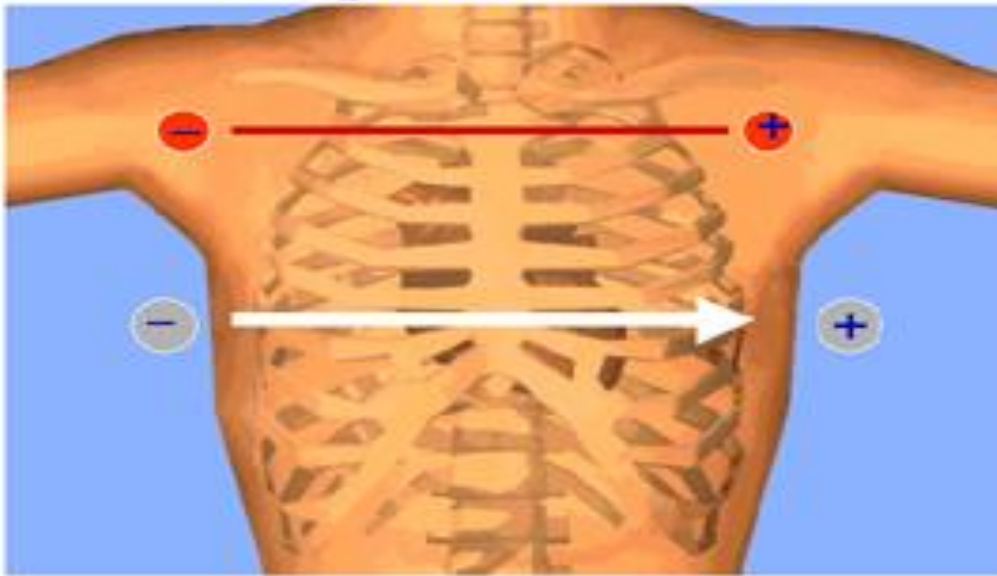
# Deflection Direction

- A current flowing toward the positive terminal of the lead is recorded as a positive or upright deflection.
- A current flowing toward the negative terminal of the lead is recorded as a negative or downward deflection.



# Deflection Direction

## Dipole-Vector



A charge traveling towards/parallel to the positive electrode will inscribe an upward deflection.

# Deflection Direction

## Dipole-Vector

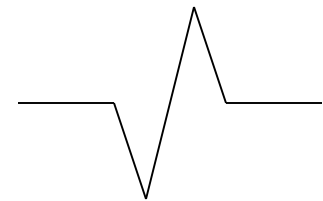
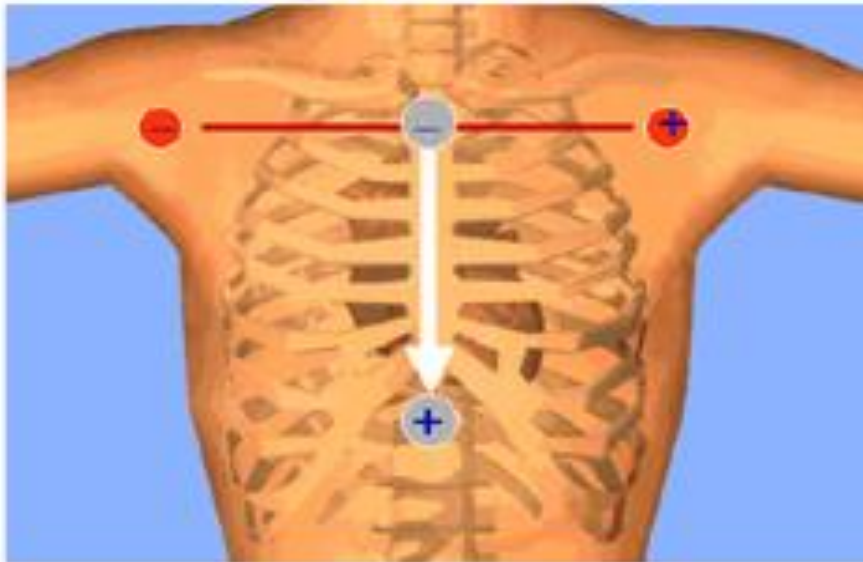


An electrical charge traveling away from the positive electrode will inscribe a downward deflection.



# Deflection Direction

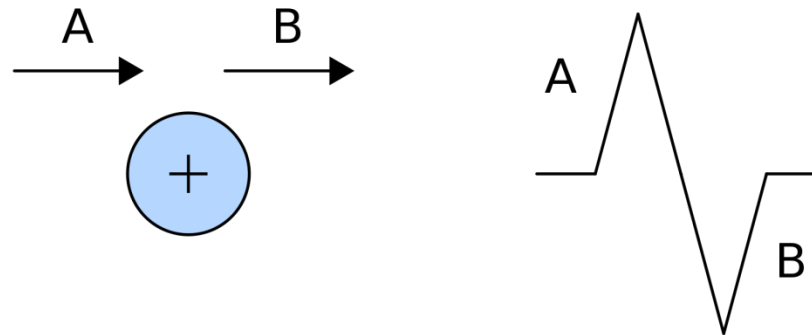
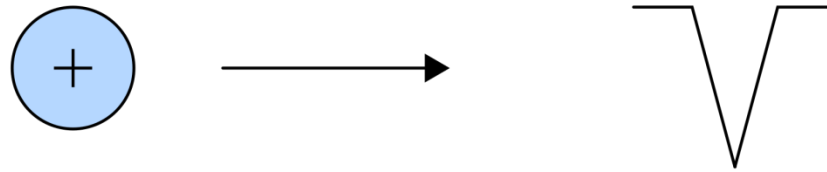
## Dipole-Vector



EQUIPHASIC

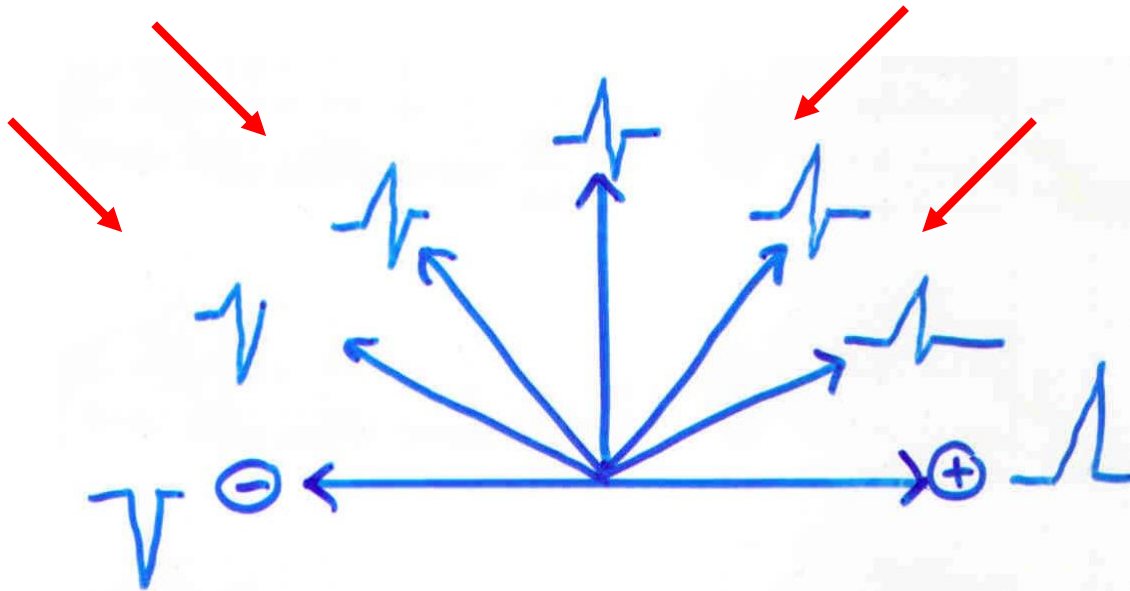
Waves traveling at a 90 degree angle to or from a lead will inscribe an isoelectric or biphasic deflection.

# Deflection Direction



# Deflection Direction- Putting it Together

- A mean vector that is neither perpendicular nor parallel to the lead produces a complex that is somewhere in between equiphasic and fully negative or fully positive.



