Introduction to 12 Lead ECGs

McHenry Western Lake County

EMS System
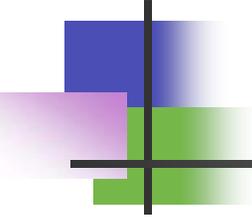
Objectives

- Why 12 Lead ECGs?
- Critical Concepts in ACS
- Monitoring vs Diagnostic ECGs
- Acquisition & Transmission
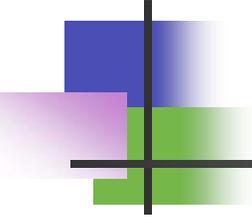
Why 12 Lead ECGs?

- **Demonstrated Advantages**
  - Rapid identification of infarction/injury
    - diagnosis made sooner in many cases
  - Decreased time to reperfusion treatment
    - speeds preparation of & time to reperfusion therapies
  - Increased index of suspicion
  - Modification to therapies
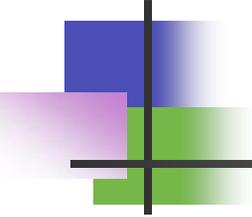
Why 12 Lead ECGs?

- **Perceived Disadvantages**
  - Increased time spent on scene
    - demonstrated at 0-4 min increase
  - Cost
    - equipment & training
  - No clinical advantage to patient & "our transport times are short"
    - demonstrated decrease in time to treatment
    - compare to early notification for trauma patients
  - Not helpful in "our system"
    - STEMI is very useful protocol!
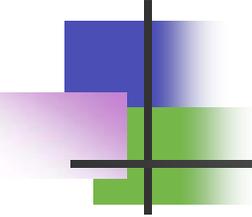
STEMI

- STEMI stands for:
- ST elevated myocardial infarction
  - The object is to decrease the time of MI to reperfusion by identifying the MI, and getting the patient the reperfusion as fast as possible.
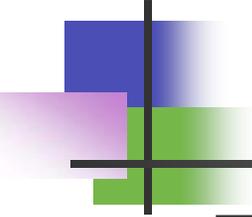
Why 12 Lead ECGs?

"The US National Heart Attack Alert Program recommends that EMS systems provide out-of-hospital 12-lead ECGs to facilitate early identification of AMI and that all advanced lifesaving vehicles be able to transmit a 12-lead ECG to the hospital"

- American Heart Association in collaboration with International Liaison Committee on Resuscitation. Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care: International Consensus on Science, Part 7: The Era of Reperfusion. Circulation. 2000; 102 (suppl I): I-175.
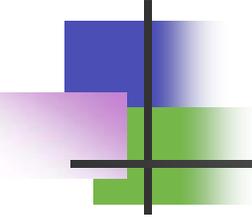
Critical Concepts in ACS

- **Ischemia**
    - lack of oxygenation
    - ST segment depression or T wave inversion

- **Injury**
    - prolonged ischemia
    - ST segment elevation

- **Infarct**
    - prolonged injury results in death of tissue
    - may or may not show Q wave
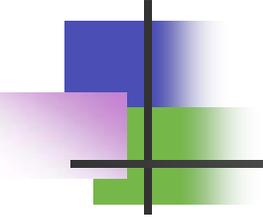
Critical Concepts in ACS

- ST elevation - the key to the acute reperfusion therapy subset

- You can't see ST elevation without a 12-lead ECG

  - Perform on *every* patient suspected of ACS

  - Obtain early

  - Repeat frequently

Critical Concepts in ACS
Will Infarct Occur?

Collateral Circulation

Plaque Rupture

Tissue Death?

Thrombus Formation

Myocardial Oxygen Demand

Coronary Vasoconstriction

Critical Concepts in ACS

Chest pain or anginal equivalent suspicious of ischemia

Immediate assessment and initial general treatment

Assess initial ECG

ST elevation or new BBB

ST depression or T inversion

Nondiagnostic - no ST-T deviation

Prepare and evaluate for reperfusion therapy

Fibrinolytics or primary PTCA

Our Focus is Here!

Critical Concepts in ACS

Acute Reperfusion Therapies

- Fibrinolytics
  - Retaplase (rPA)
 - Actiplase (tPA)
  - Streptokinase (rarely used today)

- Percutaneous Transluminal Coronary Angioplasty (PTCA)
  - Balloon angioplasty
  - Stent placement
  - Atherectomy
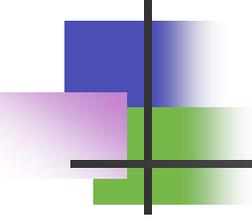
Critical Concepts in ACS

- Pain is Injury
- Pain-Free is the Goal
- Time is Muscle
- Door to Reperfusion Therapy Time is the issue
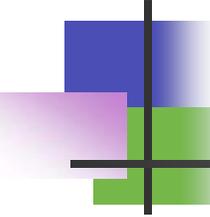
Monitoring vs Diagnostic ECGs

- Extra wires
  - 3 wires vs 10 wires
- Are there other differences?
 - Discuss your departments situation with monitors
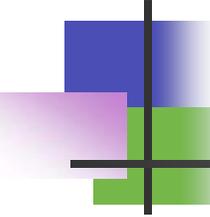
Monitoring vs Diagnostic ECGs

- **Monitoring Quality ECG**
  - Designed to provide information needed to determine rate and underlying rhythm
  - Designed to "filter out" artifact
    - Reduces the amount and degree of electrical activity seen by the ECG monitor

Monitoring vs Diagnostic ECGs

Monitor Quality
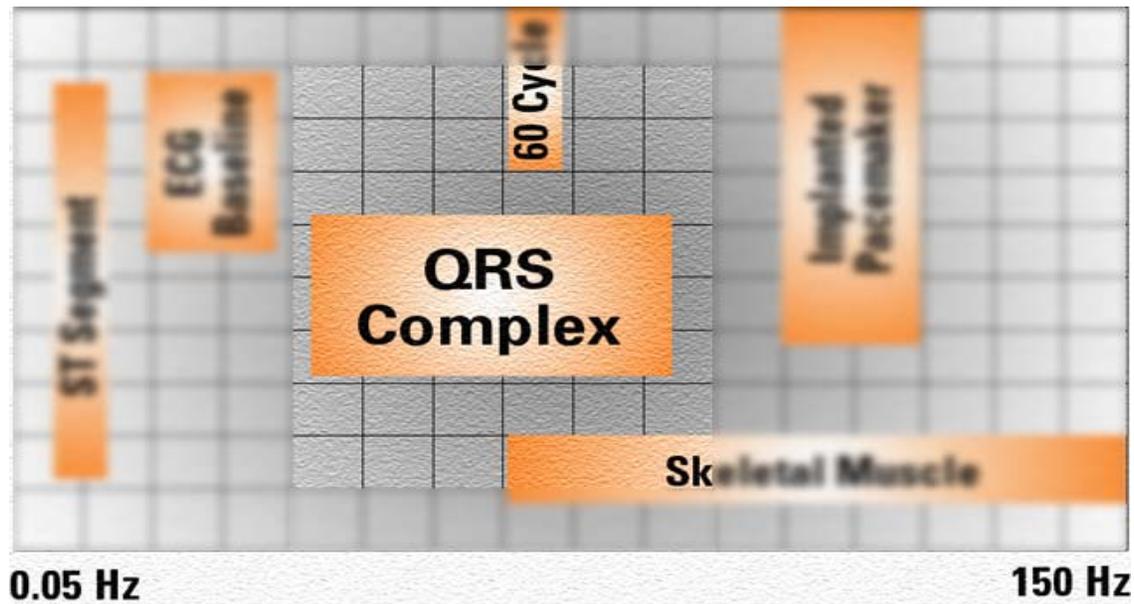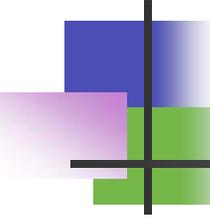
# Monitoring vs Diagnostic ECGs

