TROUBLESHOOTING

Arrhythmia Calls

No matter how sophisticated an arrhythmia monitoring program may be, no real-time monitoring equipment recognizes the presence or absence of P-waves. Therefore, it is very important to remember that alarms will not sound for certain arrhythmias unless the heart rate exceeds the upper and lower limits for heart rate.

Note: Close observation of the patient's rhythm by a trained clinician is vital.

Rhythms, such as Sinus Arrhythmia, will not be called. Sinus Bradycardia and Sinus Tachycardia will cause the system to alarm only if the rate exceeds the lower or upper alarm limits.

First Degree AV block will not be detected; Second Degree AV Blocks will be alarmed if the rate violates the lower alarm limit. Complete Heart Block will signal an alarm event if it violates the lower alarm limit.

The system will not call PACs, except only as aberrant beats. Paroxysmal Atrial Tachycardia (PAT) will trigger an alarm if the heart rate exceeds the upper alarm limit as "SV-TACH" if greater than 8 Supraventricular ectopic beats at 150 BPM. Atrial Fibrillation and Atrial Flutter will not alarm as a specific alarm, but alarm notification will occur if the rate violates the upper or lower alarm limits.

AV Nodal/Junctional Rhythm/Tachycardia will be called if the rate exceeds the upper or lower alarm limits.

The ventricular calls High PVC, Couplet, Trigeminy, Bigeminy, V-Rhythm, V-Run, and V-TACH will trigger alarm notification. V-Tach, V-Rhythm, and V-Run are called based on how the V-TACH alarm is configured. See "Configuring the V-TACH Alarm Limits" on page 115 for details.

If you find that you are missing higher level ventricular alarms, then set the lower level alarms on Couplet, and adjust the high heart rate alarm notification lower in order to catch these events.

All information contained herein is subject to the rights and restrictions on the title page.

There are three general categories of questionable arrhythmia calls.

1. **False Positive Calls** result when the arrhythmia system signals an arrhythmia when there is none. It is important to understand how the algorithm analyzed the rhythm.
2. **False Negative Calls** result when the arrhythmia system fails to detect and signal an arrhythmia event when one is present.
3. **Incorrect Analysis** occurs when the system signals that an arrhythmia event occurred, but classifies it incorrectly. Note that it is important that the system alarmed and alerted the system operator to a change in the patient rhythm.

If there are too many **false positive calls**, then the system operator may become desensitized to the alarms. That is why it is important that you understand what factors contribute to false positive calls and correct this situation when possible.

All information contained herein is subject to the rights and restrictions on the title page.

Examples

Many of the types of false positive calls are related to electrode application and signal quality. Let's consider several examples.

Example 1 - False High PVC Alarm

Problem

High PVC alarm occurs but no PVCs are present.

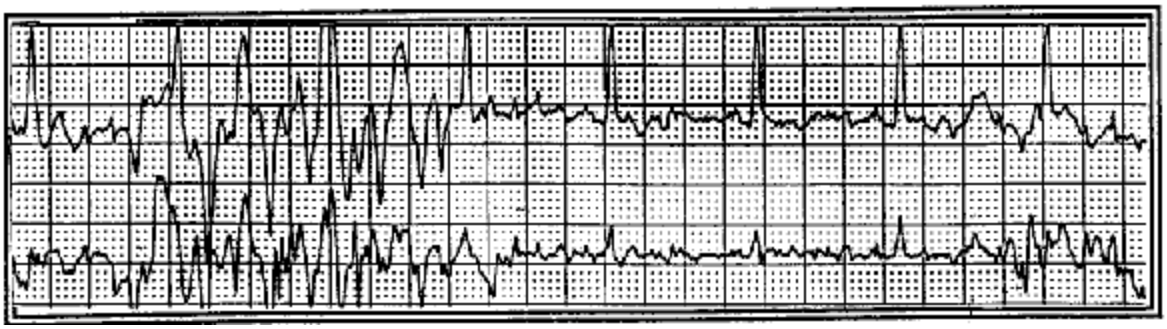


Fig. 93. Example 1 - False Positive Call

Correction

- Press the Re-learn button to discard the patient's previous templates and replace them with the current templates.
- Check for dry electrodes. It may be time to replace them.
- *Least* preferable, but still a possible solution: select a higher value for the PVC alarm or temporarily turn off the "High PVC" alarm.

