

Bedside ECG Monitoring For Nurses

BSM 6000 Series
November, 2010

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Purpose:

This self study packet is designed to introduce the monitoring users to the basic principles and procedures for ECG monitoring on the Nihon Kohden BSM 6000 bedside monitors.

Learning Objectives:

By completing this self-study packet, you will be able to:

1. Discuss normal cardiac anatomy and physiology.
2. Describe the significance of each ECG lead.
3. Discuss procedures for ECG electrode placement and skin preparation.
4. Discuss how the bedside monitor processes the ECG waveform for heart rate and arrhythmias, and for pacemaker detection.
5. Discuss the troubleshooting procedures for inaccurate heart rate and arrhythmia detection, and for pacemaker detection difficulties.
6. Discuss the ST-segment monitoring capabilities on the bedside monitors.

Introduction

The 12-lead ECG is used to help identify primary conduction abnormalities, arrhythmias, cardiac hypertrophy, pericarditis, electrolyte imbalances, myocardial infarction or ischemia, and the site and extent of these disorders. The benefits of the 12-lead are expanded as we continuously monitor the ECG leads, either all 12 or a subset of them, on the bedside and telemetry monitoring systems today.

This packet will quickly review the cardiac anatomy, and describe how the ECG tracing correlates to it. It will review how the bedside monitor processes the ECG waveform for heart rate and arrhythmias, and for pacemaker detection, and, it will discuss troubleshooting procedures for ECG monitoring processes. In addition, it will discuss the ST-segment monitoring capabilities on the Nihon Kohden bedside monitors.

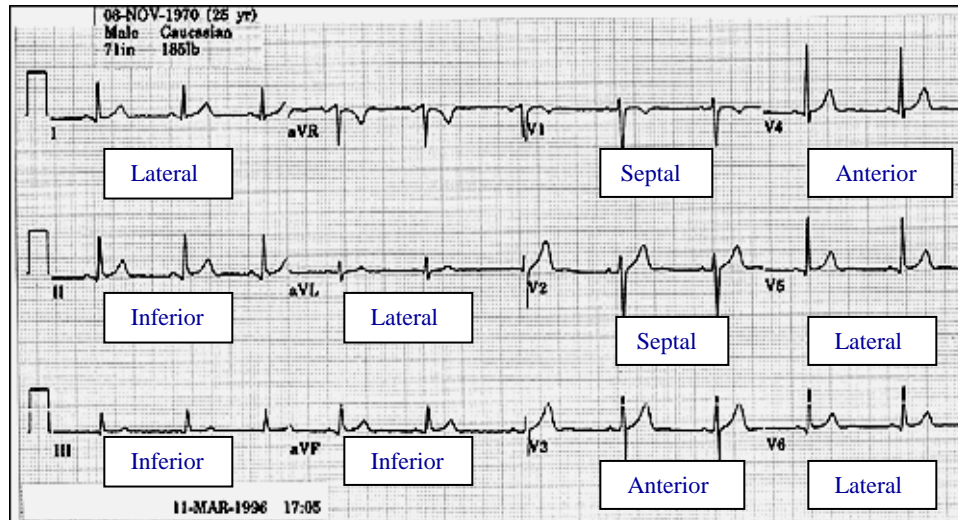
Lastly, this packet will briefly review the capabilities of the ZM-930PA multi-transmitter that is used in some nursing units with bedside monitors.

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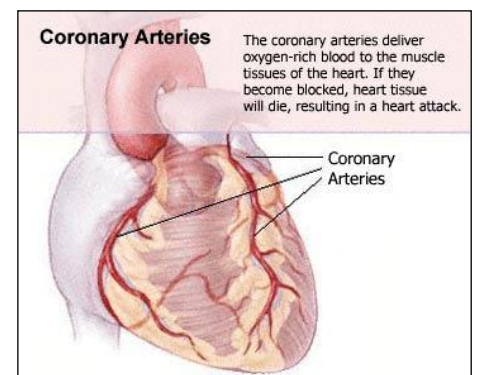
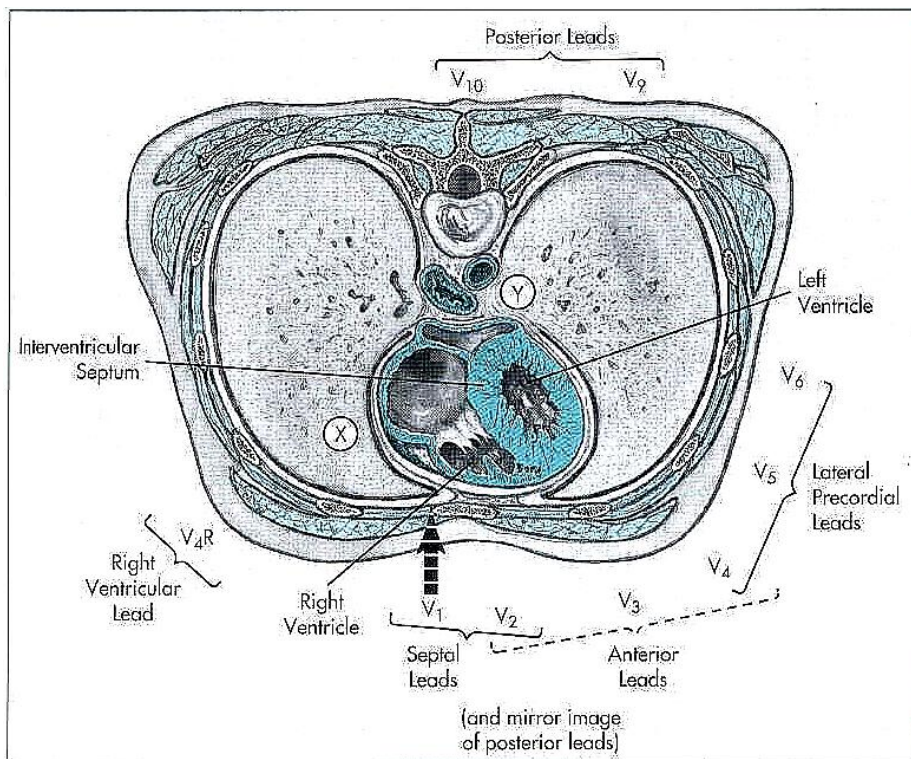
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12-lead ECG

The 12-lead ECG is an electrical snapshot of the heart, and predominantly of the left ventricle, which is a cylindrical shaped chamber and functions as the “workhorse” of the heart. Because it is the portion of the heart that pumps blood to the body and faces the highest after load pressures, it is the most vulnerable to circulatory and conduction abnormalities (Grauer, K., 1998).