- **Diagnostic Quality ECG**
  - Designed to accurately reproduce QRS, ST and T waveforms
  - Designed to look more broadly at the cardiac electrical activity
 - Unfortunately, may result in greater artifact being visible

Monitoring vs Diagnostic ECGs

Diagnostic Quality
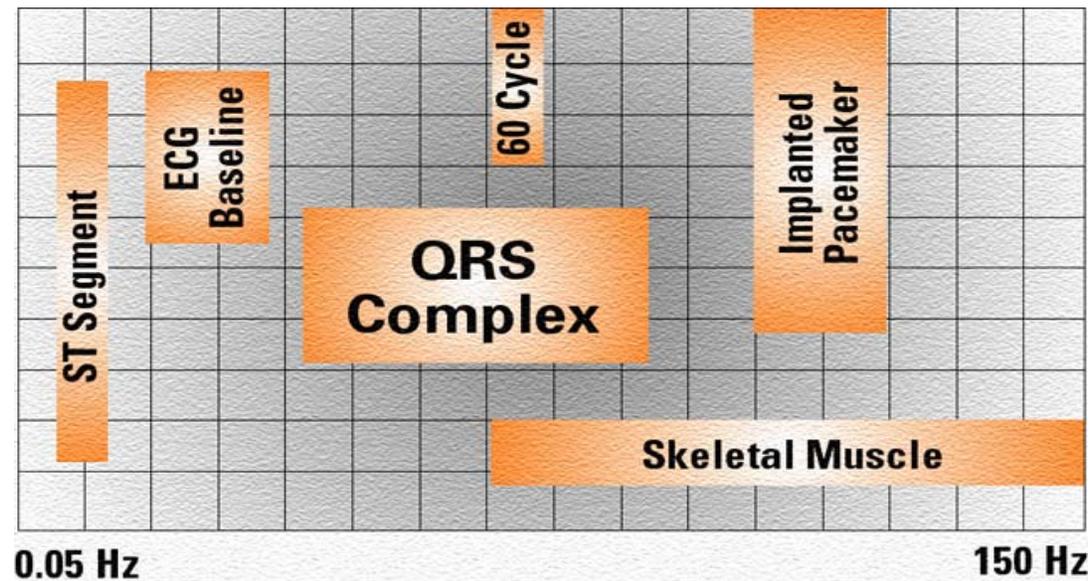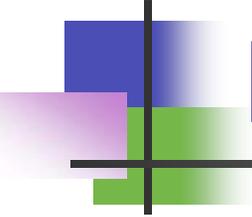
Monitoring vs Diagnostic ECGs

- Frequency Response
  - Term used to describe the breadth of the electrical spectrum viewed by the ECG monitor
  - Diagnostic quality is usually 0.05 Hz to 150 Hz
  - Monitor quality is usually 0.5 Hz to 20-50 Hz
  - Usually printed on the ECG recording strip