23-JAN-1963 (47 yr)

Male

Room:ER16

Loc.201

Vent. rate	61	BPM
PR interval	136	ms
QRS duration	98	ms
QT/QTc	390/392	ms
P-R-T axes	46 74	36

\*\*\*age and gender specific ECG analysis\*\*\*

Normal sinus rhythm

Normal ECG

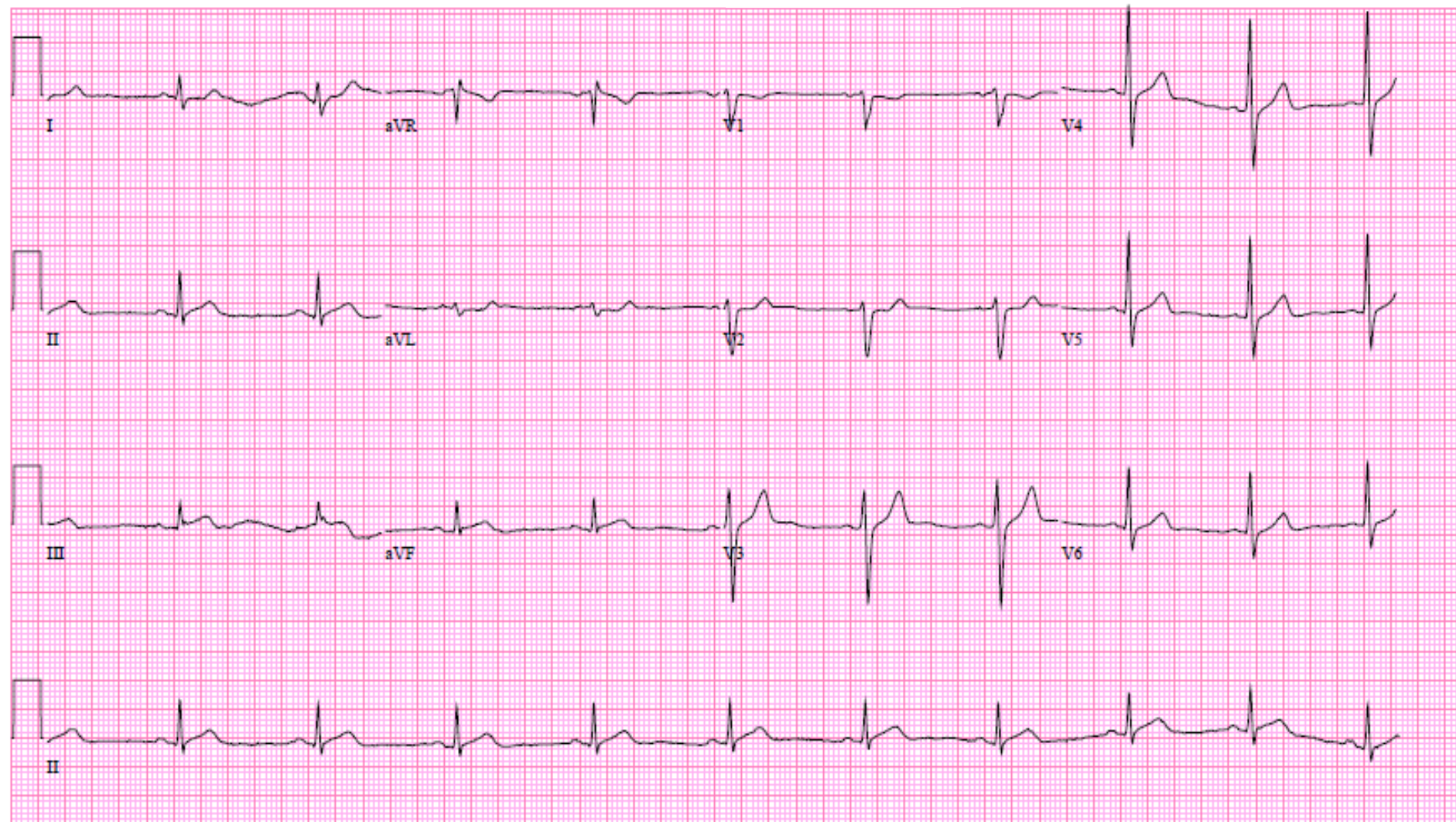
Technician:BILL PORTER-ERT

Test ind:STEMI

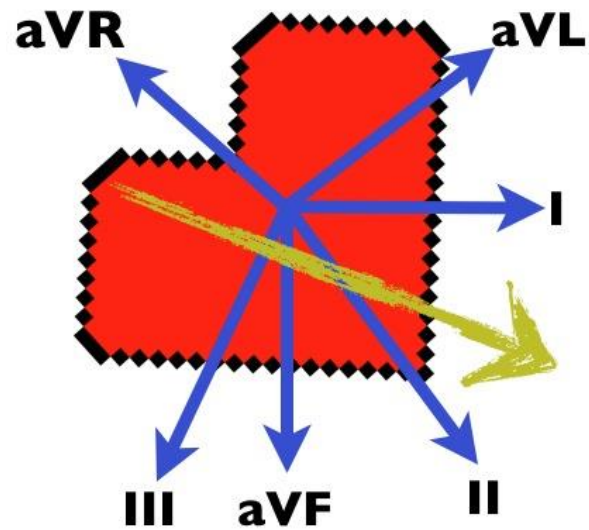
Referred by:

Unconfirmed

NOTIFIED T:

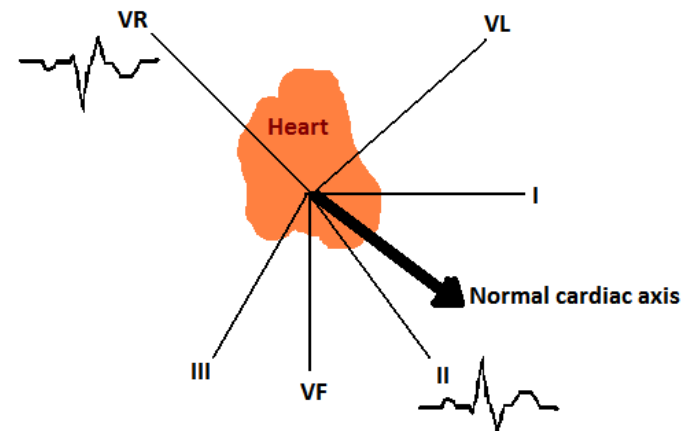


# 12-LEAD ECG ELECTRICAL AXIS



# CONCEPTS OR TERMS TO KNOW

- Electrical axis refers to the aggregate intensity and direction that electrical impulses spread through the heart (depolarization).
  - Right to left
  - 45 degree angle
  - Down towards feet
  - Anterior to posterior





# CONCEPTS OR TERMS TO KNOW

- Small deflection = weak vector
  - A small deflection may occur with the lead being farther from the heart (e.g. emphysema, thick chest wall) or with myocardial damage (e.g. diffuse coronary disease, CHF)
- Large deflection = strong vector
  - A large deflection may be normal or due to hypertrophy

