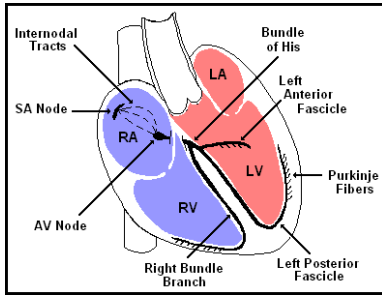




## ECG BASICS

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### The Normal Conduction System



### What is an ECG?

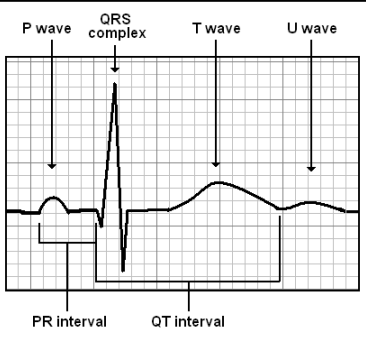
The electrocardiogram (ECG) is a representation of the electrical events of the cardiac cycle.

Each event has a distinctive waveform, the study of which can lead to greater insight into a patient's cardiac pathophysiology.

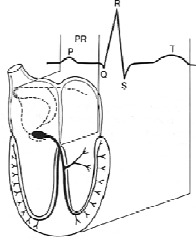
### What types of pathology can we identify and study from ECGs?

- Arrhythmias
- Myocardial ischemia and infarction
- Pericarditis
- Chamber hypertrophy
- Electrolyte disturbances (i.e. hyperkalemia, hypokalemia)
- Drug toxicity (i.e. digoxin and drugs which prolong the QT interval)

### Waveforms and Intervals

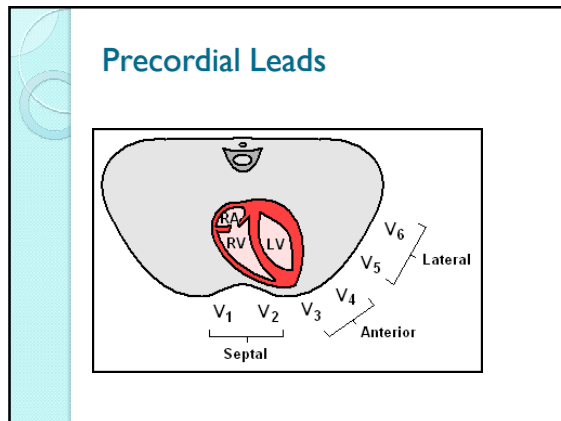
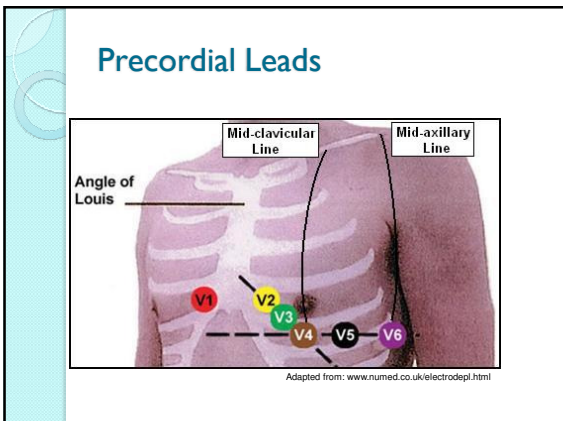


### The "PQRST"



- P wave - Atrial depolarization
- QRS - Ventricular depolarization
- T wave - Ventricular repolarization





### Summary of Leads

	Limb Leads	Precordial Leads
<b>Bipolar</b>	I, II, III (standard limb leads)	-
<b>Unipolar</b>	aVR, aVL, aVF (augmented limb leads)	V <sub>1</sub> -V <sub>6</sub>

### Arrangement of Leads on the EKG

I	aVR	V <sub>1</sub>	V <sub>4</sub>
II	aVL	V <sub>2</sub>	V <sub>5</sub>
III	aVF	V <sub>3</sub>	V <sub>6</sub>