Monitoring vs Diagnostic ECGs
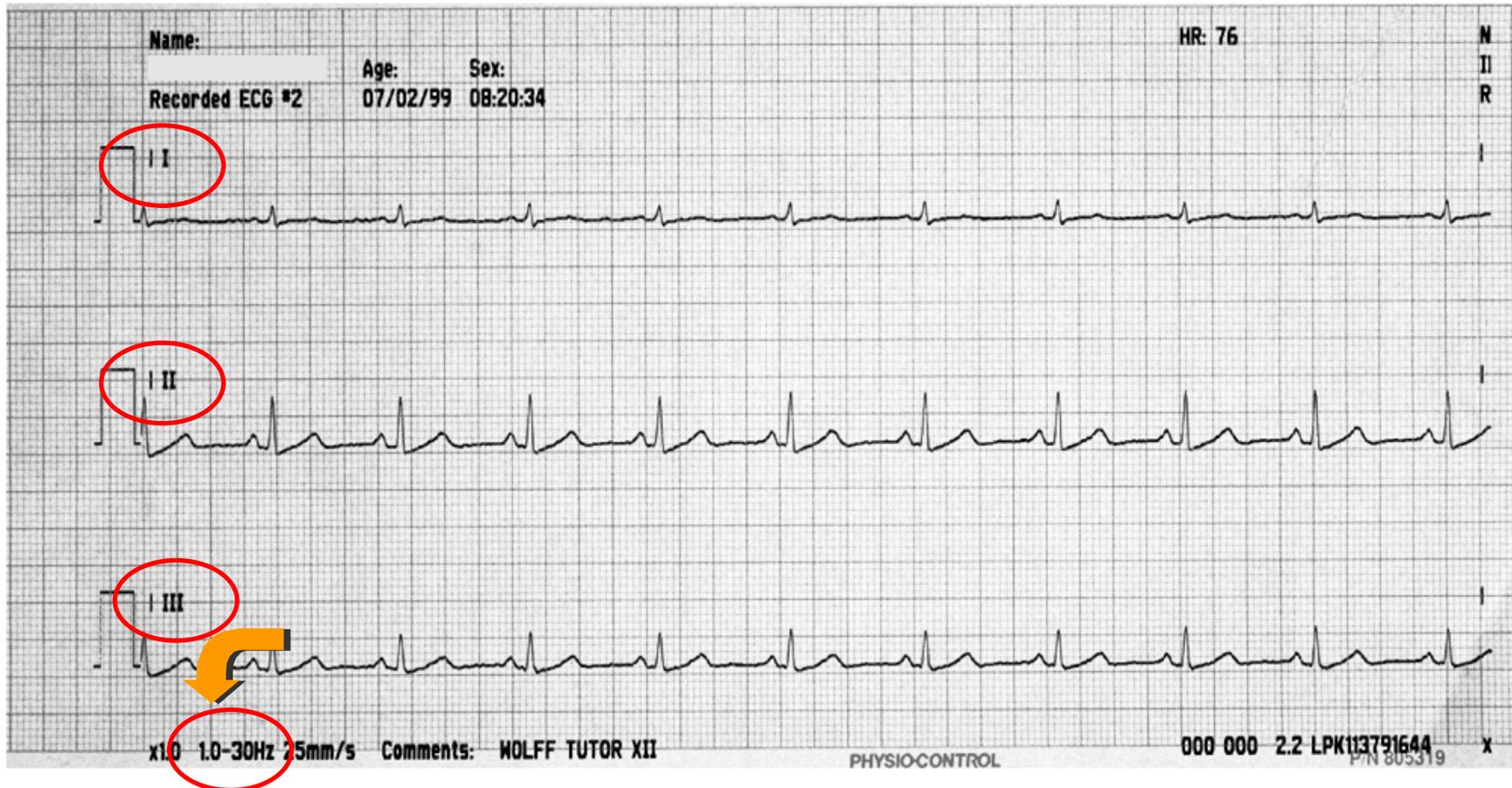
Monitoring vs Diagnostic ECGs
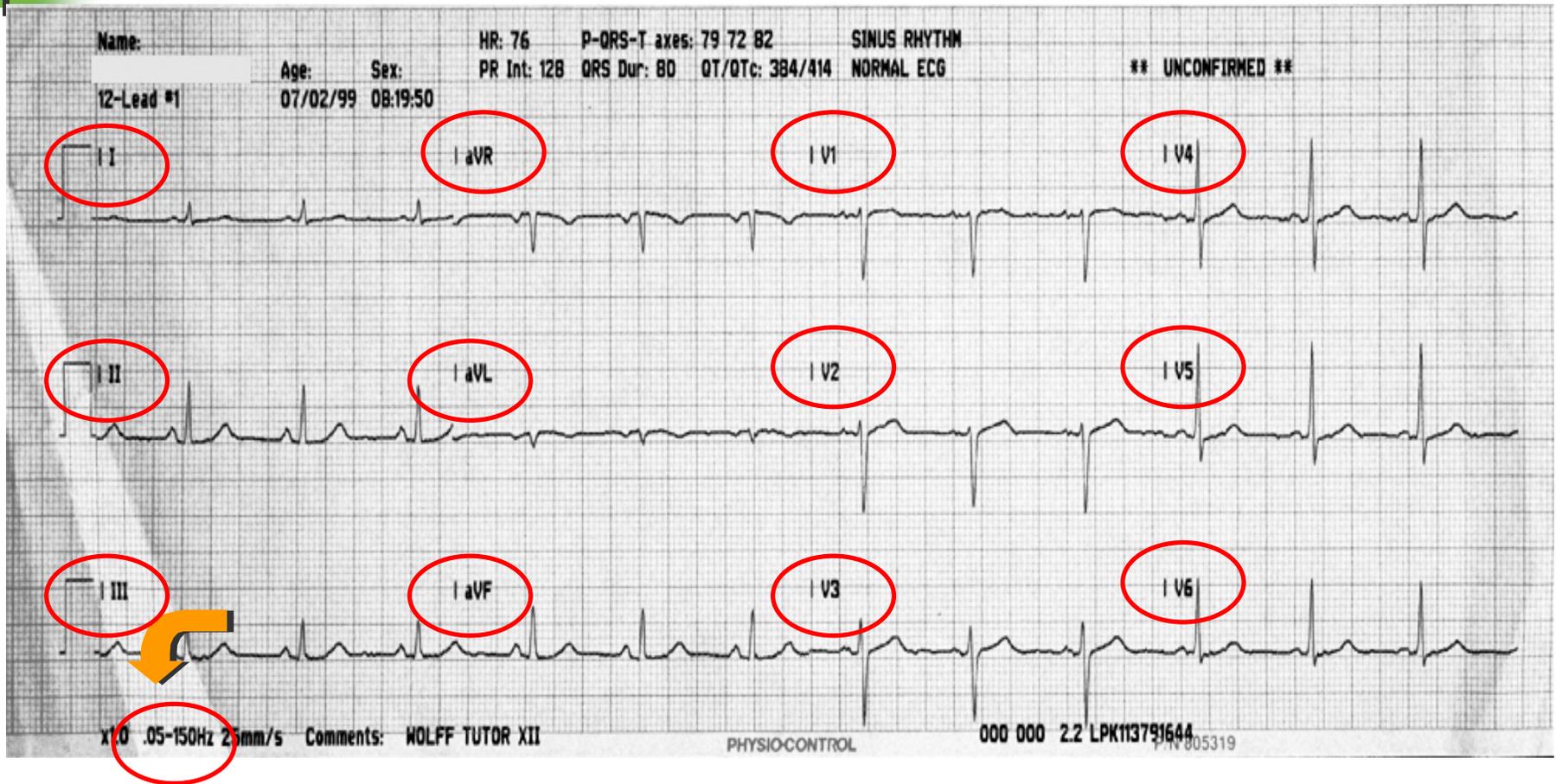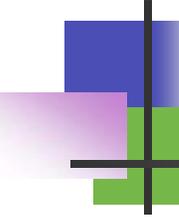
Acquisition & Transmission

- ECG quality begins with skin preparation and electrodes
  - Hair removal
  - Skin preparation
 - Age & Quality of Electrodes & Cables
  - Electrode Placement
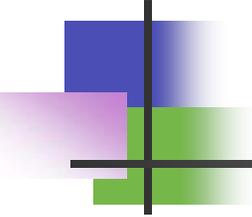
Acquisition & Transmission

- **Hair Removal**
  - Clipper over razor
    - Lessens risk of cuts
    - Quicker
    - Disposable blade clippers available
  - Most EMS systems use razors

Acquisition & Transmission
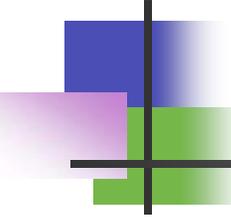
Acquisition & Transmission

- Skin Preparation
  - Helps obtain a strong signal
  - When measured from skin, heart's electrical signal about 0.0001 - 0.003 volts
  - Skin oils reduce adhesion of electrode and hinder penetration of electrode gel
  - Dead, dried skin cells do not conduct well