-90°

aVR

-150°

-30°

aVL

-180°

0°

I

180°

120°

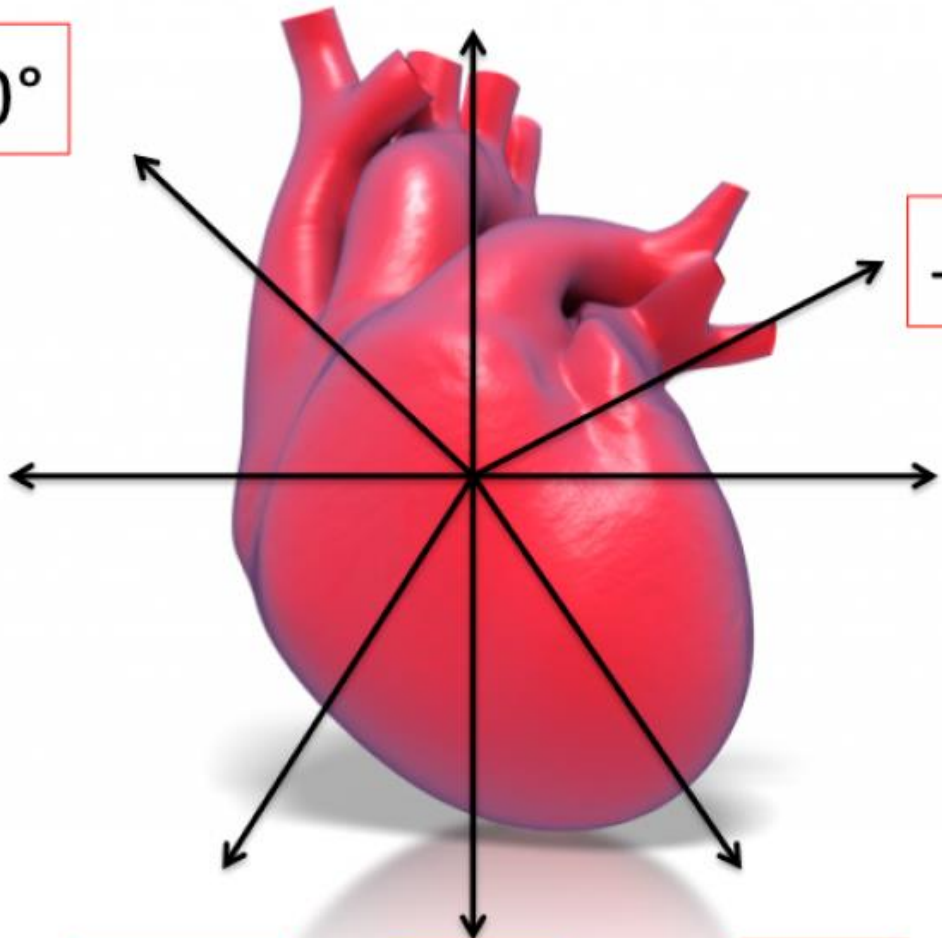
III

90°

aVF

60°

II

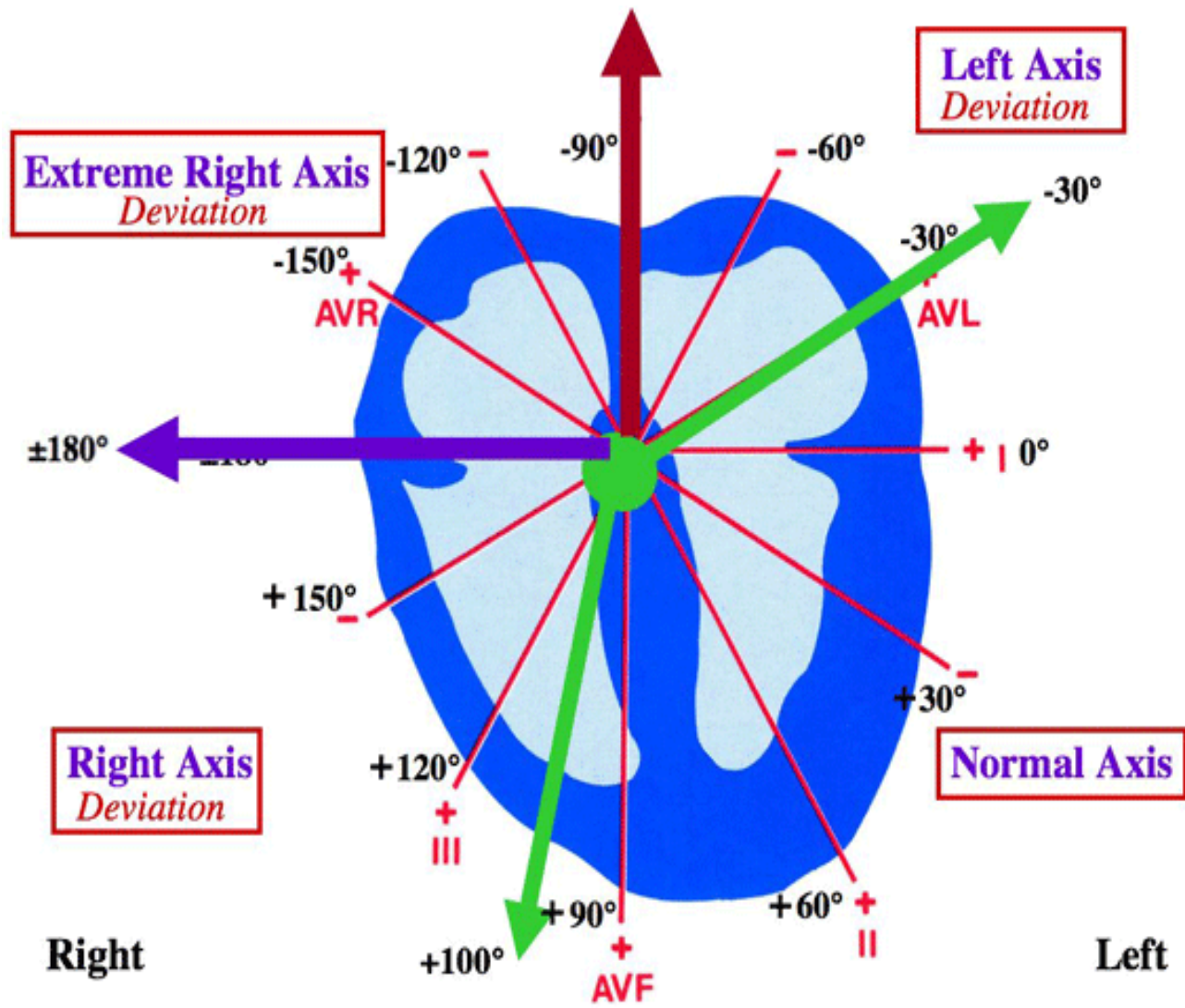


# Important Points!

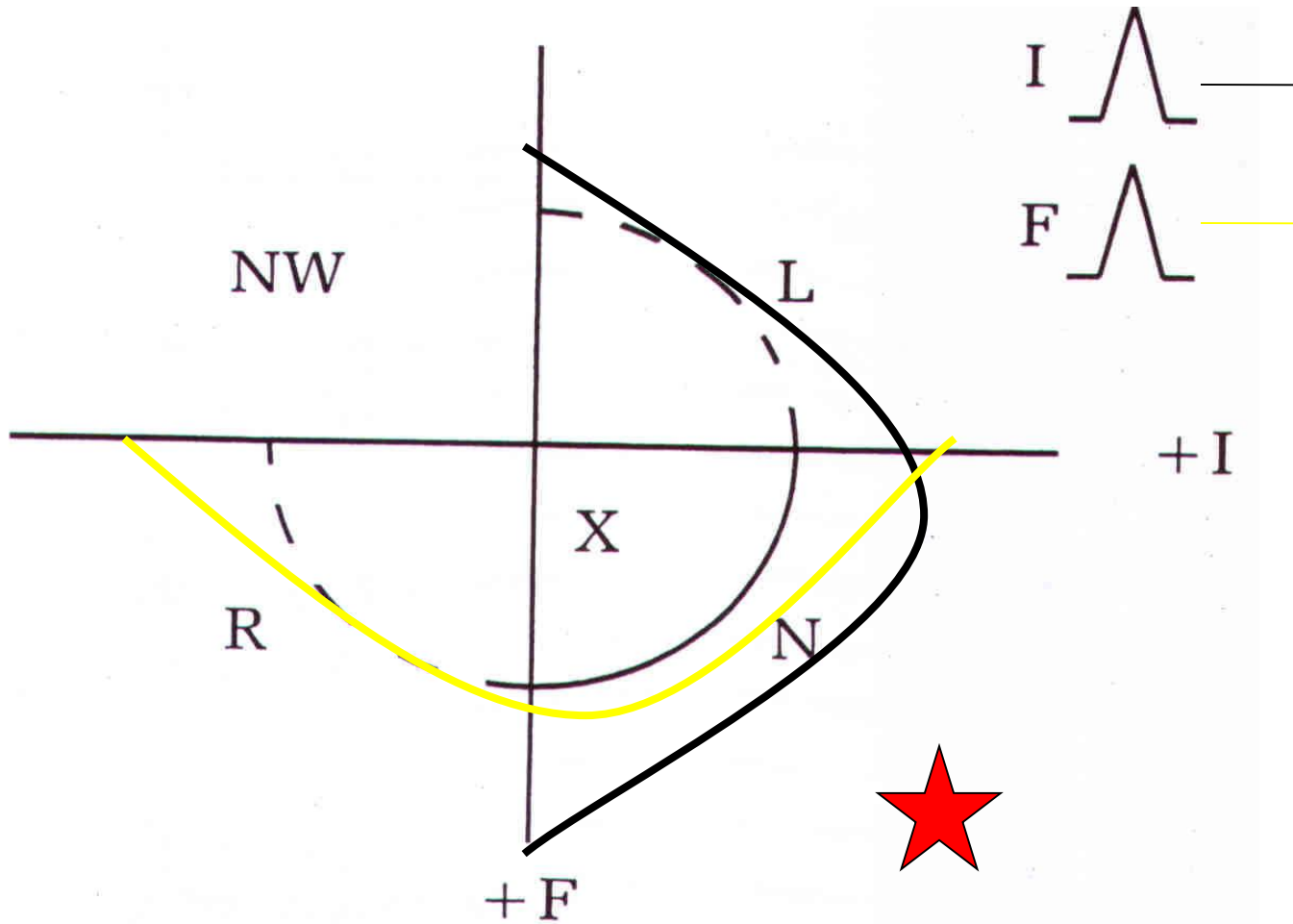
- The QRS axis represents the average direction of ventricular activation.
- Leads used to calculate the electrical axis are the frontal plane leads:
  - standard limb leads (I,II,III)
  - aV leads (aVR, aVL, aVF)

