
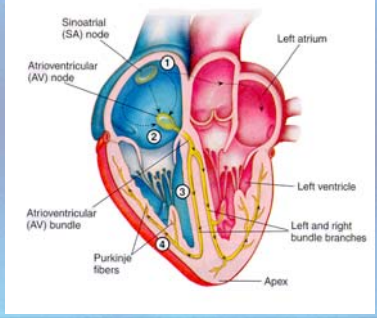


Electrocardiograms

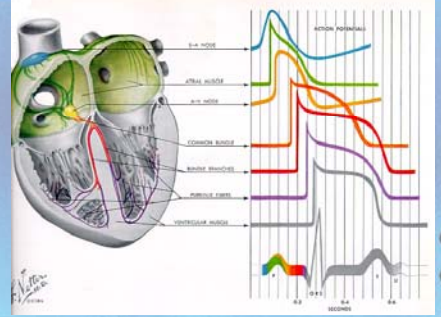


James Lamberg

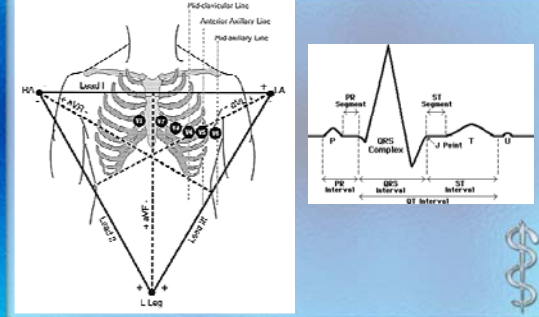
Electrical System Overview



Action Potentials

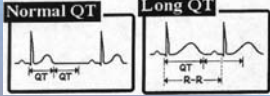


12-Lead Positioning



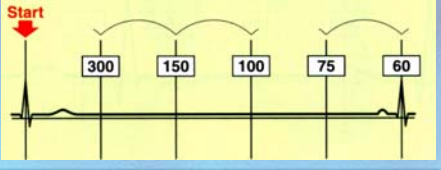
Values To Memorize

- Inherent Rates
 - SA: 60 to 100
 - AV: 40 to 60
 - Ventricles: 20 to 40
- Normal PRI: 0.12 to 0.20
 - 3 to 5 small boxes
- Normal QRS: < 0.12
 - Less than 3 small boxes
- Normal QTc: 0.35 to 0.45
 - $QT < 1/2 RR$; $QTc = QT / \sqrt{RR}$



Calculating Rates

- Count R waves in 6 seconds x 10
 - R waves between 2 sets of 3s marks
- Large boxes between R waves / 300
 - Small boxes between R waves / 1500



Standard ECG

RHYTHM STRIP 11
75 bpm/5211 cm/s

Precordial Leads

Chest Leads in the Horizontal Plane

chest leads V₁ to V₆

Determining Axis & Rotation

- Axis: Look at Lead I and aVF
 - QRS complexes
 - Positive: Normal
 - "Leaving": Left
 - "Reaching": Right
 - Negative: Indeterminate
 - Perpendicular to isoelectric lead
- Rotation: Look at V1 to V6
 - V1 or V2 isoelectric: Right
 - V3 or V4 isoelectric: Normal
 - V5 or V6 isoelectric: Left

Axis: Leads I, II, III

Determining Axis: An Example

Normal Sinus Rhythm

SINUS node is the pacemaker, firing at a regular rate of 60-100 times per minute. Each beat is conducted normally through to the ventricles.

Sinus Bradycardia

SINUS node is the pacemaker, firing regularly at a rate of less than 60 times per minute. Each impulse is conducted normally through to the ventricles.



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Sinus Tachycardia

SINUS node is the pacemaker, firing regularly at a rate of greater than 100 times per minute. Each impulse is conducted normally through to the ventricles.



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Sinus Arrhythmia

SINUS node is the pacemaker, but impulses are initiated in an irregular pattern. The rate increases as the patient breathes in and decreases as the patient breathes out. Each beat is conducted normally through to the ventricles.