Acquisition & Transmission
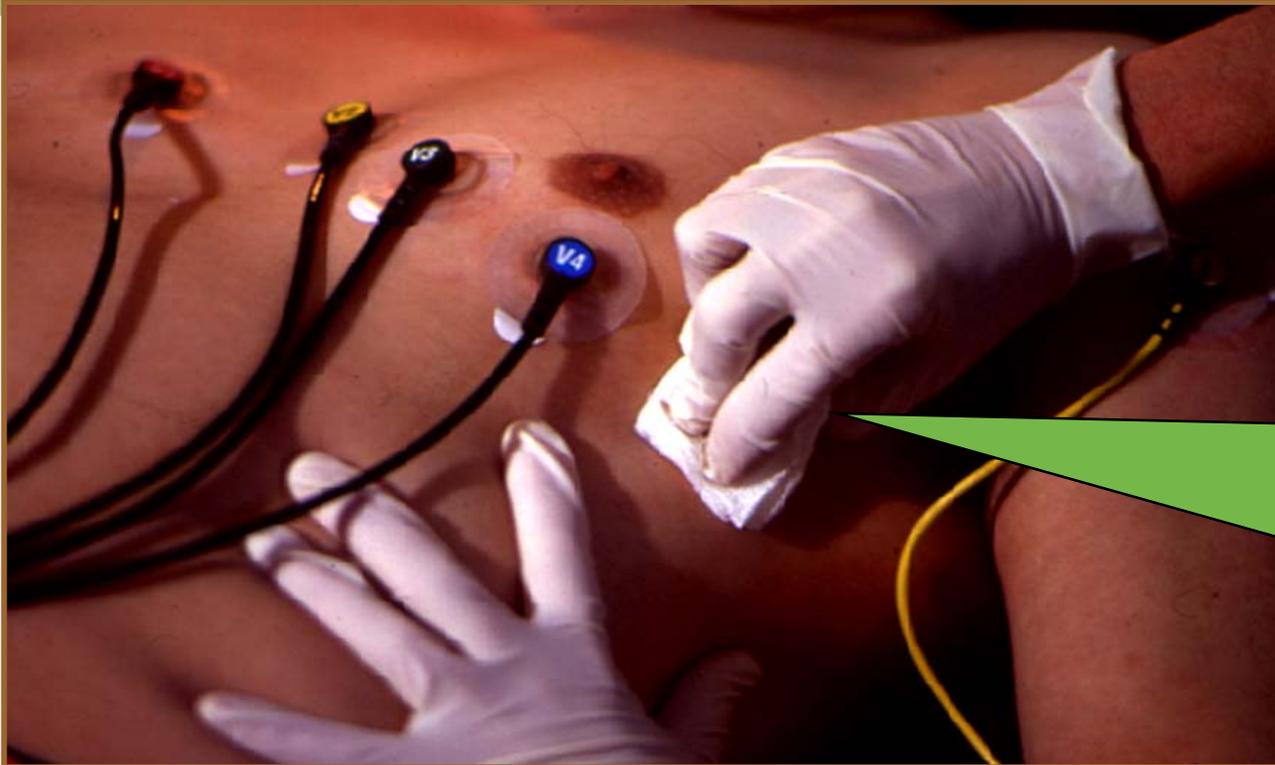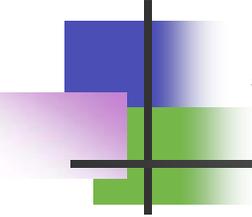
Acquisition & Transmission

- Other causes of artifact
  - Patient movement
  - Cable movement
  - Vehicle movement
  - Electromagnetic Interference (EMI)
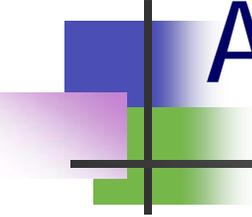
Acquisition & Transmission

- **Patient Movement**
  - Make patient as comfortable as possible
    - Supine preferred (30 degree angle)
  - Look for subtle movement
    - toe tapping, shivering
  - Look for muscle tension
    - hand grasping rail, head raised to "watch" causes muscle tremors
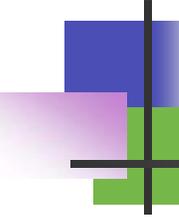
Acquisition & Transmission

- Cable Movement
  - Enough "slack" in cables to avoid tugging on the electrodes
 - Many cables have clip that can attach to patient's clothes or bed sheet
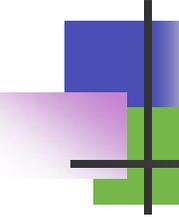
Acquisition & Transmission

- **Vehicle Movement**
  - Acquisition in a moving vehicle is NOT recommended
    - May or may not be successful
  - Tips
    - Pull ambulance over for 10-20 seconds during acquisition
   - Acquire ECG while stopped at traffic light
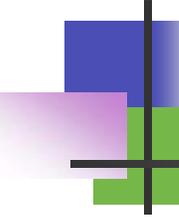
Acquisition & Transmission

- **Electromagnetic Interference (EMI)**
  - Can interfere with electronic equipment
  - 60 cycle interference is a type of EMI
  - Look for nearby cell phones, radios or electrical devices
  - No contact between cables & power cords
  - Turn off or move away from AC devices
  - Use shielded cables; inspect for cracks
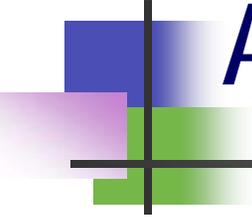
Acquisition & Transmission