# Normal Axis, RAD, and LAD

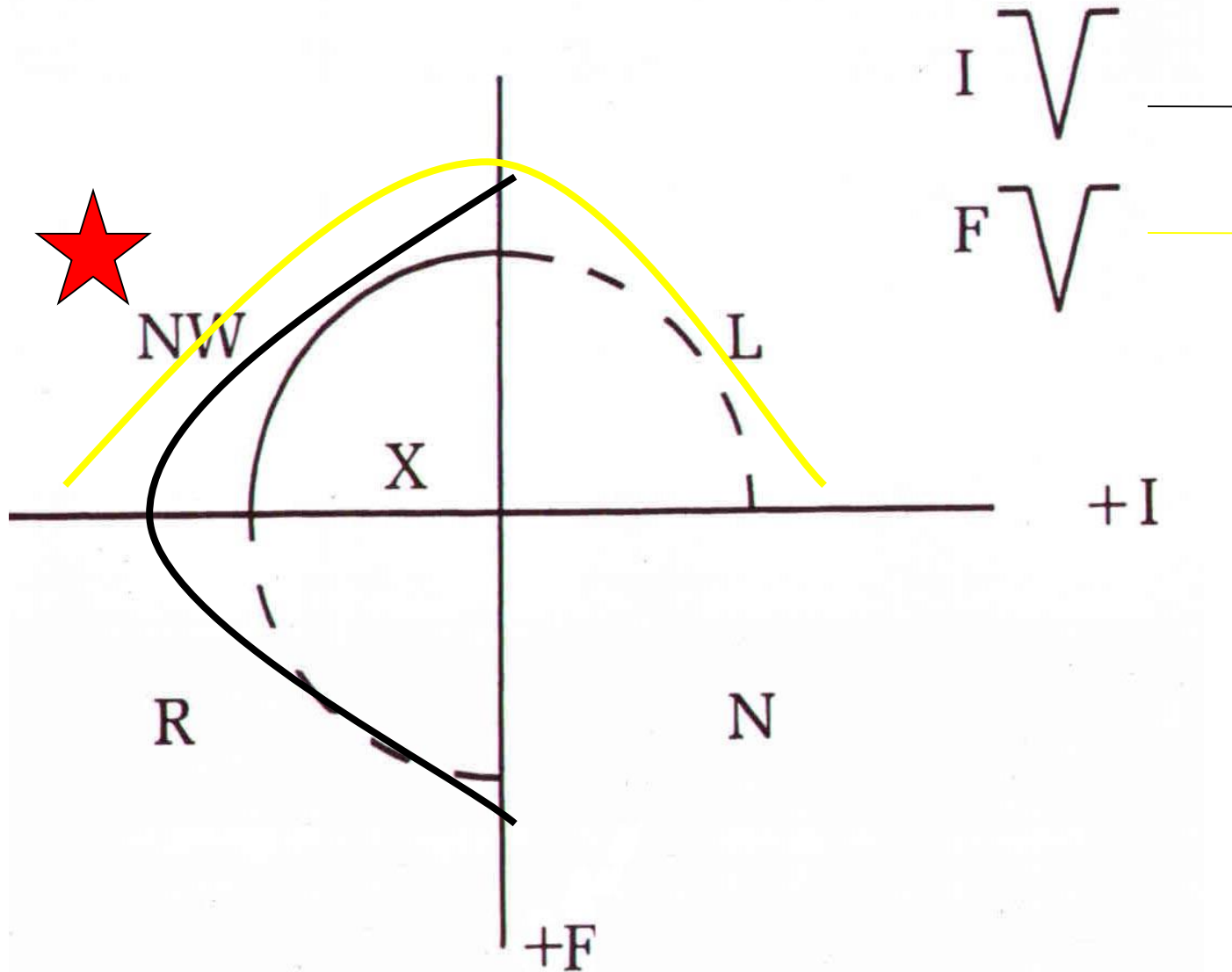
- Normal:  $-30^{\circ}$  to  $+90^{\circ}$ /  $+105^{\circ}$
- Right Axis Deviation:  $+90^{\circ}$  to  $+150^{\circ}$   
–inferior and rightward
- Left Axis Deviation:  $-30^{\circ}$  to  $-90^{\circ}$   
–superior and leftward



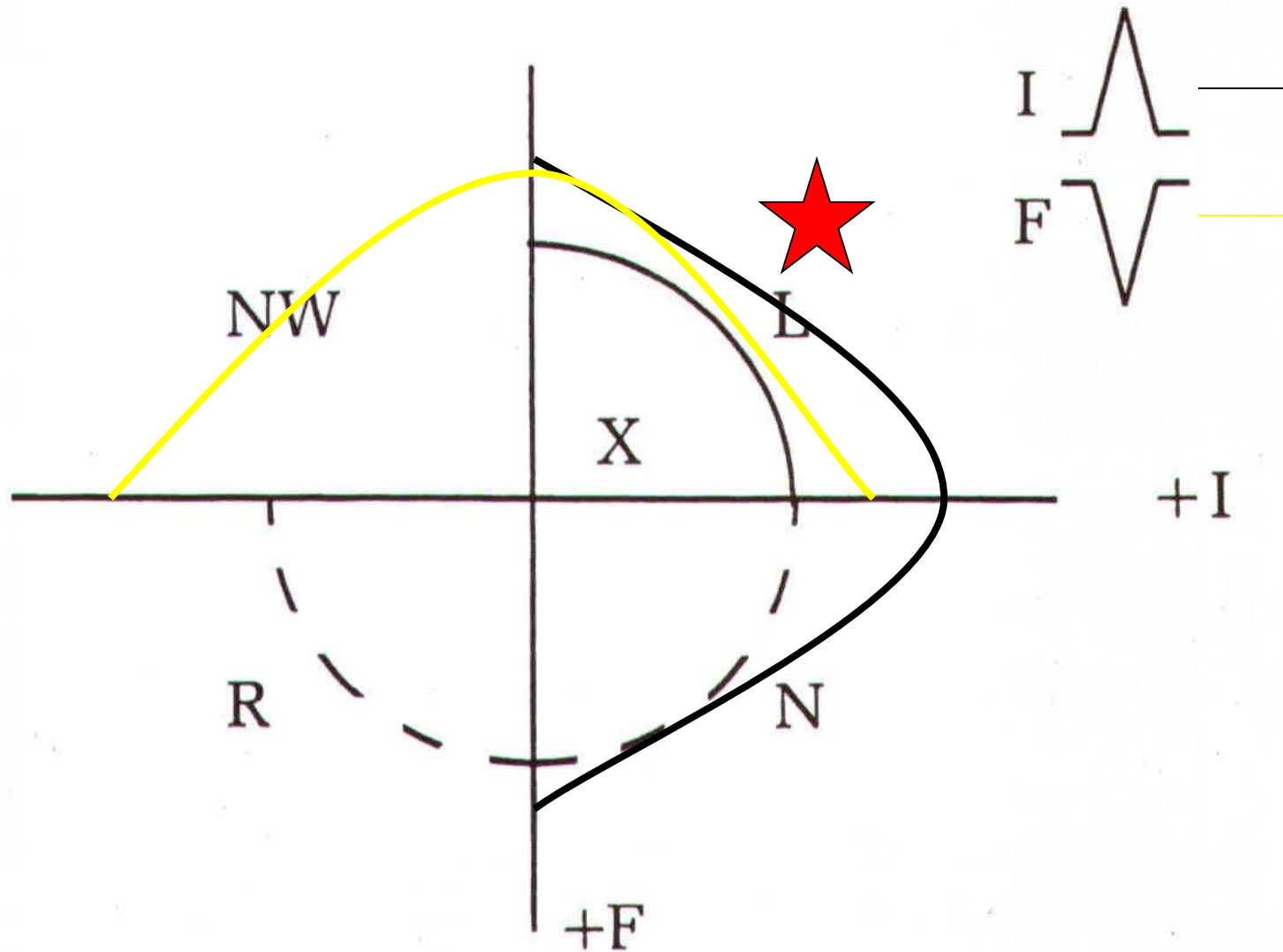
# Normal



# No-Man's Land



# Left Axis Deviation





# CAUSES OF LEFT AXIS DEVIATION

- Mechanical shifts- expiration, high diaphragm from pregnancy, ascites, abdominal tumors, obesity, emphysema
- Left anterior hemiblock OR Left bundle branch block
- Congenital lesions
- Wolf-Parkinson-White syndrome
- Hyperkalemia
- Right ventricular paced or ectopic rhythms
- Left ventricular hypertrophy
- Inferior wall MI