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Congestive Heart Failure Causes

• FAILURE

- Forgot medication
- Arrhythmia, Anemia
- Ischemia, Infarction, Infection
- Lifestyle (too much salt)
- Upregulation of cardiac output (pregnancy, hyperthyroidism)
- Renal failure
- Embolism (PE)



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First Degree Heart Block

The AV NODE holds each sinus impulse longer than normal before conducting it through the ventricles. Each impulse is eventually conducted. Once into the ventricles, conduction proceeds normally.



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Second Degree Block Type I

As the sinus node initiates impulses, each one is delayed in the AV NODE a little longer than the preceding one, until one is eventually blocked completely. Those impulses that are conducted travel normally through the ventricles.



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Second Degree Block Type II

The AV NODE selectively conducts some beats while blocking others. Those that are not blocked are conducted through to the ventricles, although they may encounter a slight delay in the node. Once in the ventricles, conduction proceeds normally.



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Third Degree Heart Block

The block at the AV NODE is complete. The sinus impulses cannot penetrate the node, and thus are not conducted through to the ventricles. An escape mechanism from either the junction or the ventricles will take over to pace the ventricles. The atria and the ventricles function in a totally dissociated fashion.



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Premature Atrial Contraction

The pacemaker is an irritable focus within the ATRIUM that fires prematurely and produces a single ectopic beat. Conduction through to the ventricles is normal.



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Premature Junctional Contraction

The pacemaker is an irritable focus within the AV JUNCTION that fires prematurely and produces a single ectopic beat. The atria are depolarized via retrograde conduction. Conduction through the ventricles is normal.



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Premature Ventricular Contraction

A PVC is a single irritable focus within the VENTRICLES that fires prematurely to initiate an ectopic complex.



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Atrial Fibrillation


The ATRIA are so irritable that a multitude of foci initiate impulses, causing the atria to depolarize repeatedly in a fibrillatory manner. The AV node blocks most of the impulses, allowing only a limited number through to the ventricles.



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Atrial Fibrillation Causes




- THE ATRIAL FIBS
 - Thyroid
 - Hypothermia
 - Embolism (PE)
 - Alcohol ("holiday heart")
 - Trauma (cardiac contusion)
 - Recent surgery (post-CABG)
 - Ischemia
 - Atrial enlargement
 - Lone (idiopathic)
 - Fever, anemia, high-output states
 - Infarct
 - Bad valves (mitral stenosis)
 - Stimulants (cocaine, theophylline, amphetamine, caffeine)



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Atrial Flutter




A single irritable focus within the ATRIA issues an impulse that is conducted in a rapid, repetitive fashion. To protect the ventricles from receiving too many impulses, the AV node blocks some of the impulses from being conducted through to the ventricles.

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Atrial Tachycardia

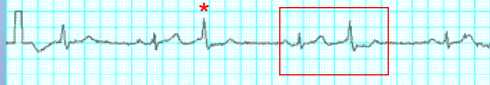



The pacemaker is a single irritable site within the ATRIUM that fires repetitively at a very rapid rate. Conduction through to the ventricles is normal.

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Atrial Bigeminy & Trigeminy

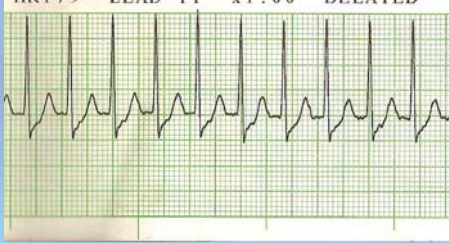

- Bigeminy
- Trigeminy

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Supraventricular Tachycardia




HR 179 LEAD II x1.00 DELAYED

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Junctional Escape Rhythm




When higher pacemaker sites fail, the AV JUNCTION is left with pacemaking responsibility. The atria are depolarized via retrograde conduction. Ventricular conduction is normal.

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Junctional Tachycardia




An irritable focus in the AV JUNCTION speeds up to override the SA node for control of the heart. The atria are depolarized via retrograde conduction. Conduction through the ventricles is normal.

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Ventricular Fibrillation

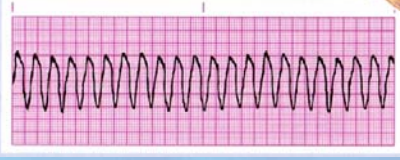


Multiple foci in the VENTRICLES become irritable and generate uncoordinated, chaotic impulses that cause the heart to fibrillate rather than contract.