- **Things to look for**
  - Little or no artifact
  - Steady baseline

Bad Tracing
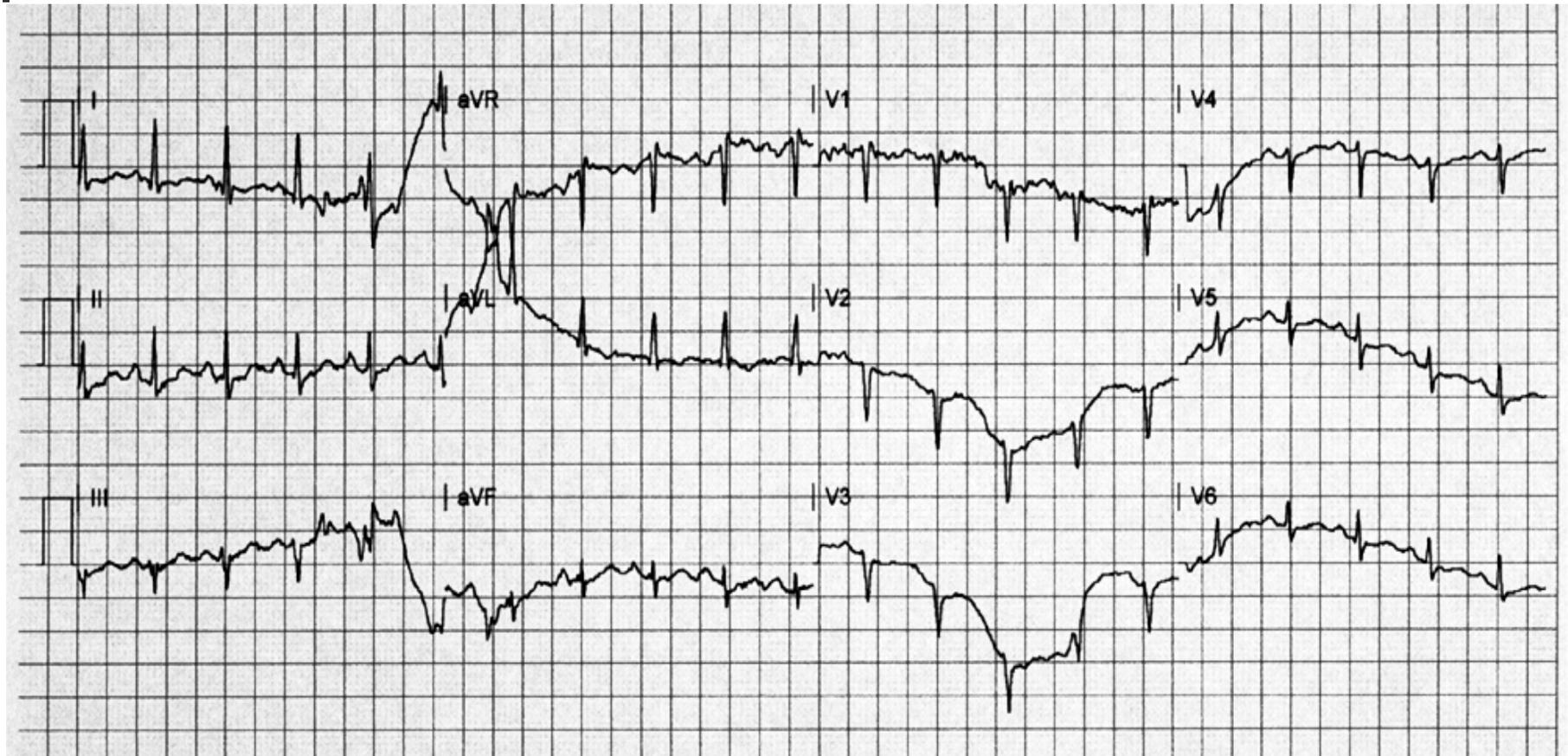
Better Tracing
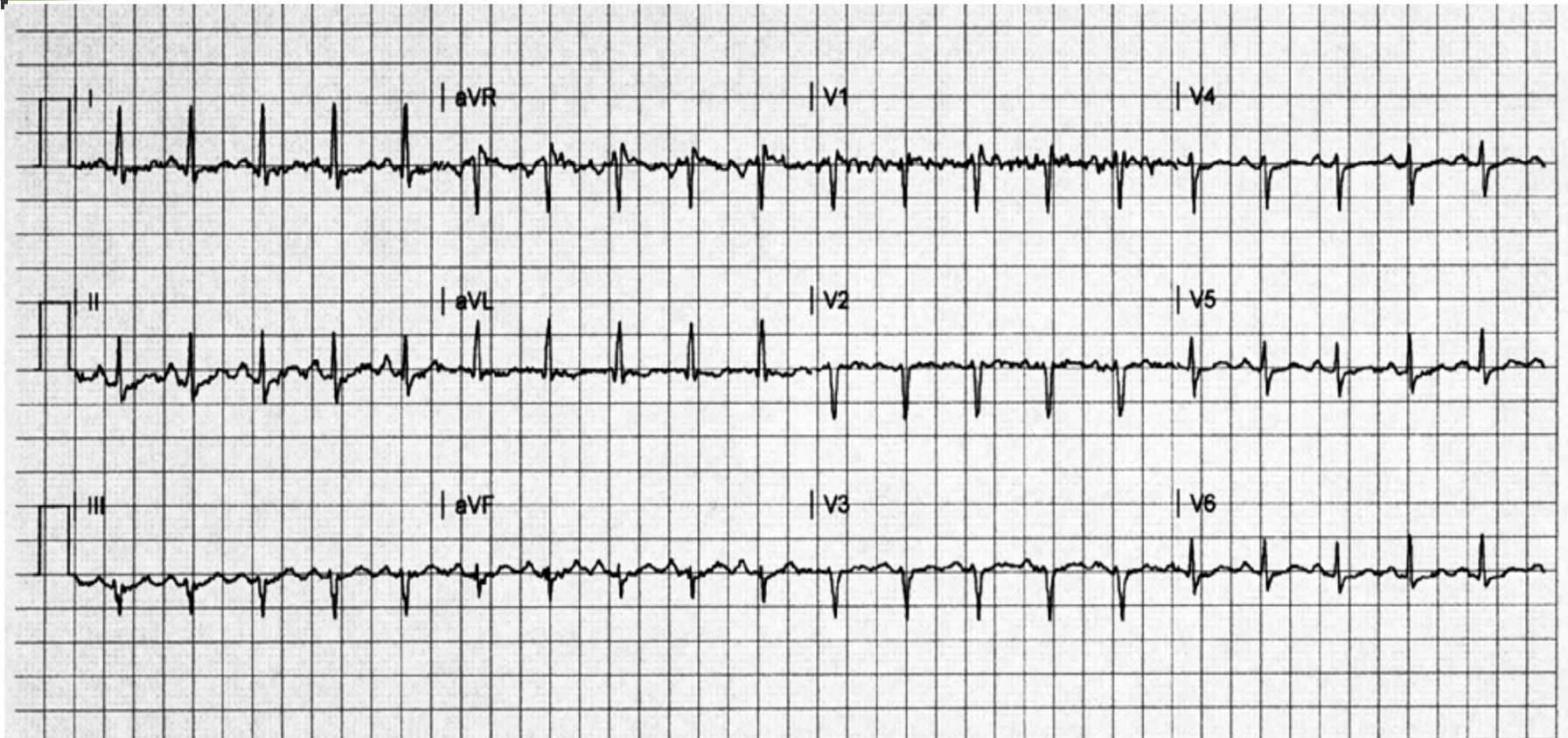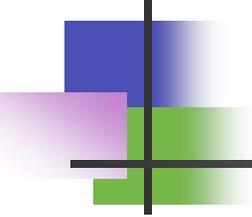
Acquisition & Transmission

- ECG Accuracy depends upon
  - Lead placement
  - Frequency response
  - Calibration
  - Paper speed