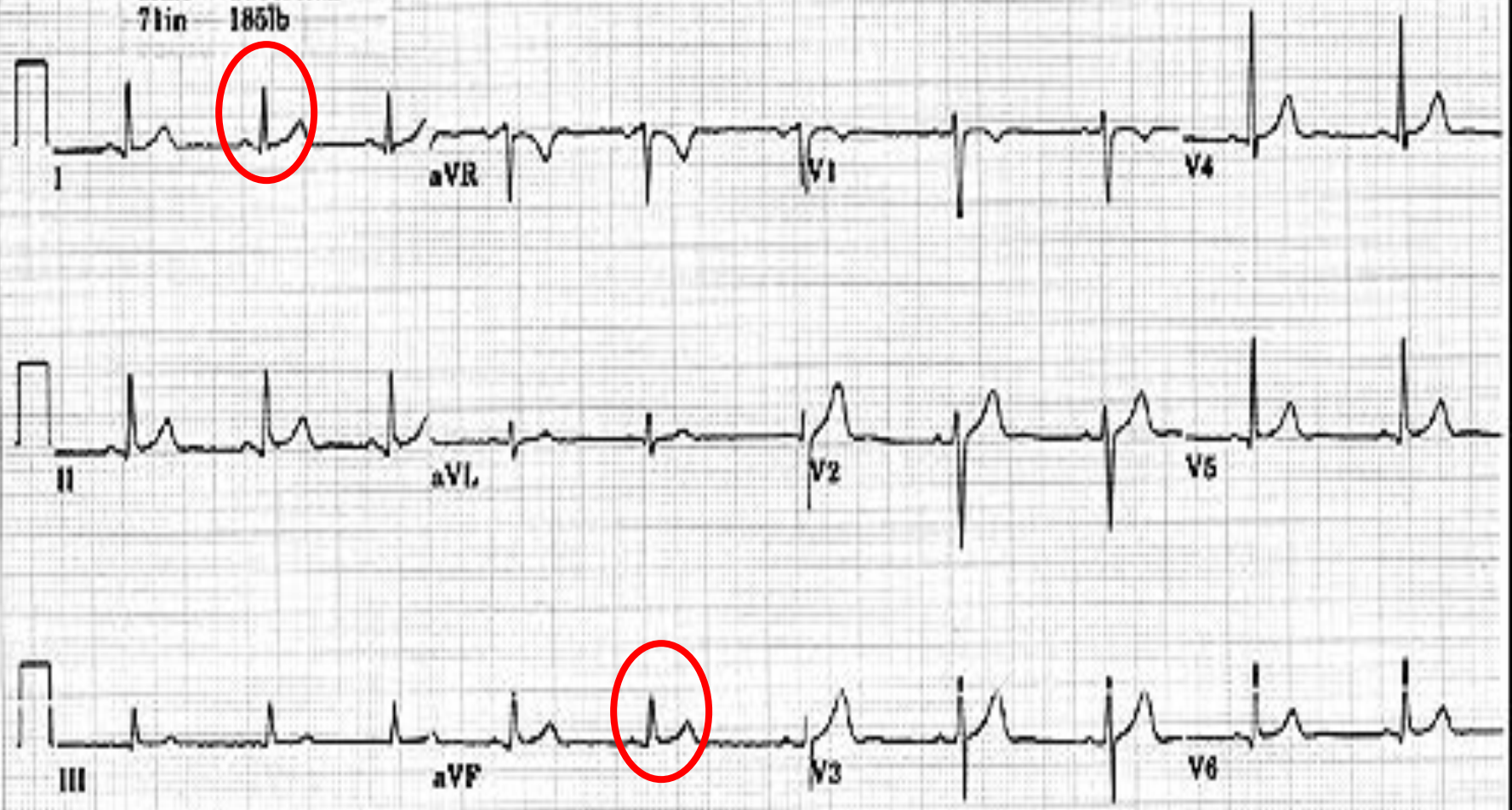
# CAUSES OF RIGHT AXIS DEVIATION

- Normal variation (to + 110)
- Mechanical shifts- inspiration, emphysema
- Right ventricular hypertrophy
- Right bundle branch block
- Left posterior hemiblock (LPH) associated with inferior MI
- Dextrocardia
- Left ventricular ectopic rhythms
- Wolf-Parkinson-White syndrome
- Anterolateral MI

# CAUSES OF ABNORMAL AXIS (NO MAN'S LAND)

- Ventricular ectopic rhythms
- Right ventricular paced rhythms
- Less commonly seen in cardiomyopathies and with multiple myocardial infarctions

08-NOV-1970 (25 yr)  
Male Caucasian  
71in 185lb



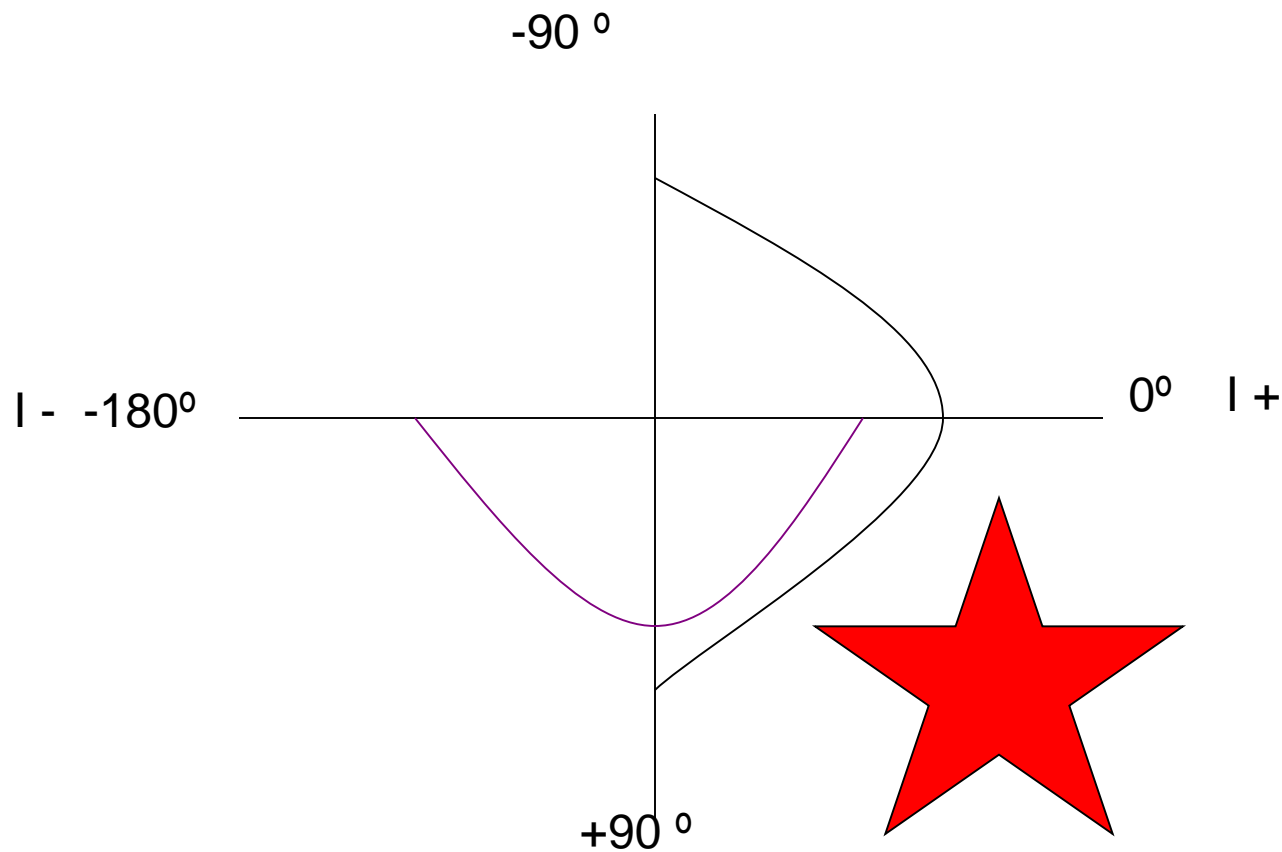
11-MAR-1996 17:05

© 1997 Frank G. Yanowitz, M.D.

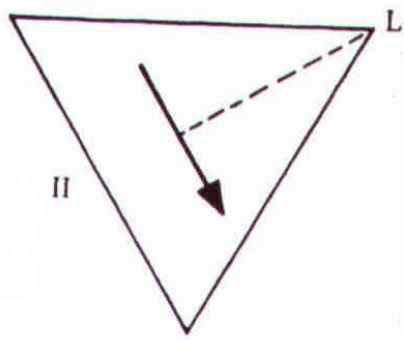
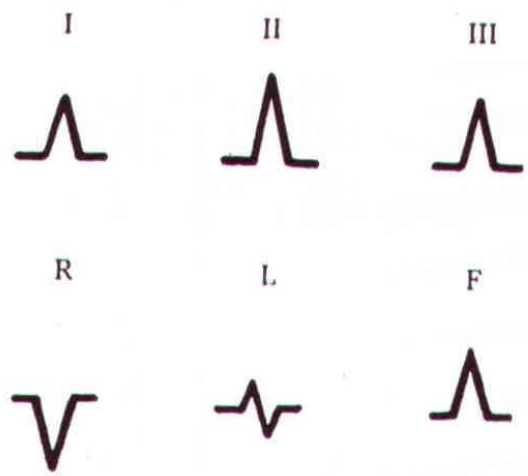
Lead I and Lead aVf are both upright!

# DETERMINATION OF AN AXIS

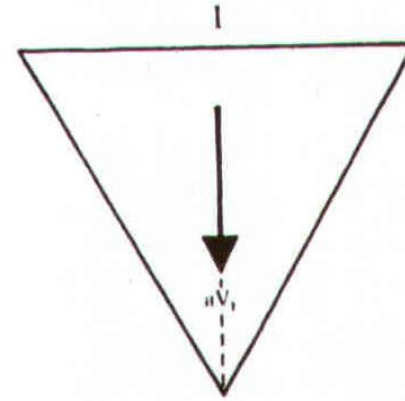
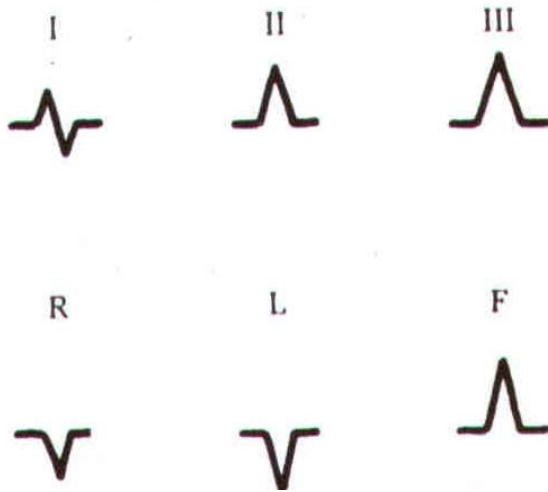
Lead I and aVf are Positive