Example 2 - False Arrhythmia Alarm

Problem

Alarms are occurring, but no abnormal arrhythmias are present. The patient's intrinsic QRS has a high degree of variability that is associated with the following:

- Atrial Fibrillation/Flutter with aberrant conduction
- Intermittent or sustained right or left bundle branch block
- Cardiomyopathy

All information contained herein is subject to the rights and restrictions on the title page.

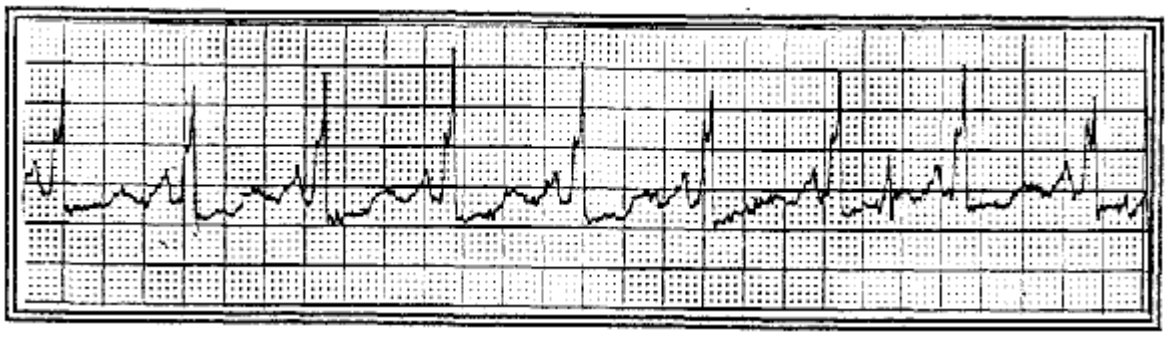


Fig. 94. Example 2 - False Positive Call

Correction

Persistent QRS variability in the patient's dominant rhythm is a rather difficult problem for computerized arrhythmia detection. Only the trained caregiver can judge if a specific QRS morphology represents a variation in the patient's basic QRS or if it is abnormal. However, in an attempt to reduce the number of alarms, you can perform the following steps:

1. Turn off all nonessential alarms
2. Press the Re-learn button when the patient's dominant QRS is stable

All information contained herein is subject to the rights and restrictions on the title page.

Example 3 - Missed Ventricular Tachycardia

Problem

Sometimes the arrhythmia system calls a ventricular arrhythmia differently than the clinicians would. Remember that the system has criteria which must be met. For example, V-TACH is called when the rate is greater than or equal to 100 BPM and 3 consecutive PVCs are detected. If the ventricular abnormal varies, then the system may mis-classify some of the beats as non-ventricular.