Limb Lead Placement
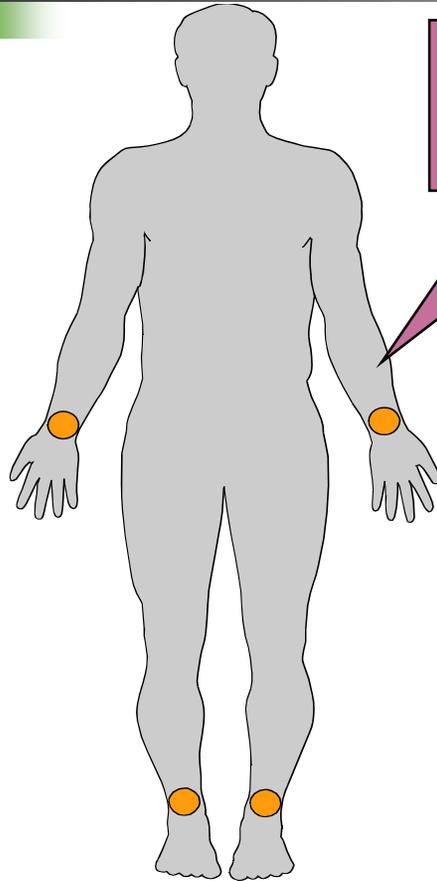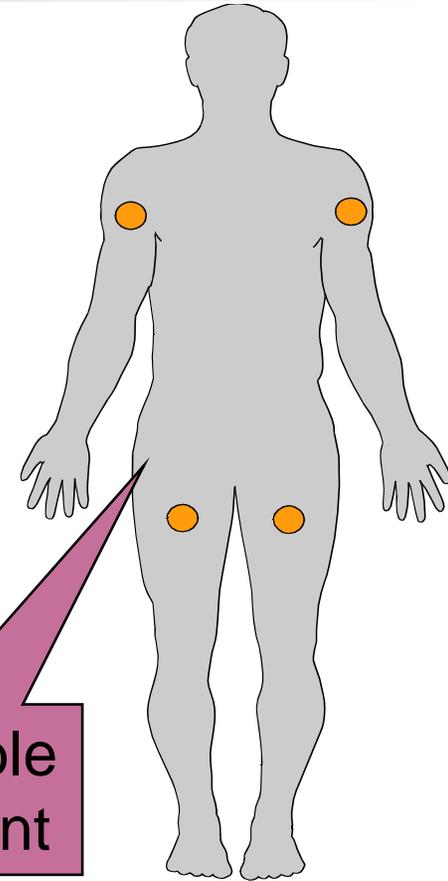
Chest Lead Placement
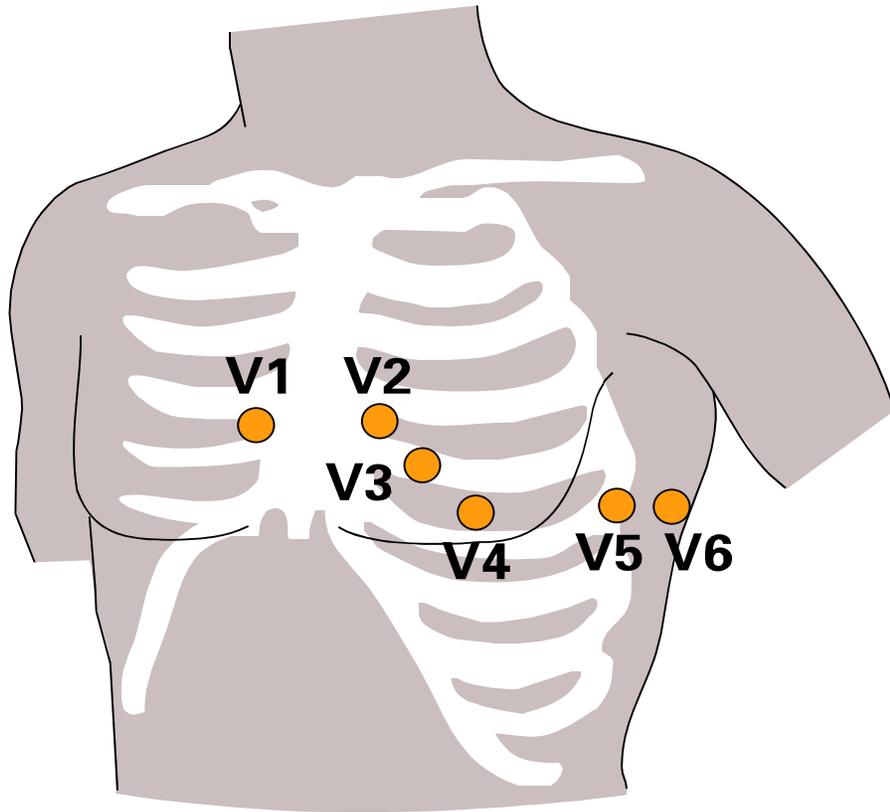
- V1: fourth intercostal space to right of sternum
- V2: fourth intercostal space to left of sternum
- V3: directly between leads V2 and V4
- V4: fifth intercostal space at left midclavicular line
- V5: level with V4 at left anterior axillary line
- V6: level with V5 at left midaxillary line

Chest Lead Placement
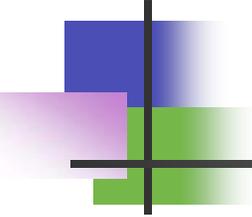
ECG Accuracy

Look for:

- Negative aVR
    - if aVR upright, look for reversed leads
- One complete cardiac cycle in each lead
- Diagnostic frequency response
- Proper calibration
- Appropriate speed
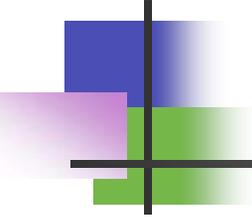
ECG Accuracy

- Frequency Response
  - Display screen is non-diagnostic
  - Use the printed ECG for ST segment analysis
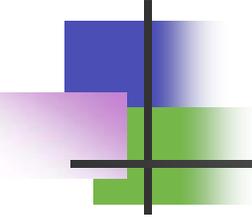
ECG Accuracy

- Calibration
  - Voltage measured vertically
  - Each 1 mm box = 0.1 mV
  - 1 mV = 10 mm
    - calibration standard
  - Confirm calibration
    - calibration impulse should be 10 mm (2 big boxes tall)
   - stated calibration should be "x 1.0"

Calibration

HR: 59   P-QRS-T Axes: -26 -40 2
PR Int: 148   QRS Dur: 100   QT/QTc: 388/388

8:08:37 PM   7/27/98   12-Lead #1

I   aVR   V1   V4

II   aVL   V2   V5

III   aVF   V3   V6

Calibration

x1.0   0.05-150Hz   25mm/sec   11 11 2.6 LPK112673
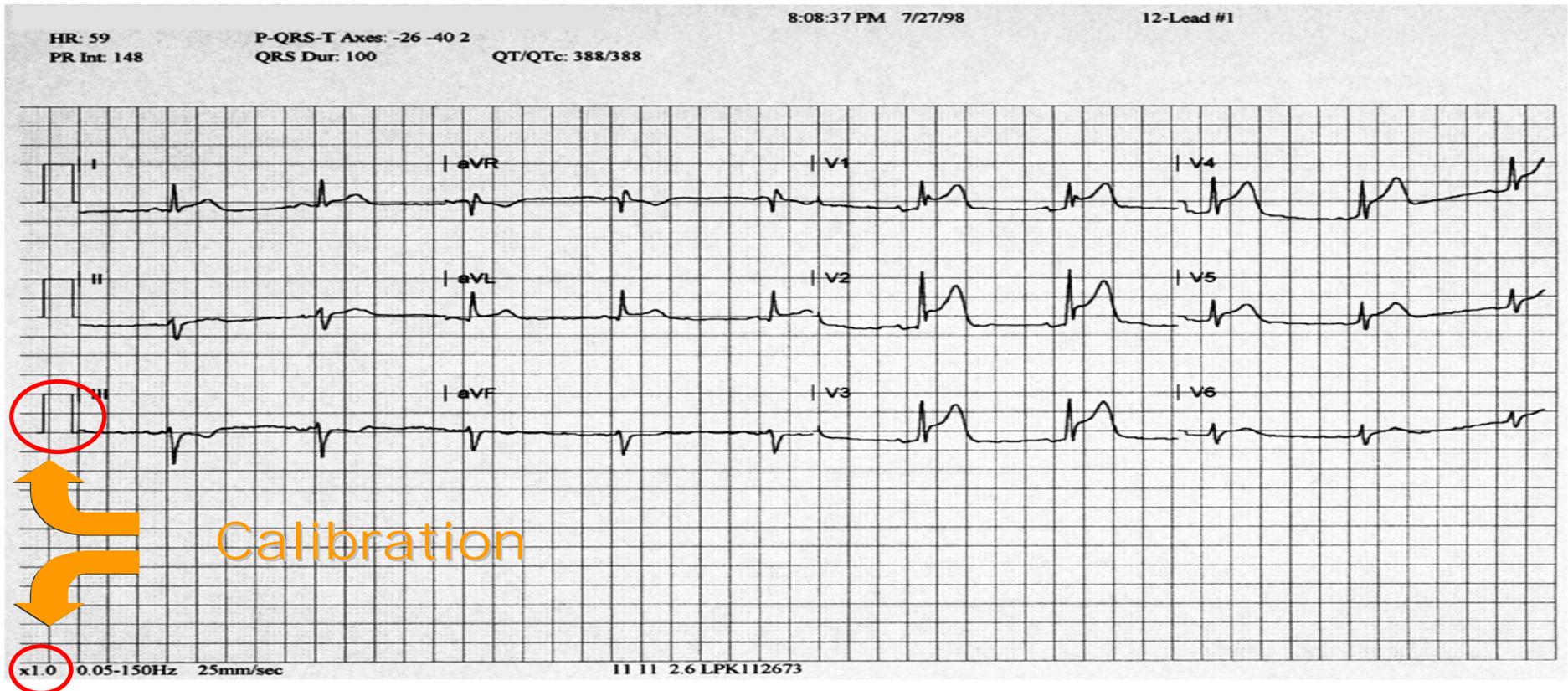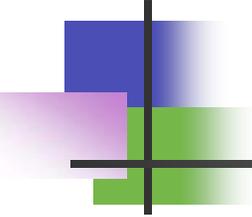
ECG Accuracy