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Ventricular Tachycardia

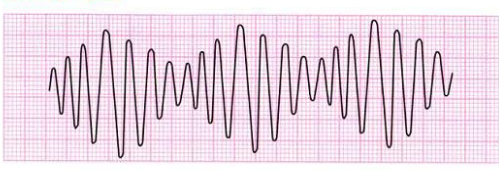


An irritable focus in the VENTRICLES fires regularly at a rate of 150-250 beats per minute to override higher sites for control of the heart.

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Torsade de Pointes

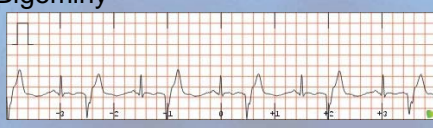
Torsade de Pointes

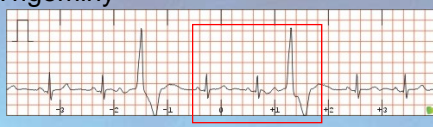

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Ventricular Bigeminy & Trigeminy

- Bigeminy






- Trigeminy

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Ventricular Asystole

The heart has lost its electrical activity. There is no electrical pacemaker to initiate electrical flow.

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Bundle Branch Blocks

- Characteristic QRS pattern in lead I, V1, and V6

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The Turn Signal Rule

- Turn-Signal Rule
 - QRS > 0.12 everywhere
 - Look V1 QRS
 - Find J point
 - Draw a horizontal line
- Triangle pointing up indicates RBBB
- Triangle pointing down indicates LBBB

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William Marrow (V1-V6)

- LBBB
 - iLLIA
- RBBB
 - ARRo

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Left Bundle Branch Block

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Right Bundle Branch Block

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Wolff-Parkinson-White

- Pre-excitation
 - Bundle of Kent
 - Delta wave
 - Slurred QRS
- Lown-Ganong-Levine
 - Bundle of James
 - Short PR Interval
 - < 0.12s

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Sick Sinus Syndrome

Sick Sinus Syndrome

ECG showing Sick Sinus Syndrome with a long P-R-T interval and a long QT interval.

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Atrial Hypertrophy

	Normal	Right	Left
II	RA LA	RA LA	RA LA
V ₁	RA LA	RA LA	RA LA

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Atrial Hypertrophy

- P Pulmonale: Right (RAH)

P pulmonale ≡ RAH
- P Mitrale: Left (LAH)

P mitrale ≡ LAH

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Ventricular Hypertrophy

- Right (RVH)
 - Right axis deviation and rotation
 - Tall QRS on right side leads
 - (V₁, V₂, V₃)
- Left (LVH)
 - Left axis deviation and rotation
 - Tall QRS on left (V₄, V₅, V₆)

Left Chest Leads in LVH

inverted T wave

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Left Ventricular Hypertrophy

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Significant Q Waves

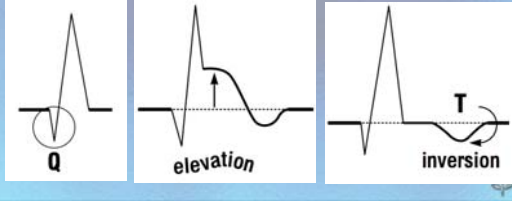
Significant Q waves

1 mm wide or $\frac{1}{3}$ of QRS amplitude

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Myocardial Infarction

- Significant Q wave = Necrosis
- ST elevation = Injury
- T wave inversion = Ischemia



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MI Location

Location	Leads
Anterior	I, V ₂ , V ₃ , and V ₄
Anterolateral	I, aVL, V ₅ , and V ₆
Lateral	V ₅ and V ₆
High lateral	I and aVL (often with V ₅ , V ₆)
Inferior	II, III, and aVF
Inferolateral	II, III, aVF, and V ₆
True posterior	Reciprocal changes in V ₁ and V ₂