Each lead on the sample represents a portion of the left ventricle, which are referred to as the septal, anterior, inferior, and lateral walls. The posterior wall is represented indirectly in the septal leads. Each of these walls is supported by a coronary artery, as depicted in the picture below (Yanowitz, F.G. 1997, Goode, D.P. 1984).



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Cardiac Anatomy and Physiology

The heart consists of four separate chambers, the right and left atria and the right and left ventricles. These chambers are separated by muscle walls vertically and valves horizontally. The tricuspid valve separates the right atria and right ventricle and the bicuspid valve separates the left atria and left ventricle. The primary purpose of the heart is to continually receive and pump the body's blood supply to and from the lungs for receiving oxygen and eliminating carbon dioxide, and to and from the body to exchange these same gases at the cellular level.

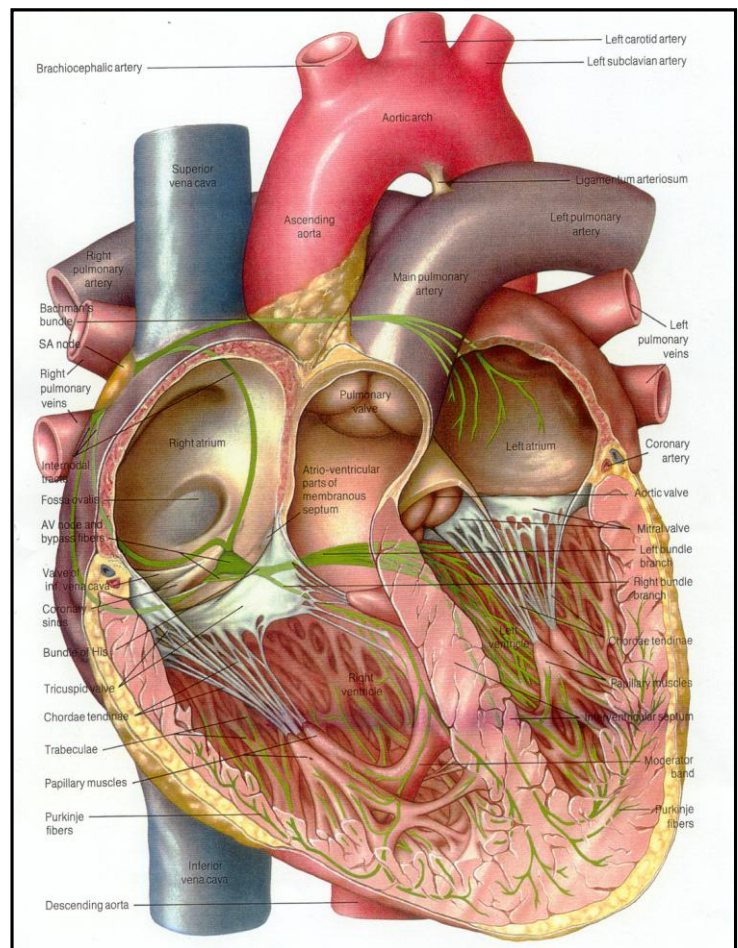
Cardiac Electrical System

In review, the heart is stimulated to contract by its own internal electrical system; the heart's generator if you will. This electrical system consists of impulse generator cells, as well as impulse conductor cells that conduct these impulses to the myocardium to stimulate it to contract and pump the blood.

The Sino-atrial (SA) node, which is located high in the right atrium, is the normal pacemaker in the heart that sets the rhythm and rate for the cardiac function. Once the impulse is generated in the SA node, it spreads throughout the atria and down to the atrio-ventricular (AV) node, where it is held so that the atria can contract. When the impulse leaves the AV node, it travels through the Bundle of His, down through the right and left Bundle branches to the Purkinje fibers that are in contact with the ventricular myocardium.

Once these cells are stimulated, they contract and squeeze the blood from the ventricles and out to the body. It is this ventricular contraction that produces the palpable pulses.

The electrical activity **MUST** precede the mechanical activity, so it is the electrical activity that we capture on the monitor as the ECG signal, **NOT** the mechanical contraction that generates the pulse.



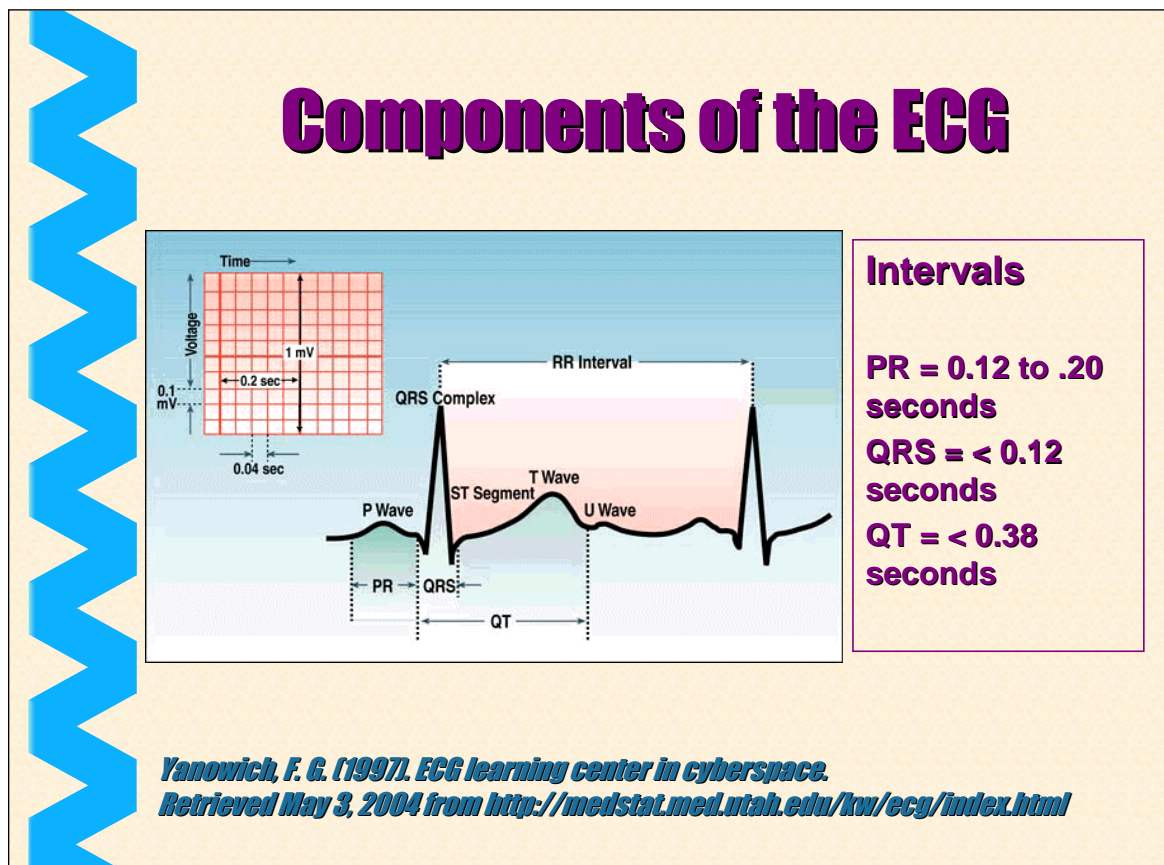
Goode, D.P. (1984)