- **Paper Speed**
  - Standard is 25 mm/sec
    - Faster paper speed means the rhythm will appear slower and the QRS wider
    - Slower paper speed means the rhythm will appear faster and the QRS narrower

Paper Speed
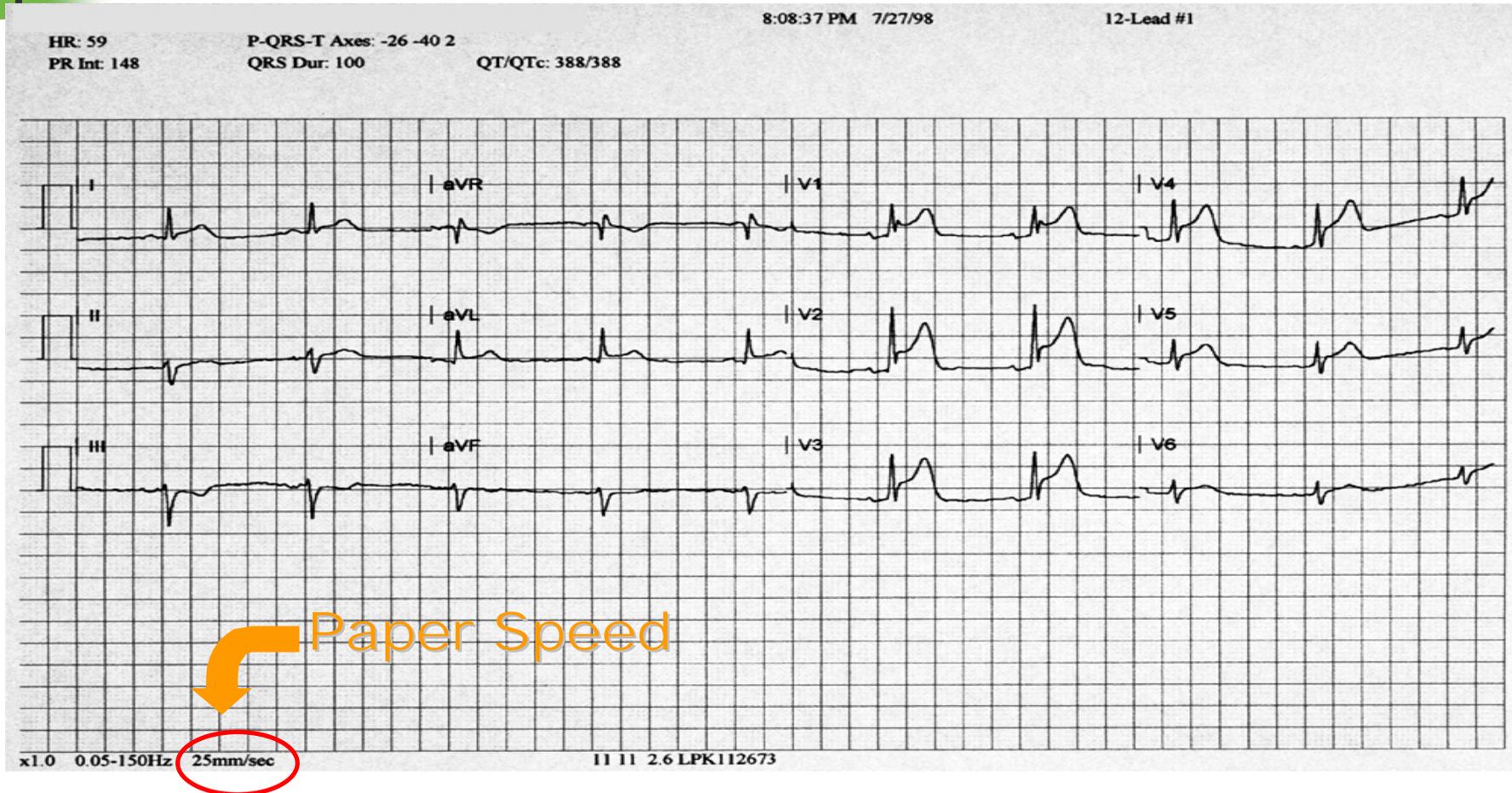
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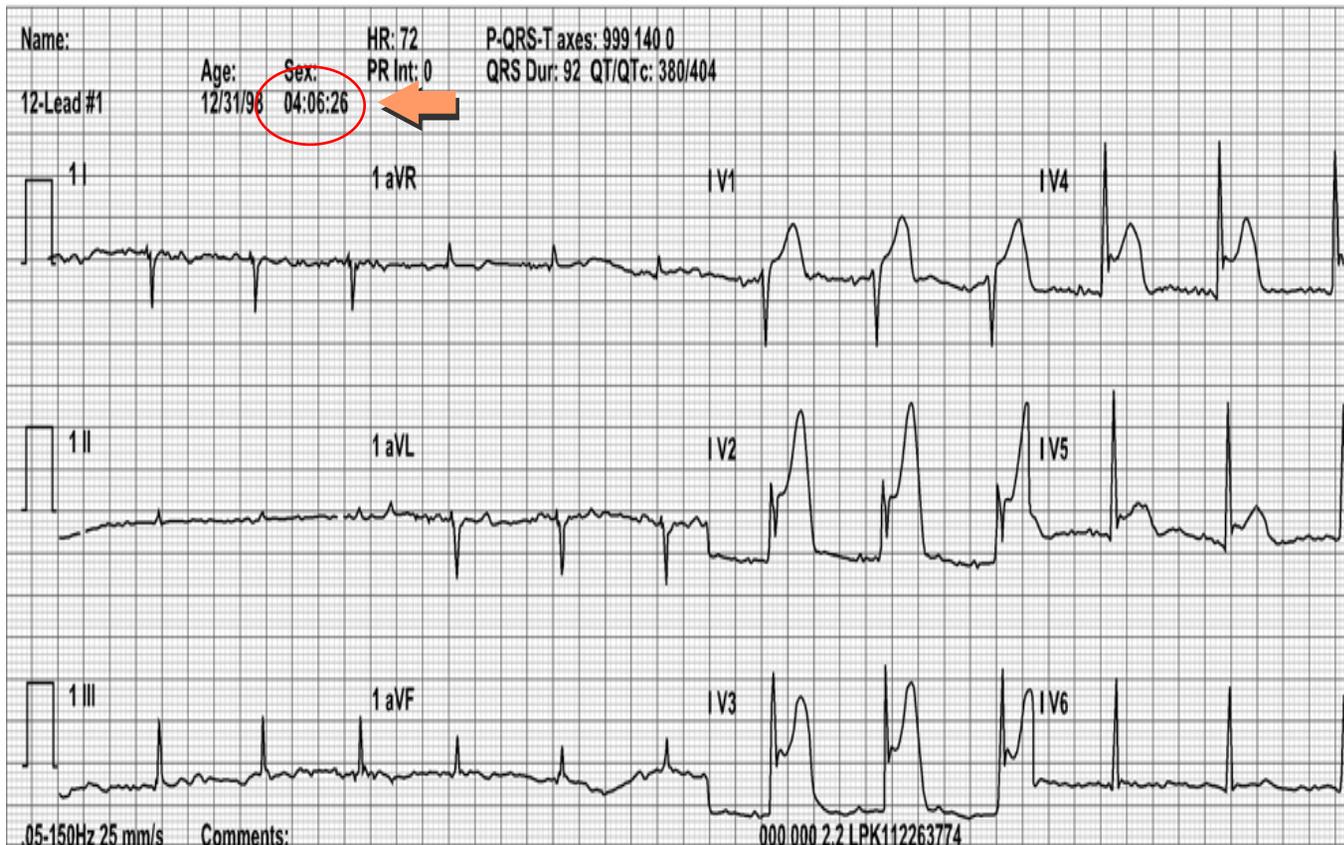
When to Acquire