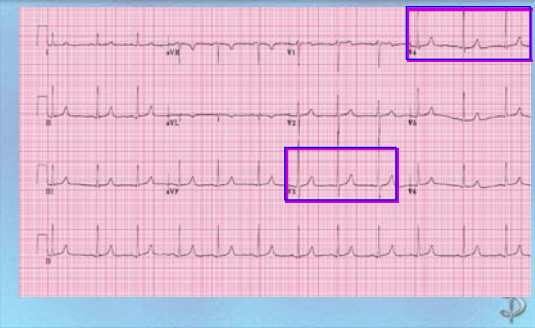
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MI Location

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

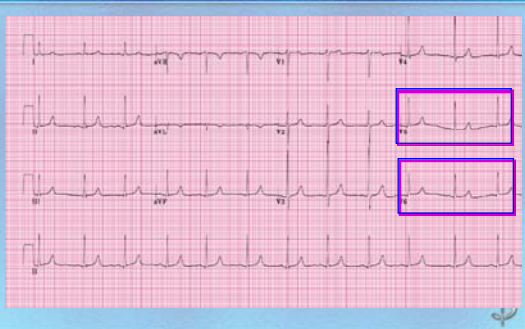
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Anterior Leads



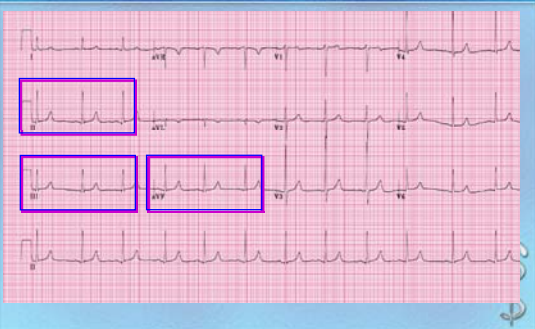
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Lateral Leads



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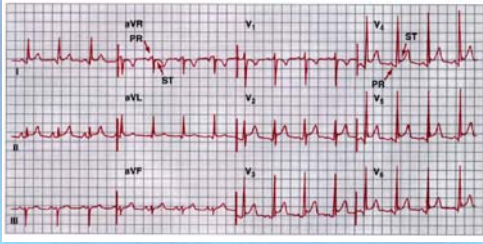
Inferior Leads



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Pericarditis

- Diffuse ST Elevation
- PR Depression



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Pericarditis Causes

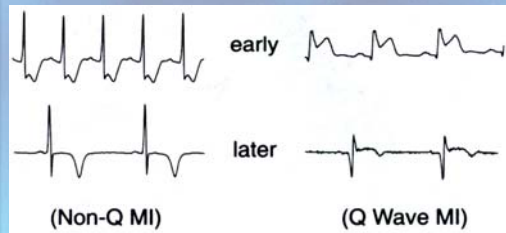
- **CARDIAC RIND**
 - Collagen vascular disease
 - Aortic aneurysm
 - Radiation
 - Drugs (hydralazine)
 - Infections
 - Acute renal failure
 - Cardiac infarction
- Rheumatic fever
- Injury
- Neoplasms
- Dressler syndrome (MI or surgery)



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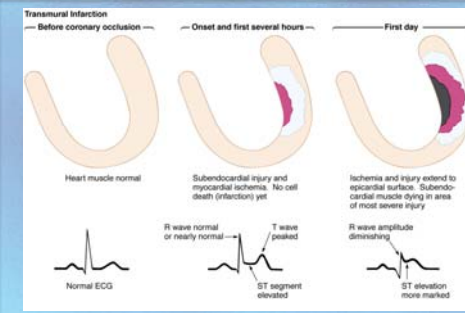
Non-STEMI versus STEMI

- Non-STEMI
- STEMI



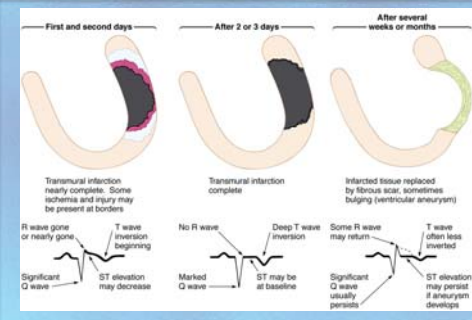
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STEMI Progression