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The Electrocardiogram

The electrocardiogram (ECG) is the electrical activity that is captured by placing conductive electrodes onto the patient. As the impulses travel throughout the heart's chambers, specific components are produced on the ECG. The p-wave represents atrial depolarization, which are the electrical changes that are required in order for the muscle to contract. The PR segment represents the length of time that the impulse is held in the AV node and Bundle of His before it proceeds through to the Bundle branches. The QRS represents the wave of ventricular depolarization as it travels through the right and left Bundle branches and the Purkinje fibers to stimulate these cells. The t-wave represents ventricular repolarization, where the myocardial cells return to the normal electrical state and prepare to receive the next impulse. Our interest lies in the lengths of time that it takes for each of these events to occur, and the normal times are listed in the image below.



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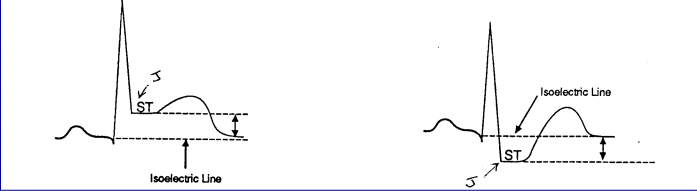
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ST Segment

Another component of the ECG tracing is the ST segment. This represents the beginning of ventricular repolarization, and should be a relatively flat portion of the tracing. This flat area on the baseline is referred to as “isoelectric” (iso = same) and it is considered to be abnormal when it is elevated or depressed. Either of these conditions may indicate an abnormal and/or ischemic (insufficient blood flow) condition within the myocardial cells. Typically, this movement from this isoelectric line is measured in millimeters (mm), and is considered to be significant when there is 1 mm of elevation or 2 mm of depression.

ST - Segment

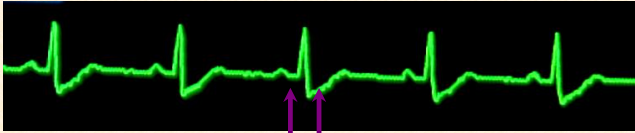
**Elevation = above isoelectric line
(myocardial ischemia in AMI - STEMI)**



The diagram shows two ECG waveforms. The left waveform shows a QRS complex followed by an ST segment that is elevated above a dashed horizontal line labeled 'Isoelectric Line'. A double-headed arrow indicates the vertical distance between the ST segment and the isoelectric line. The right waveform shows a similar QRS complex but with an ST segment that is depressed below the dashed horizontal line labeled 'Isoelectric Line'. A double-headed arrow indicates the vertical distance between the ST segment and the isoelectric line.

**Depression = below isoelectric line
(myocardial ischemia - CAD)**

ST - Segment Measurement



The image shows a green ECG tracing on a black background. A horizontal dashed line is drawn across the tracing, labeled 'Isoelectric line'. A vertical double-headed arrow is drawn from the isoelectric line to the ST segment of a QRS complex, labeled 'ST - segment relative to isoelectric'.

Normally measured in millimeters

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ECG Electrode Placement

In order to capture this electrical signal from within the patient, we must place conductive electrodes in strategic positions on the body, and the exact placement is important to insure accurate interpretation. Since the heart rests within the patient's chest, for continuous ECG monitoring, we place the limb electrodes on the chest, at the mid-clavicular lines and at the anterior axillary lines on the lower ribs. Each lead wire is labeled for the anatomical position, such as right arm (RA), left arm (LA), right leg (RL), left leg (LL), and Chest (V) 1-6. Placing them in these positions minimizes motion artifact and provides for quality tracings. The exact placement is shown below.

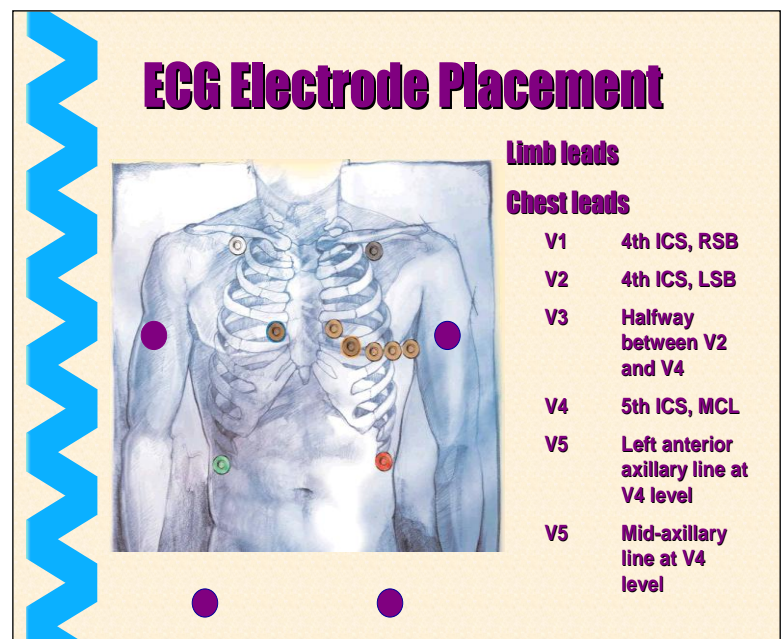
For diagnostic 12-lead samples, the Cardiologist usually prefers that the arm and leg electrodes are moved from the torso to the extremities themselves. You, as a clinician, make this decision according to policy when you do the procedure.

Skin Preparation

But not only is it important to place the electrodes correctly, but it is even more important to prepare the skin to conduct the impulses from the patient to the monitor. The following procedure for continuous ECG monitoring is accepted as policy at Renown and is supported by the American Association of Critical Care Nurses (AACN)

1. Select electrode site according to placement diagram and the patient's condition
2. Shave or trim excess hair
3. Gently abrade skin with dry gauze to remove dead cells. Dead cells interfere with electrical conduction and cause inadequate tracings for analysis
4. If the skin is oily, clean site with alcohol and friction if necessary to remove skin oils and allow the site to dry. This step is not required for every patient
5. Attach lead-wire to electrode
6. Attach electrode to patient, pressing circumference of electrode to secure
7. Change electrodes every 24 hours to insure adequacy of adhesive and conduction medium

NOTE: Fasten lead-wire to skin with tape to minimize interference from patient motion (Stress Loop), if necessary.