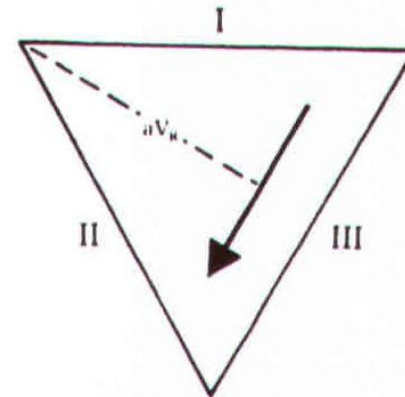
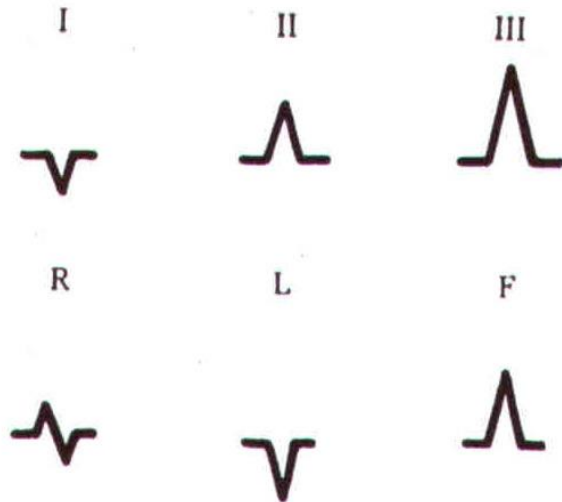
# NORMAL AXIS



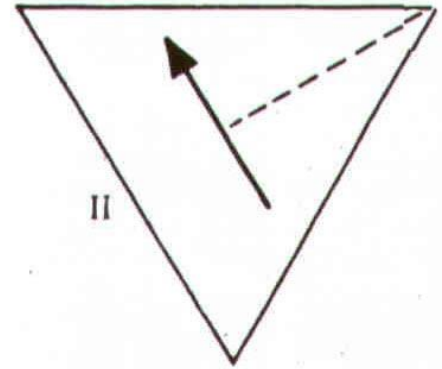
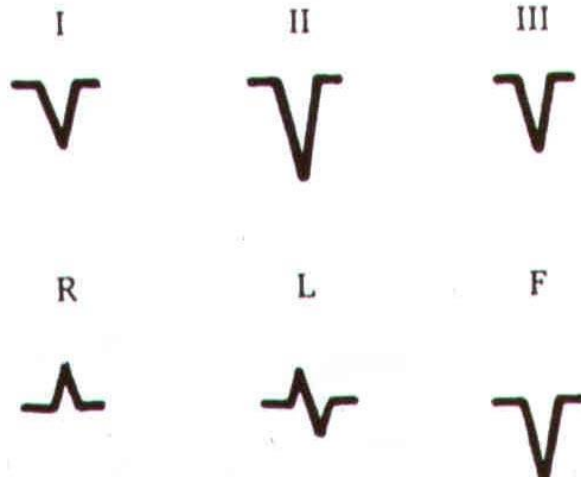
## NORMAL AXIS



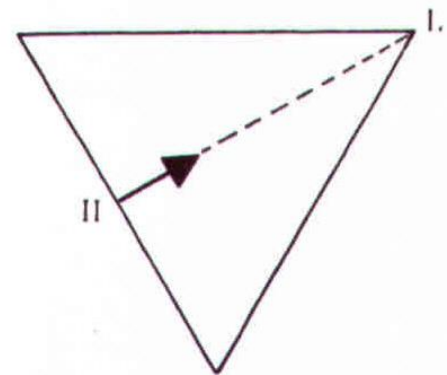
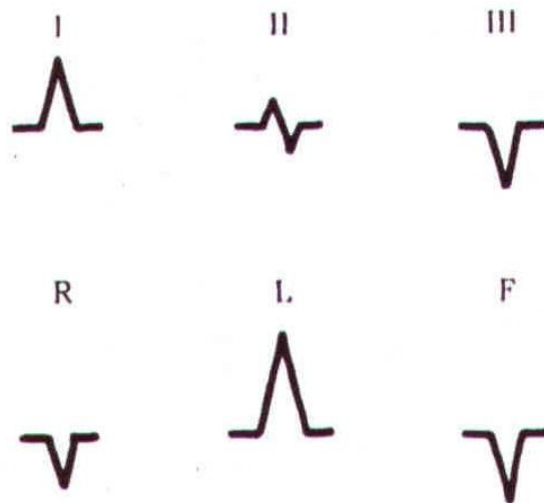
## RIGHT AXIS DEVIATION