### Anatomic Groups (Septum)

I Lateral	aVR None	V <sub>1</sub> Septal	V <sub>4</sub> Anterior
II Inferior	aVL Lateral	V <sub>2</sub> Septal	V <sub>5</sub> Lateral
III Inferior	aVF Inferior	V <sub>3</sub> Anterior	V <sub>6</sub> Lateral

### Anatomic Groups (Anterior Wall)

I Lateral	aVR None	V <sub>1</sub> Septal	V <sub>4</sub> Anterior
II Inferior	aVL Lateral	V <sub>2</sub> Septal	V <sub>5</sub> Lateral
III Inferior	aVF Inferior	V <sub>3</sub> Anterior	V <sub>6</sub> Lateral

### Anatomic Groups (Lateral Wall)

I Lateral	aVR None	V <sub>1</sub> Septal	V <sub>4</sub> Anterior
II Inferior	aVL Lateral	V <sub>2</sub> Septal	V <sub>5</sub> Lateral
III Inferior	aVF Inferior	V <sub>3</sub> Anterior	V <sub>6</sub> Lateral

### Anatomic Groups (Inferior Wall)

I Lateral	aVR None	V <sub>1</sub> Septal	V <sub>4</sub> Anterior
II Inferior	aVL Lateral	V <sub>2</sub> Septal	V <sub>5</sub> Lateral
III Inferior	aVF Inferior	V <sub>3</sub> Anterior	V <sub>6</sub> Lateral

### Anatomic Groups (Summary)

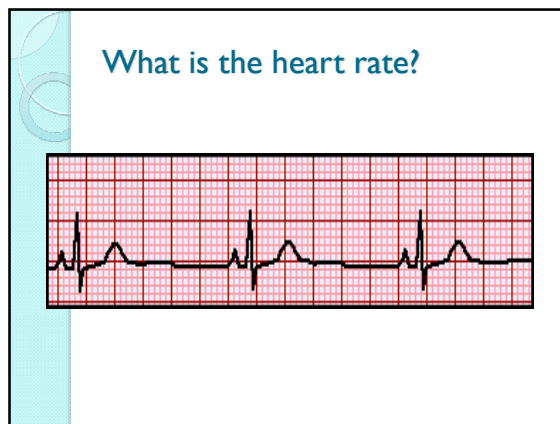
I Lateral	aVR None	V <sub>1</sub> Septal	V <sub>4</sub> Anterior
II Inferior	aVL Lateral	V <sub>2</sub> Septal	V <sub>5</sub> Lateral
III Inferior	aVF Inferior	V <sub>3</sub> Anterior	V <sub>6</sub> Lateral

- ### Determining the Heart Rate
- Rule of 300
  - 10 Second Rule

### Rule of 300

Take the number of “big boxes” between neighboring QRS complexes, and divide this into 300. The result will be approximately equal to the rate

Although fast, this method only works for regular rhythms.



### What is the heart rate?



### What is the heart rate?



### HEART RATE?



### The Rule of 300

It may be easiest to memorize the following table:

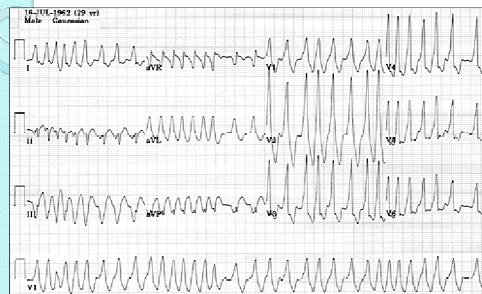
# of big boxes	Rate
1	300
2	150
3	100
4	75
5	60
6	50

### 10 Second Rule

As most ECGs record 10 seconds of rhythm per page, one can simply count the number of beats present on the EKG and multiply by 6 to get the number of beats per 60 seconds.

This method works well for irregular rhythms.

### What is the heart rate?



### The QRS Axis

The QRS axis represents the net overall direction of the heart's electrical activity.