ECG Electrode Sidebar

Prepping the skin is crucial as ECG electrodes conduct the small electrical currents (less than 1mV) from the patient to the monitor. The monitor, or transmitter, then amplifies this current so that it can be displayed on the screen. If an electrode becomes dry or makes poor contact with the skin, or if the dead skin cells accumulate under it, it cannot conduct the current, but rather, holds onto it, causing a "saturation" of the ECG signal on the screen. When this occurs, the signal is too strong for the monitor to display until the electrode discharges it, much like a static electricity discharge. When the signal is saturated, an offset is seen on the ECG tracing and a loss of signal is detected until the charge is released, and the electrode can continue to conduct.

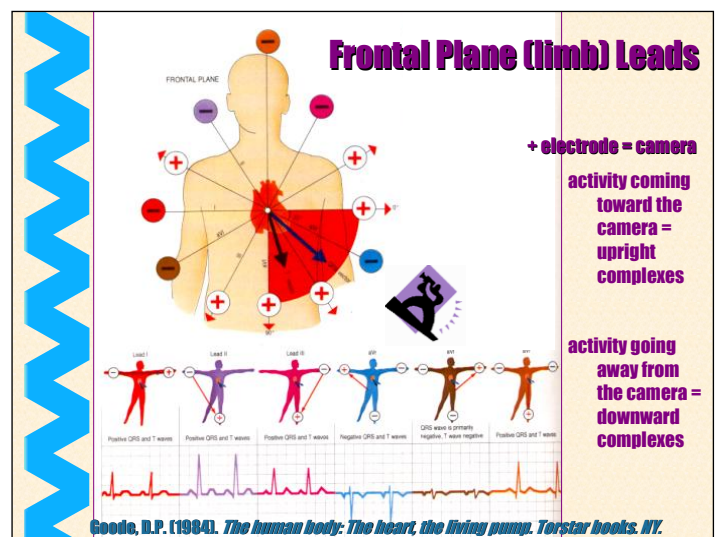
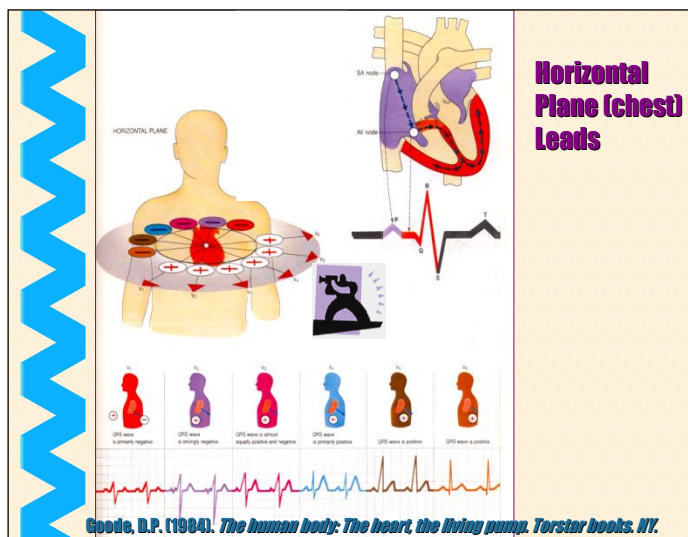
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Continuous ECG Monitoring

Once the electrodes are placed correctly, and the lead wires are attached, the signal is acquired and displayed on the monitor. If we are monitoring all twelve ECG leads, they will appear collectively or individually as selected by the clinician. We know that the heart produces its own electrical signals, and that the flow is typically occurring in a consistent manner with each cardiac cycle. This flow is in a leftward and inferior direction, and the “leads” are actually vectors, or views, of that ECG signal, from different strategic points on the body. These leads are acquired through the ECG electrodes and lead wires, working together to produce a comprehensive image of the heart.

Einthoven first captured this ECG signal in 1902 by placing metal electrodes into his subjects’ skin (Drew, 2002). One electrode had a positive charge, another had a negative charge, and still another served as the ground to produce an electrical circuit. The positive electrode was the one used to capture the signal from within the subject, but the negative electrode and the ground were required in order to do so. Now, our multiple lead wires allow us to view different leads by alternating the positive, negative, and ground charges, depending on which lead we want to view. Think of each of these positive electrodes as cameras, taking movies of the electrical activity as it moves through the heart. The pictures below illustrate the positive and negative poles for each lead.



We are able to view twelve ECG leads with only ten electrodes because the four limb electrodes capture the bipolar leads I, II, and III, aVR, aVL, and aVF to provide the six limb leads. Add the six uni-polar chest leads, and you have the 12-lead ECG.

As we view these ECG limb leads and chest leads, any activity that the camera captures coming toward it produces a positive deflection from the isoelectric line on the ECG tracing. If the activity is moving away from the camera, a negative deflection is produced. The ECG signal is a series of positive and negative waveforms that are produced as the activity moves through the three dimensional cardiac structure. You can see what the normal complexes should look like in each lead in the pictures above. Either we can monitor these leads continuously, or we can capture a 10-second 12-lead “snapshot” to use as a diagnostic tool.

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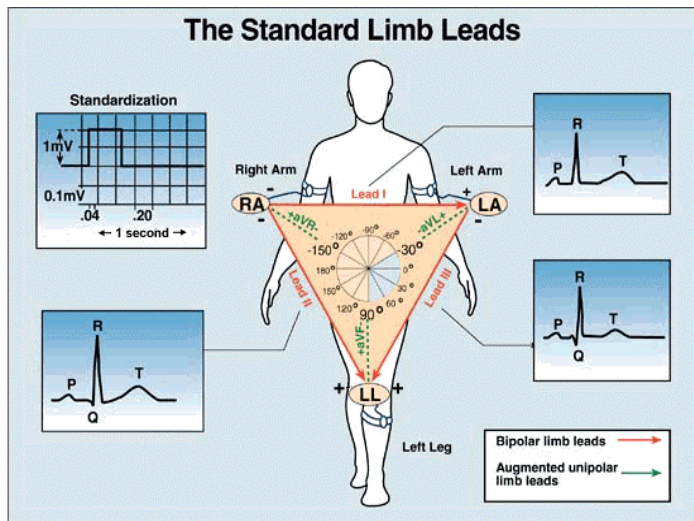
Arrhythmia Monitoring

Continuous ECG monitoring capability began in the early to mid 1960's through a joint campaign by the American Heart Association and the American Medical Association (Meltzer, 1965). These two organizations combined efforts to research ways to decrease mortality from myocardial infarctions (MI), as they learned that a major risk of death in these patients was for sudden cardiac death from ventricular arrhythmias.