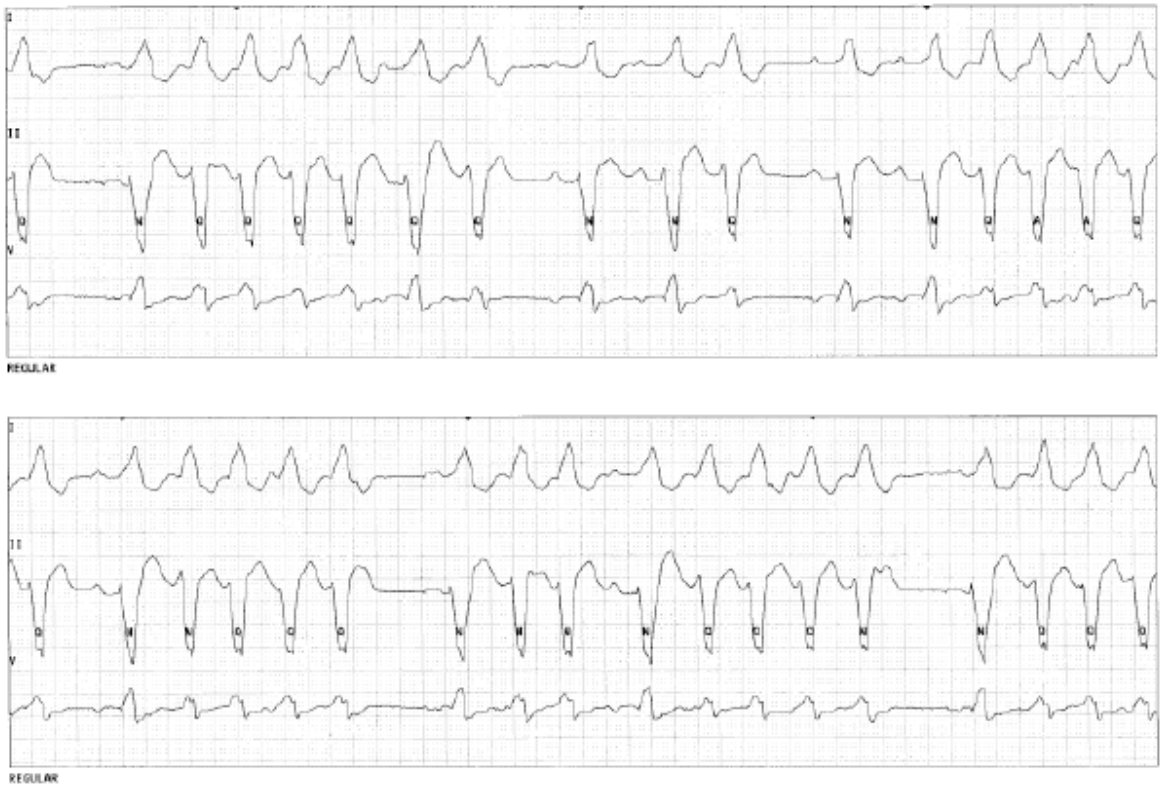


Fig. 95. Example 3 - Missed V-TACH Call

Correction

In these situations, the high heart rate limit may be decreased, which will provide alarm notification. Enabling a lower level ventricular alarm may provide a safety factor for an alarm call, such as Couplet. This may be called before the system qualifies the rhythm as V-TACH and would provide proper alarm notification to obtain the attention of the system operator or caregiver.

All information contained herein is subject to the rights and restrictions on the title page.

Example 4 - Excessive Artifact or Poor Signal Quality

Problem

Older analog systems made the differentiation between electrical and physical interference (artifact), and poor signal strength or antenna interference, difficult because they both showed up as artifact on the ECG signal. With newer digital systems, troubleshooting the causes of interference is much easier. Most interferences related to the antenna system will show up as gaps (drop outs) in the waveform.

Artifact caused by 50-60 cycle interference or muscle/motion artifact will appear on the ECG waveform as artifact.

Several causes of artifact will be considered (some are physiologic and some are non-physiologic).

1. **50-60 Cycle Interference**

   This shows up in the signal as a wide fuzzy baseline that is fairly consistent in size. The source of this type of interference is from the electrical wiring in the hospital or other equipment in the area that uses an electrical source. Signals are more prone to this type of noise if equipment or wall outlets are not properly grounded. Poor skin preparation and electrode contact, as well as broken lead wires, can also leave the system "open" to detecting this type of extraneous noise.