Abnormalities of axis can hint at:

- Ventricular enlargement
- Conduction blocks (i.e. hemiblocks)

### The QRS Axis

By near-consensus, the normal QRS axis is defined as ranging from  $-30^\circ$  to  $+90^\circ$ .

$-30^\circ$  to  $-90^\circ$  is referred to as a left axis deviation (LAD)

$+90^\circ$  to  $+180^\circ$  is referred to as a right axis deviation (RAD)

### Determining the Axis

- The Quadrant Approach
- The Equiphasic Approach

### Determining the Axis

Predominantly Positive      Predominantly Negative      Equiphasic

### The Quadrant Approach

1. Examine the QRS complex in leads I and aVF to determine if they are predominantly positive or predominantly negative. The combination should place the axis into one of the 4 quadrants below.

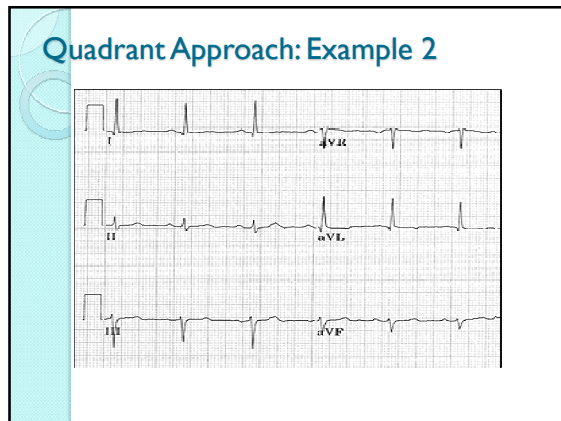
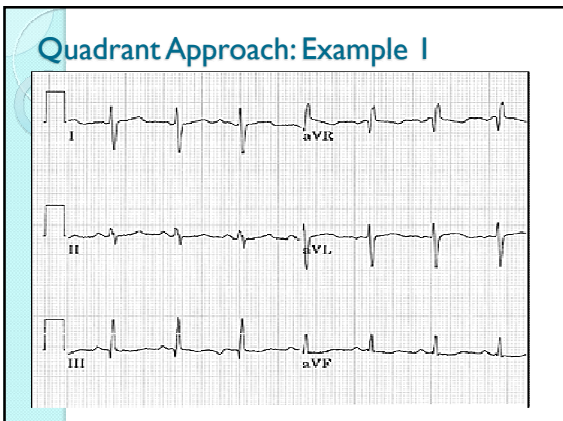
	Lead aVF	
	Positive	Negative
Lead I	Positive	Normal Axis
	Negative	RAD
		LAD
		Indeterminate Axis

### The Quadrant Approach

2. In the event that LAD is present, examine lead II to determine if this deviation is pathologic. If the QRS in II is predominantly positive, the LAD is non-pathologic (in other words, the axis is normal). If it is predominantly negative, it is pathologic.

	Lead aVF	
	Positive	Negative
Lead I	Positive	Normal Axis
	Negative	RAD
		LAD
		Indeterminate Axis





- ### MYOCARDIAL INFARCTION
- Normal ECG
  - ST Segment Elevation
  - Development of Q waves
  - ST segment returns to baseline
  - T waves become inverted
  - MYOCARDIAL ISCHEMIA
    - ST Segment depression

- ### HEART BLOCK
- **FIRST DEGREE HEART BLOCK**- PR MORE THAN 200ms
  - **SECOND DEGREE HEART BLOCK**
    - MOBITZ TYPE 1: Constant PP interval, progressive PR, followed by dropped beat- WENCKEBACH PHENOMENA
    - MOBITZ TYPE 2- P wave not followed by a QRS complex / constant PR / slightly wide QRS complexes – likely to progress to third degree
  - **THIRD DEGREE HEART BLOCK**- When p waves are not followed by QRS for several beats (3:1 /4:1)/ ventricular rate usually 30-40 bpm

- **RBBB**: RSR I Pattern in VI
  - **LBBB**: Notched R wave in V6
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