The first cardiac care units were opened in the mid 1960's with physician-trained cardiac nurses who cared for the patients and observed continuous ECG tracings for changes in the rhythm. As a result of this initiative, countless lives were saved and intensive care units with ECG and bedside monitoring capabilities evolved to the point that they are today.

One aspect of today's ECG monitor is the capability to monitor for arrhythmias. This computer algorithmic function was first introduced as an adjunct to the heart rate alarms in 1969. Many changes have occurred since then, but the basic function remains the same, whereby the monitor "learns" a dominant QRS complex (the one that occurs most frequently during the learning phase), and then compares all other beats to this.

The early days of ECG monitoring allowed clinicians to view a single lead of ECG. This single lead was lead II from Einthoven's triangle, as it was the lead with the tallest QRS due to the "camera angle" of the triangular electrode placement. But as medical researchers discovered the value of continuously viewing different ECG leads, the ECG monitoring capabilities evolved to include a 5-electrode monitoring system that allowed for continuous monitoring of up to 7 ECG leads, to include one V (chest) lead. Drew (2003) discusses the benefit of monitoring V1 to diagnose tachy-arrhythmias by the related morphological changes that are observed in the tracing. The table below (Drew, 2002) illustrates these changes.



Einthoven's Triangle (Yanowich, 1997)

Configuration V_1	Favors
Taller left peak 	VT
Biphasic RS or rS 	VT
Triphasic rS ^R or rR ^R 	SVT

V1 Morphology (Drew, 2002)

Today, we use a 6-electrode monitoring set to provide for monitoring two V-leads; V1 for arrhythmias and typically, V3 for monitoring the ST segments in the anterior wall. We will discuss ST segment monitoring later in this article. Typically, lead II is displayed as the top ECG waveform on the bedside monitor because it provides for the tallest QRS to be used for heart rate and arrhythmia detection. Lead V1 is typically displayed as the second ECG lead to be used for comparison in real-time and stored waveforms, but the clinician is able to change these leads in the ECG setup menu based on the need for monitoring on the individual patient. V6 may be used for arrhythmia monitoring if the V1 position is not available due to dressings, etc.

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Arrhythmia Monitoring

The ECG waveform is monitored for heart rate, arrhythmias, ST segment measurements and pacemaker activity. Single or multi-lead analysis is available, and when ARRHYTHMIA ANALYSIS setting is set to ON, the monitor uses a template matching method to determine the ECG rhythm in the monitored analysis lead or leads. It “learns” the rhythm over about a 10-second period and displays the dominant QRS when the patient is attached to the monitor, when the lead is changed, when a “CHECK ELECTRODE” alarm is resolved or when the patient’s dominant ECG waveform changes. This dominant QRS(s) is displayed in the ECG menu and is the reference waveform that is used to compare with each beat of the real time waveform and to label arrhythmias accordingly. Up to eight templates are created if the complexes are variable, such as with atrial fibrillation, and with demand pacemakers. If the new beat exceeds the criteria for a normal beat, the monitor will analyze it and make a call based on the following criteria:

Event	Description
Asystole	> 3-10 seconds (selectable) with no QRS – most select 3 seconds
VF	Greater than four seconds of ventricular fibrillation
VT	Ventricular Tachycardia. 9 or more consecutive VPC’s at a rate >100/min
VPC Run	VPC short run. User selects 3-8 consecutive VPC’s – most select 3
Couplet	Paired VPC’s
Early VPC	VPC with a time interval from the preceding normal QRS of < approx. 40% of normal R-R
Bigeminy	3 or more consecutive pairs of VPC and normal QRS
Freq VPC	VPC rate/minute reaching or exceeding preset VPC limit
Tachycardia	Reaching the upper HR limit
Bradycardia	Reaching the lower HR limit

When abnormal beats are identified by the monitor, it labels them in the algorithm, and it annotates them on the on the stored event in the Arrhythmia Recall screens. The following annotations are used:

- N: Normal beat
- V: Ventricular premature contraction (VPC)
- P: Paced beat
- -: Noise
- ?: Cannot classify (learning)

These annotations are helpful in determining the cause of an alarm, as the clinician can determine if the beats are true, if there is NOISE in the tracing that prevented the monitor from being able to analyze the rhythm, or if the monitor is labeling artifact as ventricular beats. The clinician can take appropriate action based on his or her interpretation of the call.

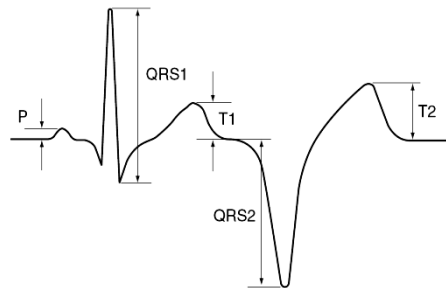
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Optimal QRS Morphology in the Monitored Lead(s)

To determine the best lead or leads for arrhythmia monitoring on an individual patient, (Trace 1 and/or Trace 2); insure that the electrodes are placed in the appropriate positions on the patient and then view all leads in the ECG 12-lead Display screen to decide which lead best meets the following criteria;

- Normal QRS must be greater than 0.5 mV (one large box at x1 sensitivity on the ECG paper) and less than 2.0 mV (four large boxes) amplitude for arrhythmia detection.
- Normal QRS should have similar amplitude to VPC beat or paced beat.
- P wave should be less than 0.2 mV (2 small boxes at x1 sensitivity) amplitude (otherwise may be counted as another QRS).
- T wave amplitude should be less than 1/3 of the normal QRS (otherwise may be counted as another QRS).
- The selected lead should have minimal baseline noise to provide for accurate QRS detection.



QRS1 = Normal QRS
QRS2 = VPC

The ECG QRS Detection Sensitivity is set to AUTO for the monitor to automatically find the optimal sensitivity for arrhythmia processing, which should be x1 or x2. If you find that the ECG waveform requires a x4 display setting, this indicates that the amplitude of the ECG signal is inadequate, and you risk having events go undetected or for having false asystole or bradycardia alarms. Insure that the left leg electrode is positioned appropriately to provide the tallest QRS complex in lead II.



The monitor will analyze the rhythm and annotate the beats, but it is possible that a V-tach rhythm could be interpreted as v-fib and vice versa due to the varying morphology of some complexes. If the true event is labeled as either V-tach or V-fib, the interpretation is considered to be accurate.