Note times and differences in these two ECGs for the same patient
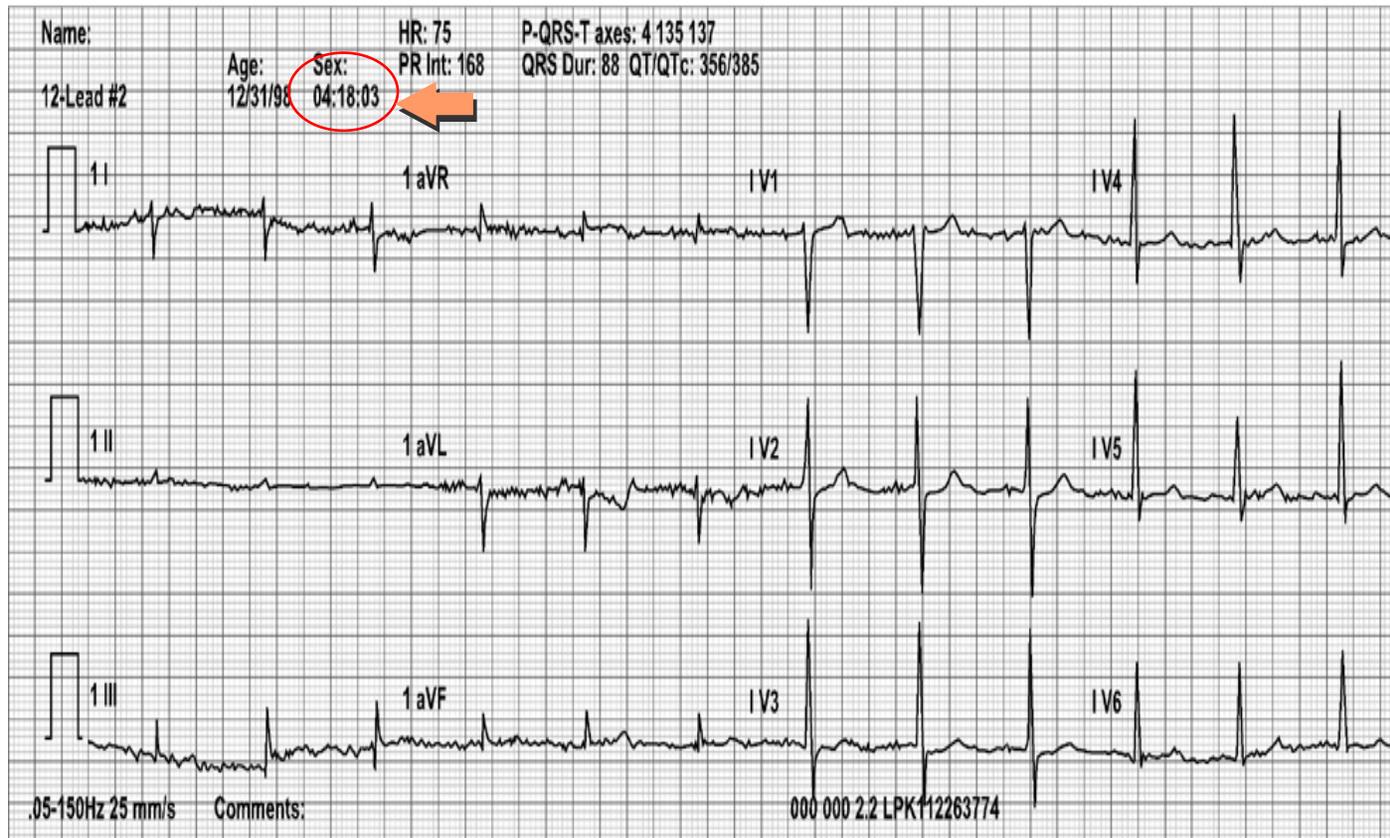
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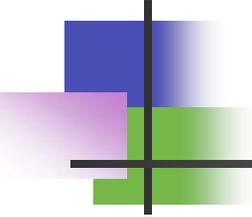
When to Acquire

Assessment	Treatment
Vital Signs	Oxygen
Oxygen Saturation	Aspirin
IV Access	Nitroglycerin
12-Lead ECG	Fentanyl
Brief History	

Modified from *"The Ischemic Chest Pain Algorithm"*, ACLS Textbook, Chapter 9, American Heart Association, 1997.
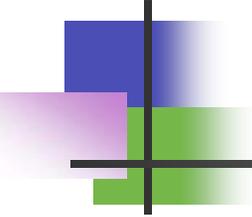
Exposing the Chest

Immediately upon suspecting ACS...

- Remove all clothing above the waist
  - Or, open shirt/blouse
- Replace with gown (if possible)
  - Allows for complete exam
  - Minimizes wire entanglement
  - Enhances quick defib if VF occurs
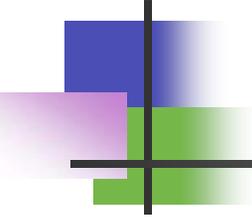
Transmission

- Transmit information as soon as possible
    - Can use patient's land-line
    - Many EMS systems use cell phone enroute
- Coordinate with ED
    - Correlate ECG with a specific patient
    - Early notification of AMI is key!!!
    - Remember STEMI!!!
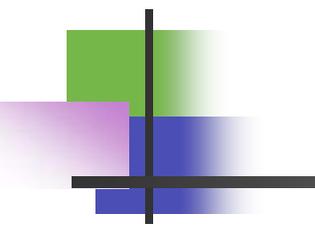
Special Thanks!

To Acute Coronary Syndrome Consultants, Inc.

Tim Phalen, Gary Denton and Assoc.

and Temple College for the use of their materials in this presentation