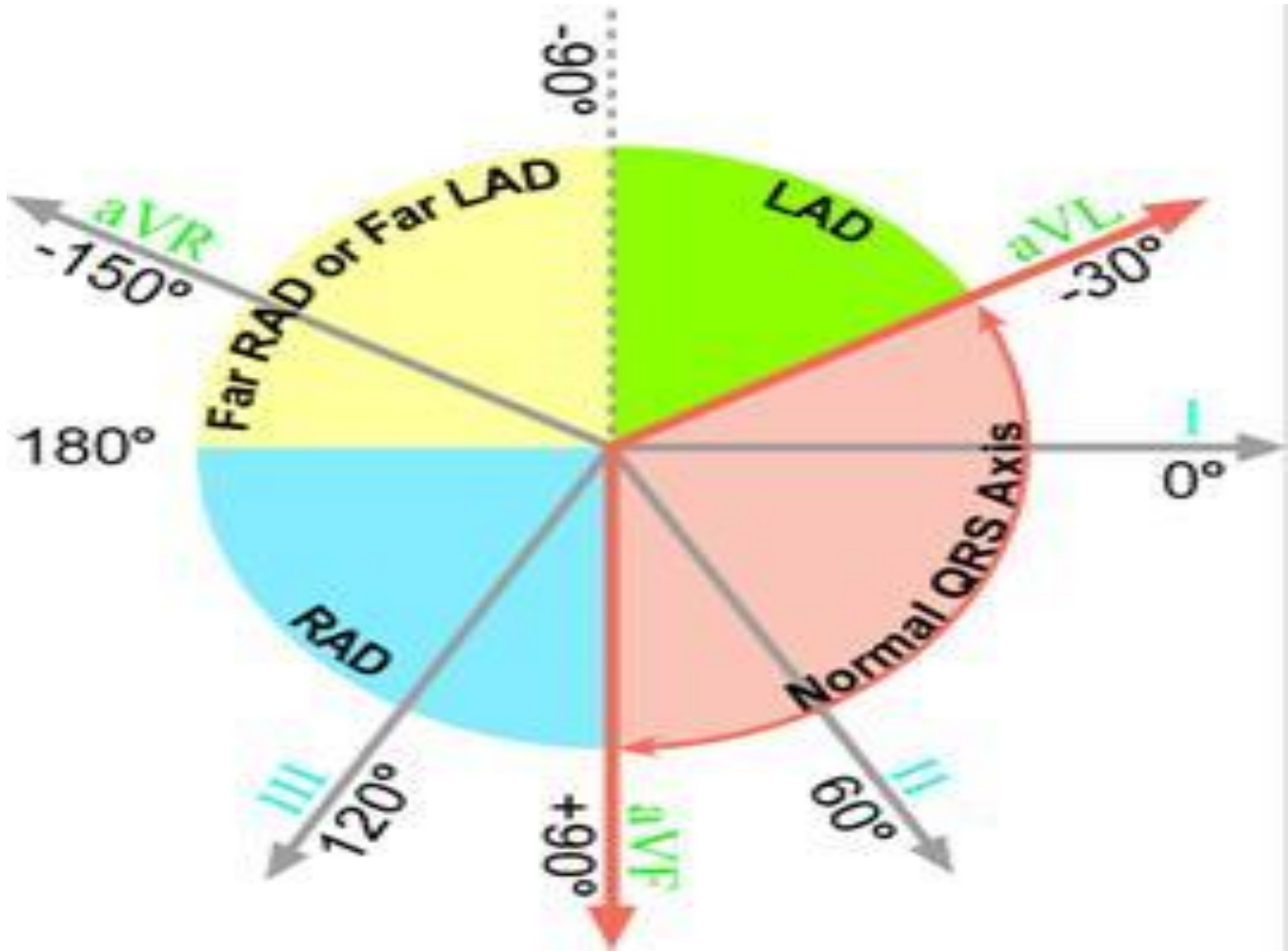
## NO MAN'S LAND



## LEFT AXIS DEVIATION

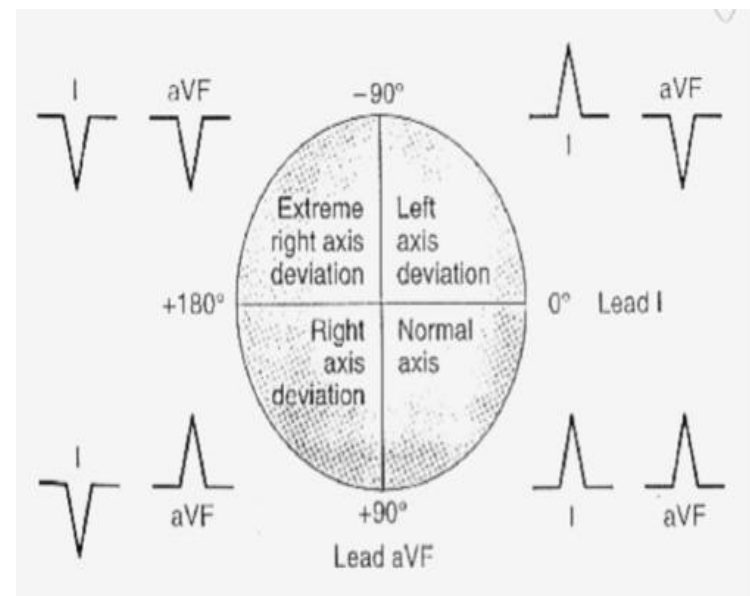
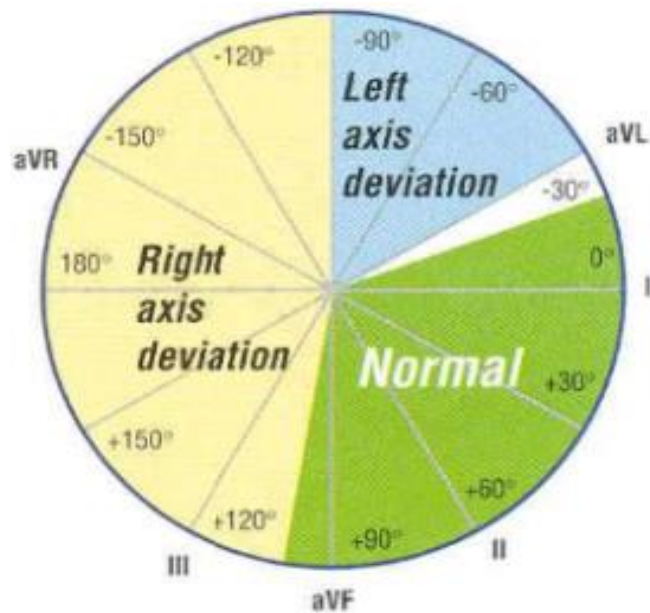




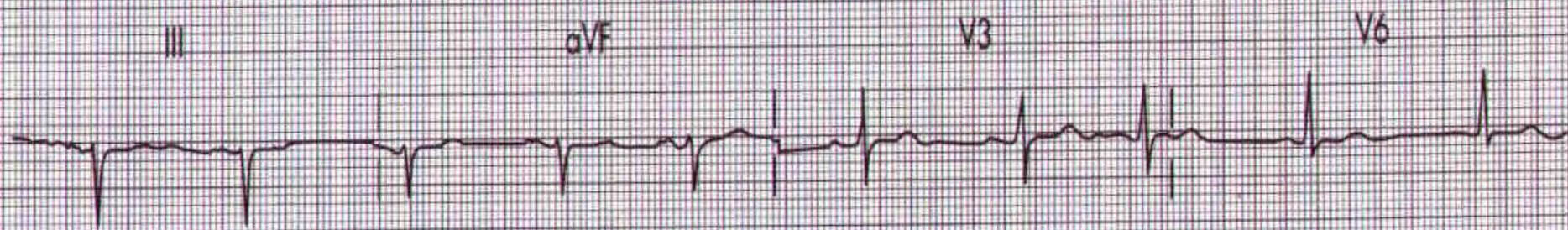
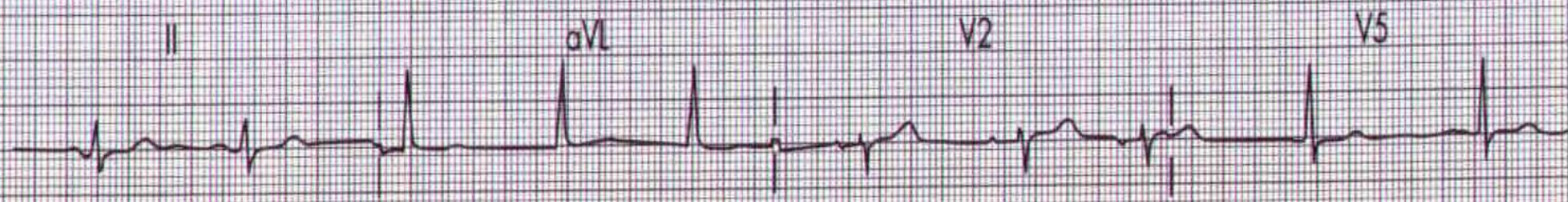
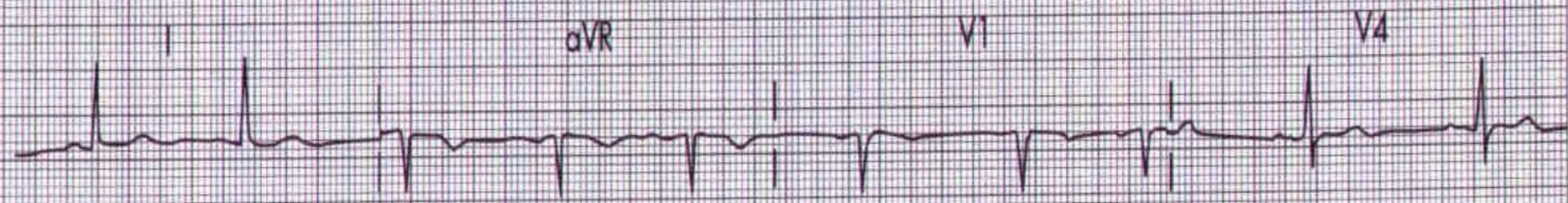