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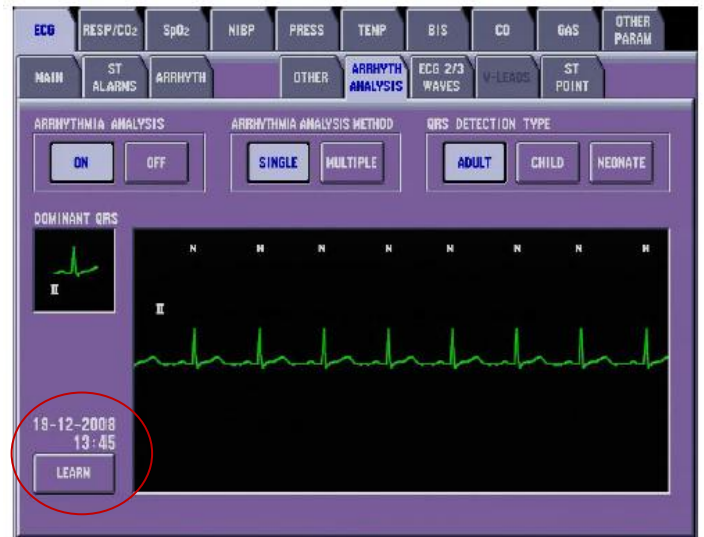
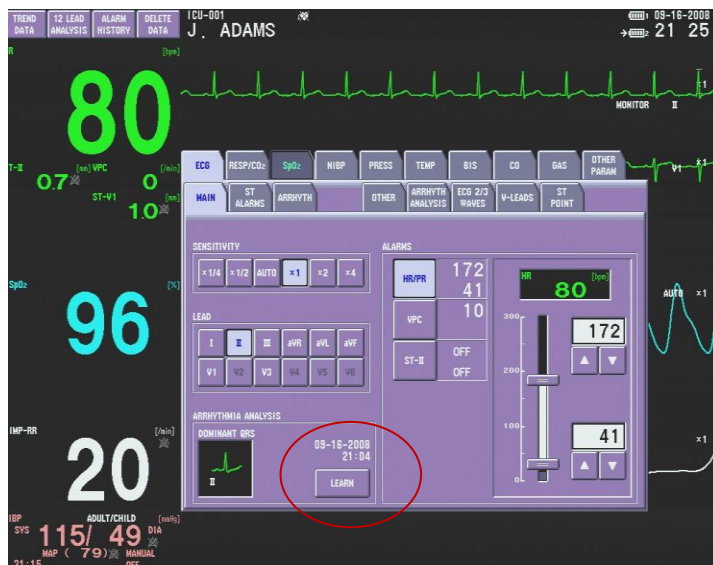
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LEARN ECG

There are times when you should manually "relearn" the reference ECG waveform, such as when the QRS morphology has changed, or if the monitor is labeling a normal beat a VPC or an abnormal rhythm as normal. If there is any doubt about the arrhythmia analysis, assess the current rhythm against the dominant complex(es) on the ECG>ARRHYTH ANALYSIS screen where you can see the annotations in real-time, and then if necessary, manually relearn the patient's rhythm using the LEARN key in this or the ECG>MAIN screen.

This process learns the current complexes for about 10 seconds and creates a new dominant QRS in the analysis lead(s). This action should eliminate the false analysis as long as adequate tracings are maintained as previously discussed.

CAUTION: Do not learn ventricular complexes as this directs the monitor to learn them as normal and to disregard them when they occur. This can lead to missed ventricular rhythm events on the monitor.



Selecting the ECG Lead

The top ECG lead is selected on the ECG>MAIN tab. The second and third displayed leads are selected in the ECG 2/3 WAVES tab. The top two leads are displayed on the main screen at the central monitor, and all eight leads are available in the 12 Lead Display view for the patient.

Auto Lead Change

The AUTO LEAD CHANGE function (ECG>OTHER) allows the monitor to switch leads when single limb lead monitoring electrodes are lost (RA/LA/LL) to continue ECG monitoring and arrhythmia processing. When this occurs, an AUTO LEAD CHANGE message appears on the screen to indicate that the selected lead is not available. When the electrode is replaced, the selected monitored lead is displayed.

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Pacemaker Detection

The monitor detects the presence of a paced rhythm on the *top ECG waveform* if the PACE DETECT function is turned to ON and if the pace impulse is of a voltage that the monitor can detect. Any beat that is detected to be preceded by a pacer spike is labeled as P and is not analyzed for arrhythmias. When pacing is detected, a PACING message appears above the ECG waveform on the screen. A small white mark appears above each pace impulse if the pacing MARK is turned to ON.

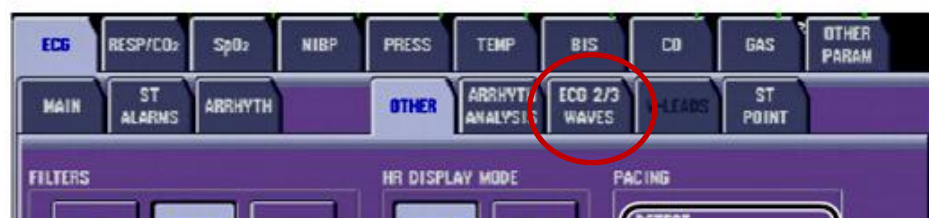


When pacing is 100%, a paced dominant complex is displayed and the monitor continues to assess for non-paced beats. If the rhythm changes to a non-paced one, the algorithm analyzes the new non-paced complexes and annotates them accordingly. That dominant QRS is used to compare all subsequent non-paced beats to determine arrhythmia status. Demand pacing allows enough non-paced beats to be detected and a dominant non-paced QRS to be learned and displayed.

There are many types of pacemakers on the market today, so if the paced rhythm is not being detected, or if the monitor is labeling the paced beats as ventricular, it may be because the algorithm cannot “see” the pace impulse but sees the wide QRS. In this case, the clinician has options to improve the detection.

It may be necessary to “relearn” the rhythm as we discussed, but changing the top displayed lead is a better choice as the monitor only uses this tracing for pacemaker detection. The V1 lead may be beneficial for pace detection if the electrode is placed correctly at the 4th intercostal space at the right sternal border (RSB), as this position provides a different view of the electrical activity.

NOTE: if you place the V1 lead in the first displayed lead position, it is important to also change the second displayed lead from V1 to the second analysis lead choice in the ECG 2/3 waves menu.