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STEMI Progression



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ST Segment Elevation

- **ELEVATION**
 - Electrolytes
 - Left bundle branch block
 - Early repolarization
 - Ventricular hypertrophy
 - Aneurysm
 - Treatment (pericardiocentesis)
 - Injury (acute MI, contusion)
 - Osborne waves (hypothermia)
 - Nonocclusive vasospasm



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ST Segment Depression

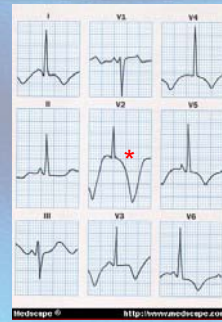
- DEPRESSED ST
 - Drooping valve (mitral valve prolapse)
 - Enlargement or LV with strain
 - Potassium loss (hypokalemia)
 - Reciprocal ST depression (inferior MI)
 - Embolism (PE)
 - Subendocardial ischemia
 - Subendocardial infarct
 - Encephalon hemorrhage
 - Dilated cardiomyopathy
 - Shock
 - Toxicity of digitalis, quinidine



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Abnormal T Waves

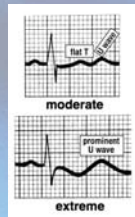
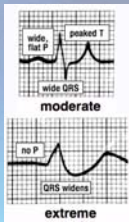
- Subarachnoid hemorrhage
- Cerebral hemorrhage
- Cerebral thrombosis



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Electrolytes & Drugs

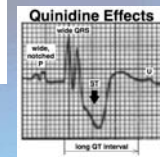
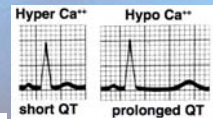
- Hyperkalemia
 - High K+
 - Peaked T
- Hypokalemia
 - Low K+
 - Flat T, U Wave



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Electrolytes & Drugs

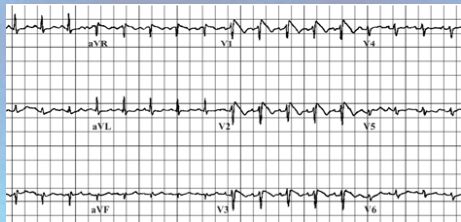
- Hypercalcemia
 - Short QT
- Hypocalcemia
 - Long QT
- Digtalis
 - Sloping ST
- Quinidine
 - Long QT
 - Notched P



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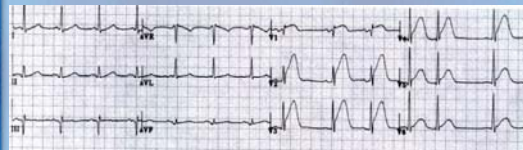
Brudada Syndrome

- Asian Males
- ST Elevation in V1, V2, V3



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Interpretation Example #1



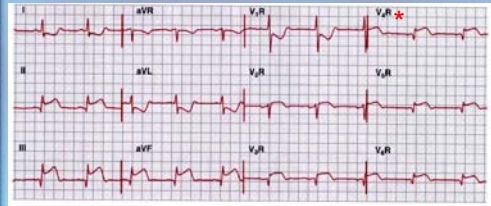
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Interpretation Example #2



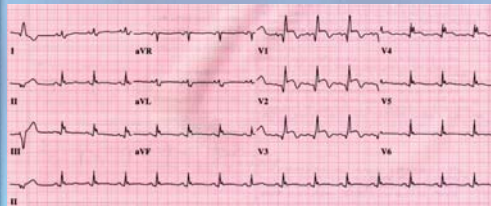
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Right Sided ECG



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Interpretation Example #3



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Interpretation Example #4



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Interpretation Example #5



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Interpretation Example #6



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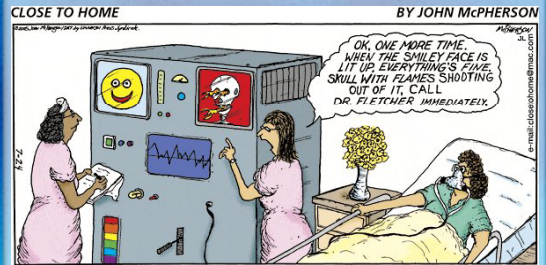
Tools of the Trade

- Recommend
 - Calipers
- Useful
 - Magnifier
- Avoid
 - Rulers



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Questions?



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