<https://www.youtube.com/watch?v=yJCFO5qJW84>

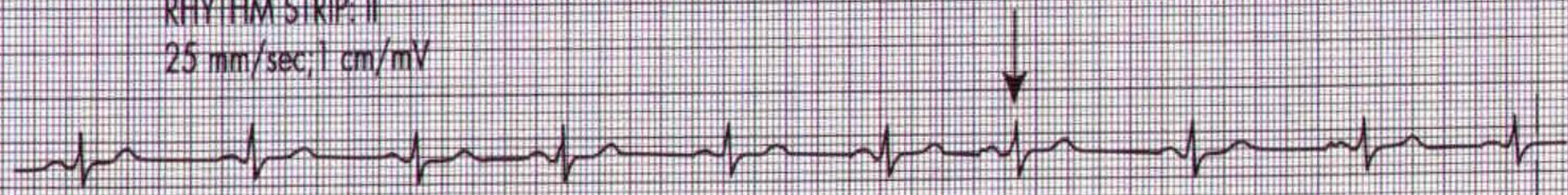
# Axis Deviation- Quick Check



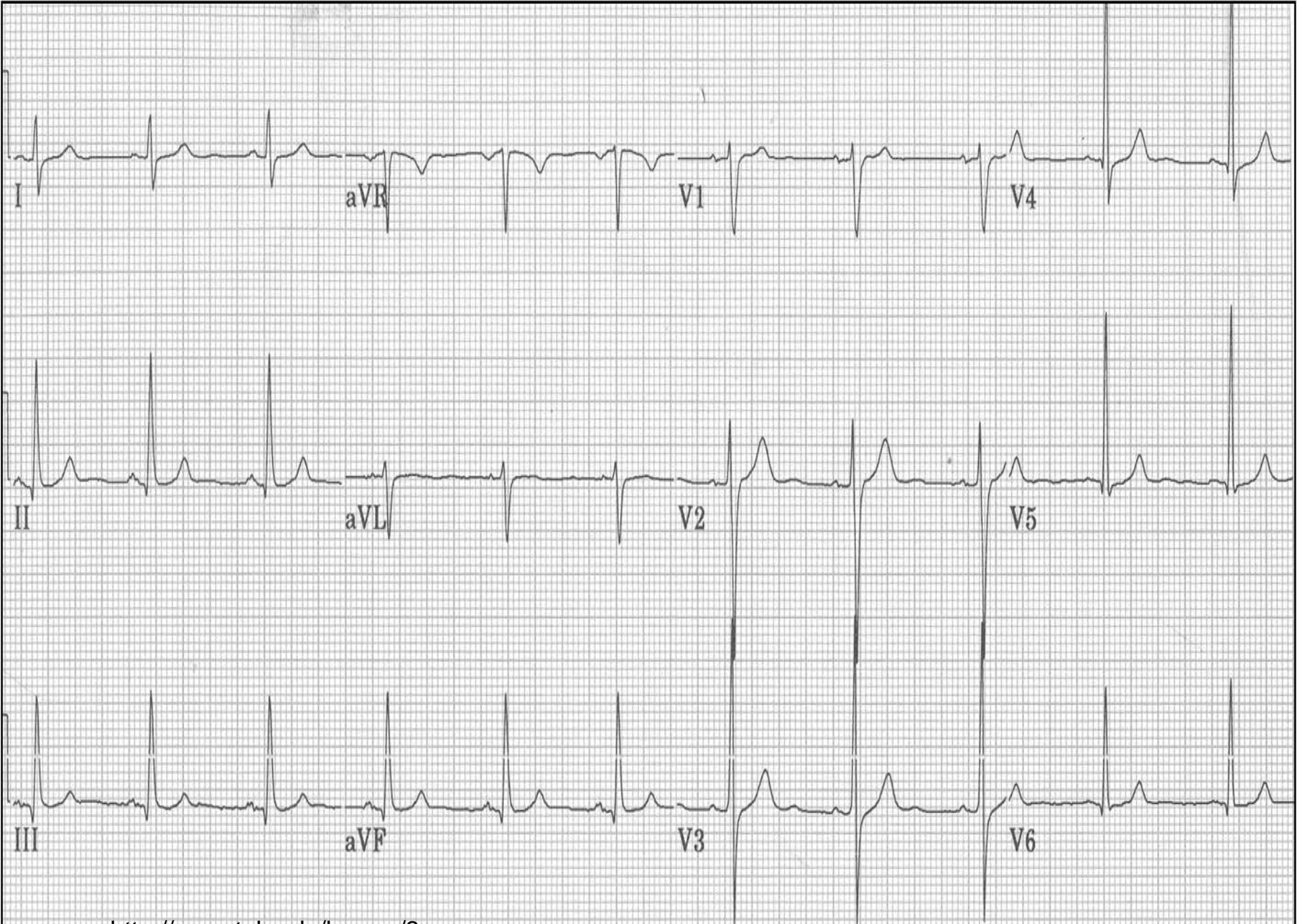


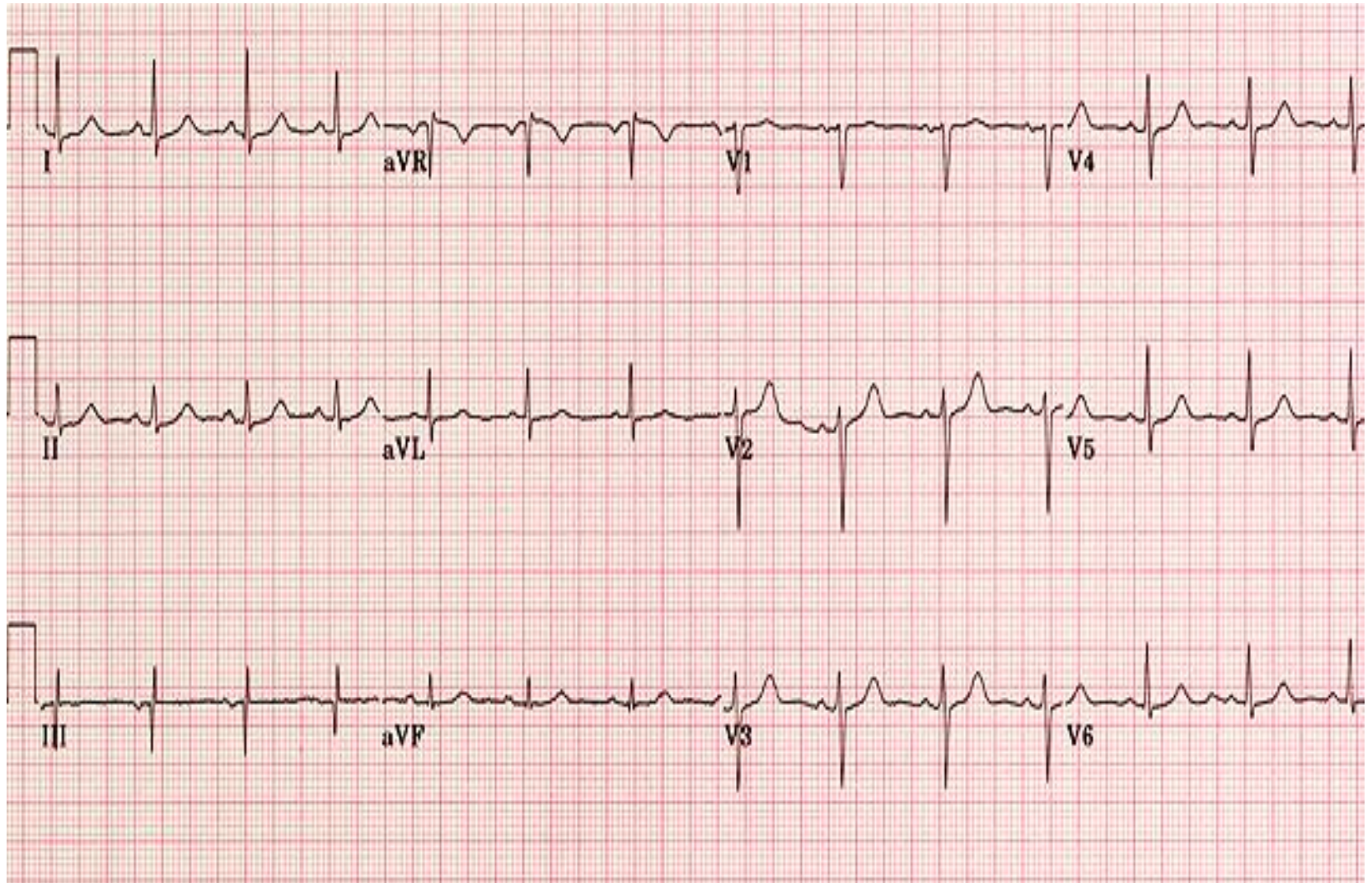


RHYTHM STRIP: II  
25 mm/sec; 1 cm/mV











ASSESSMENT	LOOK AT	LOOK FOR
<b>Context</b>	Patient, Chart	<ul style="list-style-type: none"> <li>Clinical condition</li> <li>Changes over time</li> </ul>
<b>Rhythm and Rate</b>	Rhythm Strip (Lead II)	<ul style="list-style-type: none"> <li>Arrhythmias</li> <li>Threats to perfusion</li> </ul>
<b>Ischemia/Infarction</b>	All Leads <ul style="list-style-type: none"> <li>V<sub>1</sub>-V<sub>4</sub> (anterior)</li> <li>V<sub>5</sub>-V<sub>6</sub>, aVL, I (lateral)</li> <li>II, III, aVF (inferior)</li> </ul>	<ul style="list-style-type: none"> <li>ST changes</li> <li>T wave changes</li> <li>Q waves</li> <li>Loss of R waves</li> </ul>
<b>Axis</b>	Leads I and aVF	<ul style="list-style-type: none"> <li>QRS upright in I and aVF (normal axis)</li> <li>QRS up in I, down in aVF (LAD)</li> <li>QRS down in I, up in aVF (RAD)</li> <li>QRS down in I and aVF (ERAD)</li> </ul>
<b>Chamber Enlargement</b>	Atrial Enlargement V <sub>1</sub> —	<i>Diphasic P:</i> <ul style="list-style-type: none"> <li>Initial deflection is larger (RAE)</li> <li>Terminal deflection is larger (LAE)</li> </ul>
	II—	<i>Unusual P Morphology:</i> <ul style="list-style-type: none"> <li>Tall, peaked P wave (RAE)</li> <li>Notched P wave (LAE)</li> </ul>
	Ventricular Enlargement V <sub>1</sub> —	<i>High-Amplitude QRS Complexes:</i> <ul style="list-style-type: none"> <li>R wave longer than S (RVE)</li> <li>Extremely deep S (LVE)</li> </ul>
	V <sub>6</sub> —	<ul style="list-style-type: none"> <li>S wave larger than R (RVE)</li> <li>Extremely tall R (LVE)</li> </ul>
<b>Intraventricular Conduction Defects</b>	V <sub>1</sub> —	<i>Wide QRS:</i> <ul style="list-style-type: none"> <li>Notched R wave (RBBB)</li> <li>Deep, slurred S wave (LBBB)</li> </ul>
	V <sub>6</sub> —	<ul style="list-style-type: none"> <li>Broad S wave (RBBB)</li> <li>Broad notched R wave (LBBB)</li> </ul>
<b>Miscellaneous Abnormalities</b> • Hyperkalemia	All Leads	<ul style="list-style-type: none"> <li>Tall, peaked T waves</li> <li>Wide, flat P waves</li> <li>Widening of QRS</li> <li>Disappearing ST segment</li> <li>Merging QRS and T</li> </ul>
• Hypokalemia	All Leads	<ul style="list-style-type: none"> <li>Flat T waves</li> <li>Increasingly prominent U waves</li> </ul>
• Hypercalcemia	All Leads	<ul style="list-style-type: none"> <li>Prolonged QT interval (for rate)</li> </ul>
• Hypocalcemia	All Leads	<ul style="list-style-type: none"> <li>Short QT interval (for rate)</li> </ul>
• Digitalis Toxicity	All Leads	<ul style="list-style-type: none"> <li>Sloping ST segment</li> <li>ST depression</li> <li>Diphasic or inverted T wave</li> <li>Short QT interval</li> </ul>
• Pericarditis	All Leads	<ul style="list-style-type: none"> <li>Elevated, concave ST segment</li> <li>Diffuse ST changes not correlated to coronary vessels</li> </ul>

# Websites/Videos

- <http://www.youtube.com/watch?v=URBREKIUALk>
- <http://www.youtube.com/watch?v=YsiNFaDtTYo>
- <http://www.youtube.com/watch?v=MU71NqijEu0>
  
- <http://ecg.utah.edu/>
- <http://www.ecglibrary.com/ecghome.html>
- <http://lifeinthefastlane.com/resources/ecg-database/>
- <http://www.12leadecg.com/full/ecgindex.aspx>

**THANK YOU!!!**

**QUESTIONS?**