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Arrhythmia Troubleshooting

Because the arrhythmia algorithm depends on quality ECG tracings to make its interpretation, further troubleshooting for false or no arrhythmia alarms may be required. The following table is a guide for this process:

PROBLEM	POSSIBLE CAUSE	ACTION
Heart rate is undercounted	R wave amplitude is less than 0.5 mV at x1 sensitivity	<p>*The monitored lead is the top one (single lead) or two (multi-lead) ECG leads</p> <ul style="list-style-type: none"> • Insure that LL electrode is on the left lower rib at the anterior axillary line. • Use multi-lead analysis. • Insure that AUTO sensitivity is selected • Select the ECG lead and/or sensitivity that provides a QRS amplitude of > 0.5 mV tall (one large box at x1 sensitivity on the ECG paper)
Heart rate is being double counted	Large P or T wave is being counted as a QRS	<ul style="list-style-type: none"> • Insure that electrodes are in the correct positions. • Use multi-lead analysis. • Choose another ECG lead that displays a smaller P or T wave. The QRS must be more than double the size of the T or the P wave.
Rhythm is classified as Asystole when ECG rhythm is NSR	<p>R wave amplitude is less than 0.5 mV and monitor is unable to sense and count QRS complexes</p> <p>Narrow QRS's can be counted as pacing spikes.</p>	<ul style="list-style-type: none"> • Insure that LL electrode is on the left lower rib at the anterior axillary line. • Use multi-lead analysis. • Turn Pace detection to OFF.
Difficulty in monitoring a Paced rhythm	<p>Pacing detection is turned OFF</p> <p>Pacer spike is too small and monitor is unable to detect</p> <p>Pace spike is too large and monitor is calling Asystole</p>	<ul style="list-style-type: none"> • Turn Pacing detection to ON • Insure that electrodes are in the correct positions or reposition LL higher on ribs. • Monitor V1 as the top displayed lead and change second lead to lead II
Monitor not alarming for arrhythmias	<p>Is there NOISE or artifact?</p> <p>Arrhythmia detection is turned to OFF. Individual arrhythmia alarm is turned to OFF.</p>	<ul style="list-style-type: none"> • Monitor suspends arrhythmia monitoring during NOISE situations. Correct the problem that is causing the noise. • Turn arrhythmia detection to ON • Turn individual alarm ON.
Monitor is falsely alarming for movement and artifact	<p>Are electrodes fresh and secure?</p> <p>Are electrodes placed correctly?</p> <p>Lead wires act as a part of the electrical system and conduct motion to the monitor.</p> <ol style="list-style-type: none"> 1. Are lead wires secured with stress loops? 2. Is cable stabilized? 	<ul style="list-style-type: none"> • Change electrodes at least every 48hrs • Place electrodes between bones and clear of large muscles • Secure lead wires with stress loops <div style="text-align: center;">  </div> <ul style="list-style-type: none"> • Secure ECG cable to prevent movement between wires and electrodes
Monitor is not storing arrhythmia alarms	<p>Arrhythmia detection is turned OFF</p> <p>Arrhythmia Recall is turned OFF</p>	<ul style="list-style-type: none"> • Turn arrhythmia detection to ON • Turn Arrhythmia Recall to ON
Monitor is not switching leads when the RA, LA or LL is lost	This only occurs with the 6 or 12 electrode sets	Turn AUTO LEAD CHANGE function to ON in the ECG>OTHER menu

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Diagnostic 12-lead ECG

The diagnostic 12-lead ECG is used to help identify conduction abnormalities due to changes in the conduction network itself, or due to ischemic myocardial cells. One of the primary reasons for doing the procedure is to look for the indicators of myocardial infarction (MI): the presence of q-waves, ST elevation and inverted t-waves (Grauer, 1998). The pictures below illustrate the causes of each of these conditions.

ST Segment Elevation (→ Injury)

Early ("hyperacute") stage Coved ("tombstoning") ST segment elevation (= acute injury pattern)

T Wave Inversion (→ Ischemia)

Early T wave inversion Deeper, symmetric T wave inversion (= ischemia)

Development of Q Waves

Early Q wave development Established Q wave stage QS complex

Reciprocal ST Segment Depression

Mirror image ST depression Subtle reciprocal ST segment depression

Principal Indicators of Acute Myocardial Infarction

Grauer, K. (1998). A practical guide to ECG interpretation (2nd edition). Mosby, St. Louis

Myocardial Infarction Zones

Ischemia = inverted T-waves

Injury = ST elevation

Necrosis = Q-waves

Coronary arteries keep the beating heart supplied with the oxygen for its essential pulsations. Trouble strikes when the coronary arteries become blocked. A normal coronary artery (1) has a large lumen which allows free blood flow. Blockage begins as plaque, or atheroma, a layer of fatty substance, builds up on the lining of the artery (2). The artery lumen becomes hardened, a condition exaggerated by the deposition of granules of calcium. (3). The cardiac muscle beyond the blockage becomes deprived of blood—a state known as myocardial ischemia. The muscle then dies. This is myocardial infarction.

1 Lumen 2 Build up of atheroma 3 Calcium deposits in vessel walls

Superior vena cava Ascending aorta Pulmonary artery Left atrium Great cardiac vein Left anterior descending branch of left coronary artery Blood flow in coronary artery reabsorbable Myocardial infarct (area of dead muscle)

Right coronary artery Right ventricle Inferior vena cava

Normal ECG Myocardial infarction ECG

Goode, D.P. (1984). The human body: The heart, the living pump. Torstar books. NY.

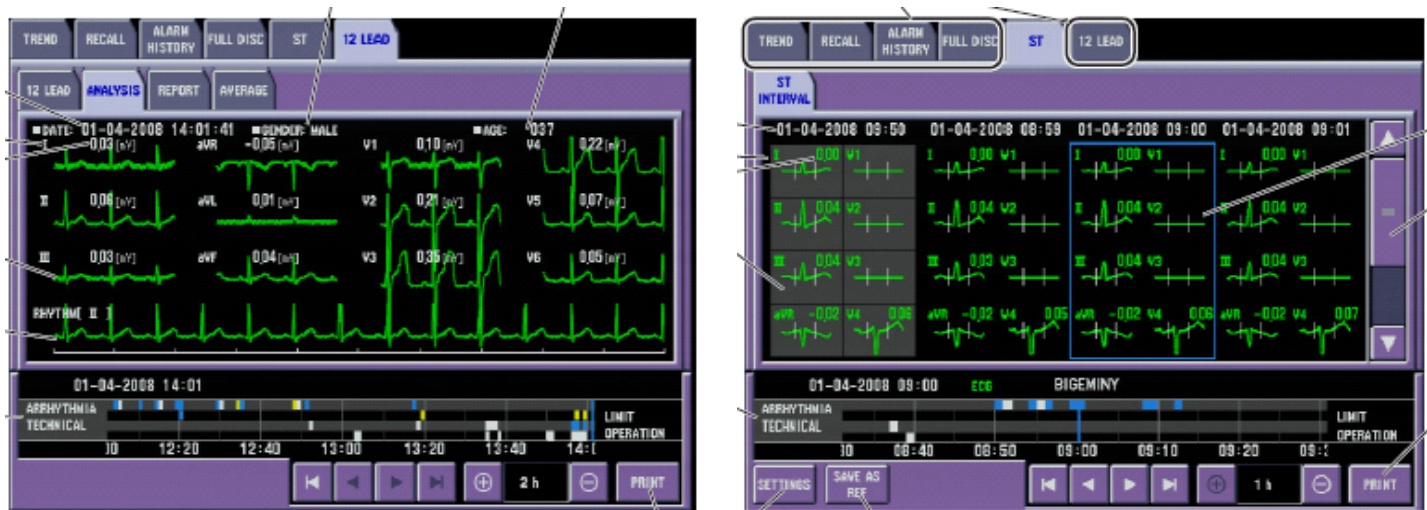
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ST Segment Monitoring

The 10-second snapshot 12-lead ECG is a single point in time, and your patients' cardiovascular status is a dynamic process. Unless you take this 12-lead at the time that he is experiencing a change in his condition, you will not see these changes on the sample. The Nihon Kohden bedside monitor is capable of doing a diagnostic 12-lead ECG if needed, but continuous ST segment monitoring on all leads that you are monitoring is always available and automatic. That is where continuous monitoring in as many leads as possible is beneficial.

These values are displayed on the screen for the displayed leads, and all leads are captured as digital numeric values (mm of elevation or depression) and as minute-average waveforms within some monitors' storage functions. There is also an alarm function to notify you of changes if you desire.



Nursing Considerations

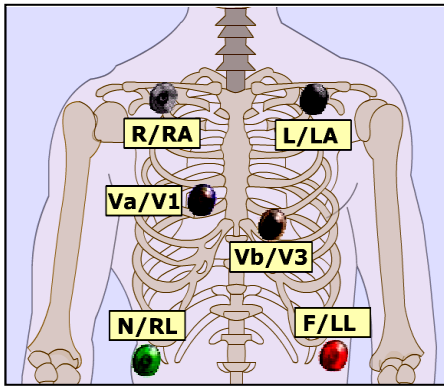
It is important to monitor as many leads as possible when you are concerned about the ST segments. Ideally, all 12-leads should be monitored in order to detect subtle changes. But, if you do not continuously monitor all 12 leads, it is important to monitor the leads that are appropriate for that patient. Drew (2003) and Krukoff determined that the ST fingerprint may be valuable if you must choose to monitor fewer leads. This is the lead that has been shown to represent changes during a cardiac event, such as during an MI or during vessel occlusion in the cardiac catheterization lab. If this fingerprint is not known, and you must choose certain leads, then the following guide is suggested to monitor the most sensitive leads for ST changes (Drew, 2003):

Inferior – Lead III Anterior – Lead V3 Lateral – Lead V5

It is also extremely important to use proper skin preparation and electrode placement procedures as previously described, and to consider this data as a part of the whole clinical assessment. ST changes can occur as a result of conditions other than MI or cardiac ischemia, such as when the patient turns over in bed and the heart moves closer to the chest wall. Clinical judgment is required with ST segment monitoring as with any physiologic monitoring procedure. Nihon Kohden instructional courses and materials support the AHA Scientific Statement on ECG monitoring (2004) and suggest that when using the six electrode ECG set, the Va electrode should be placed in V1 for arrhythmia monitoring and the Vb electrode should be placed in V3 to monitor the anterior wall for ST changes. Changes to these V-lead positions are recommended based on the patient conditions and hospital protocols for monitoring based on them.

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V1 and V3 Placement with 6 Electrodes

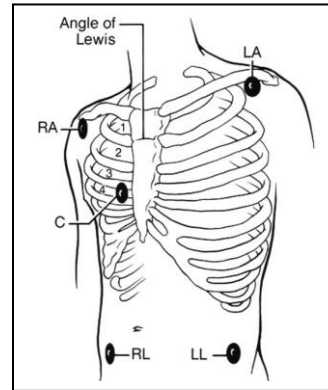


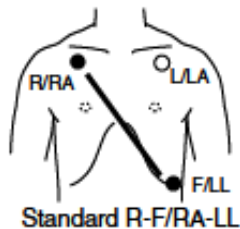
Illustration from AHA Scientific Statement

According to the AHA Scientific statement, to more closely approximate the limb leads on the 12 lead ECG sample, the arm electrodes are placed closer to the shoulder in the infraclavicular fossas and the left leg electrode should be placed below the rib cage on the left side of the abdomen.


Be aware that these positions may result in a lower voltage QRS in lead II on some patients and the shoulder positions can result in motion artifact that affect the quality of ECG and arrhythmia monitoring.

To change the lead label for the Va and Vb leads when you change their physical positions on the patient, select the appropriate lead label in the ECG>V-LEADS menu

Respiration Monitoring



In addition to ECG monitoring that we've discussed above, the Nihon Kohden monitors and transmitters detect respiration by the lungs inflating and deflating between the right arm and left leg ECG electrodes (R-F). By placing the LL electrode on the lower rib at the anterior axillary line, you will see a good respiration lead, in addition to the ECG on most patients.

The flashing lungs  are the breath indicators. When the monitor detects the rise (inspiration) and fall (exhalation) in a respiratory cycle, it flashes the lungs next to the rate and adds the breath to its rate. The rate displayed is a moving number that updates every three seconds and is based on the previous detected breaths. The keys to accurate respiratory detection are 1) fresh electrodes; 2) the recommended electrode placement; 3) the appropriate respiratory lead and sensitivity for the patient.

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Conclusion

Continuous ECG monitoring was developed to provide clinicians with continuous ECG information in an effort to improve mortality rates for patients experiencing acute myocardial infarctions. But through the decades of using this technology in conjunction with their clinical expertise, clinicians have identified many more clinical applications for it.

ECG monitoring has become a standard of care, not only in intensive care units, but in virtually every patient care area in the hospital. The technology has evolved to be able to detect the heart rate and rhythm, to include paced ones, and we are now able to monitor this rhythm for morphological and ST changes so that we can detect changes in our patient's condition and to intervene in a timely manner. By acquiring the best tracings possible and by monitoring in the appropriate leads for the patient, clinicians facilitate improved outcomes during his hospital stay.

The Nihon Kohden monitoring system provides the capability to continuously monitor one, eight, or all 12 leads of ECG, and the bedside monitors provide for obtaining a diagnostic and interpretive "snapshot" for the clinician to use in the course of hospital treatment. This technology is a tool in the clinician's assessment toolbox, to be used in conjunction with clinical judgment, and not as a replacement for it, and the clinician's responsibility is to insure that this monitor data is accurate and valid.

We do this by using the proper ECG monitoring procedures for skin preparation and electrode placement, by choosing the appropriate leads for monitoring based on the patients' condition, and by addressing true as well as false alarm situations. The analysis that is reported by the monitor is only as good as the information that it has to work with. If it is provided with good information for analysis, it will report data that is useful in clinical decision-making that supports the ultimate goal for improving patient outcomes.

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