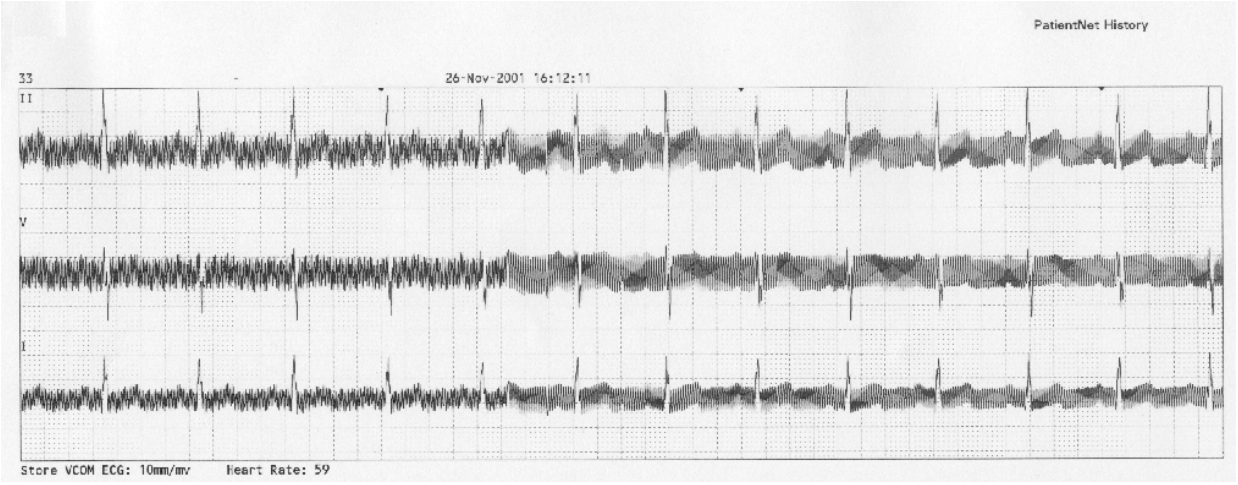


Fig. 96. Example 4 - 50-60 Mz Cycle Interference

All information contained herein is subject to the rights and restrictions on the title page.

2. Muscle Artifact

Muscle artifact is also known as electromyographic signals (EMG) and are produced by the normal electrical activity associated with muscle movement. The only difference between the electrical muscle activity and the electrical heart activity is that cardiac voltage is generally consistent and muscle voltage is erratic. Because the bandwidth of muscle noise is so similar to the ECG signal, it cannot be totally eliminated by filtering. If the filter was increased enough to eliminate muscle artifact, then the majority of the ECG components would also be eliminated.

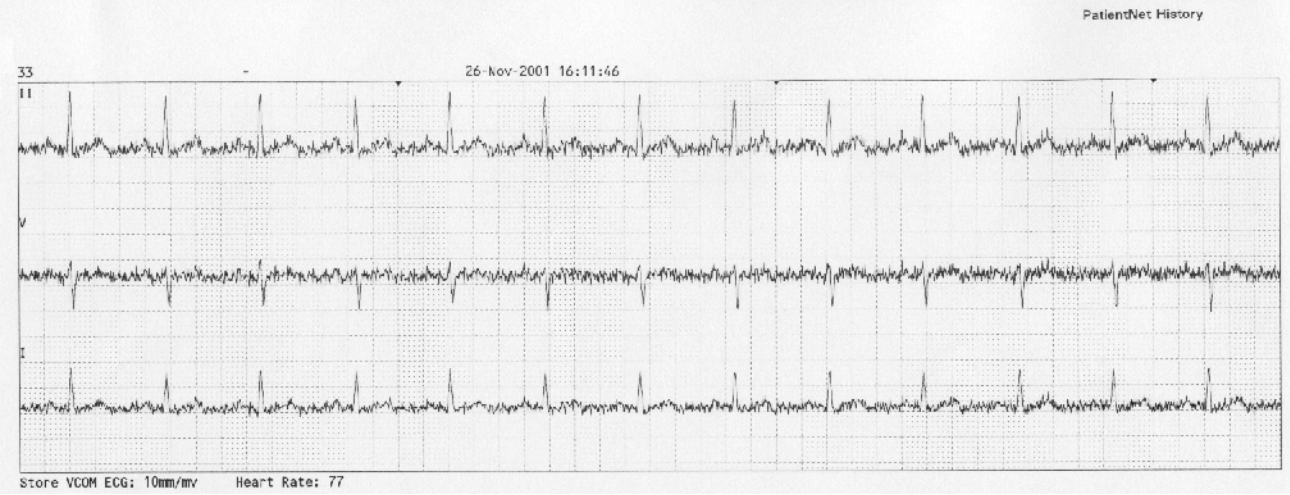


Fig. 97. Example 4 - Muscle Artifact

Excessive muscle artifact may be due to seizure activity, Parkinson's disease of other diseases that cause somatic tremors. Tension, pain, and a cold environment may also cause patients to have an increase in muscle activity. Proper skin preparation and electrode placement in areas away from skeletal muscle can reduce this type of artifact, but will never eliminate it completely.

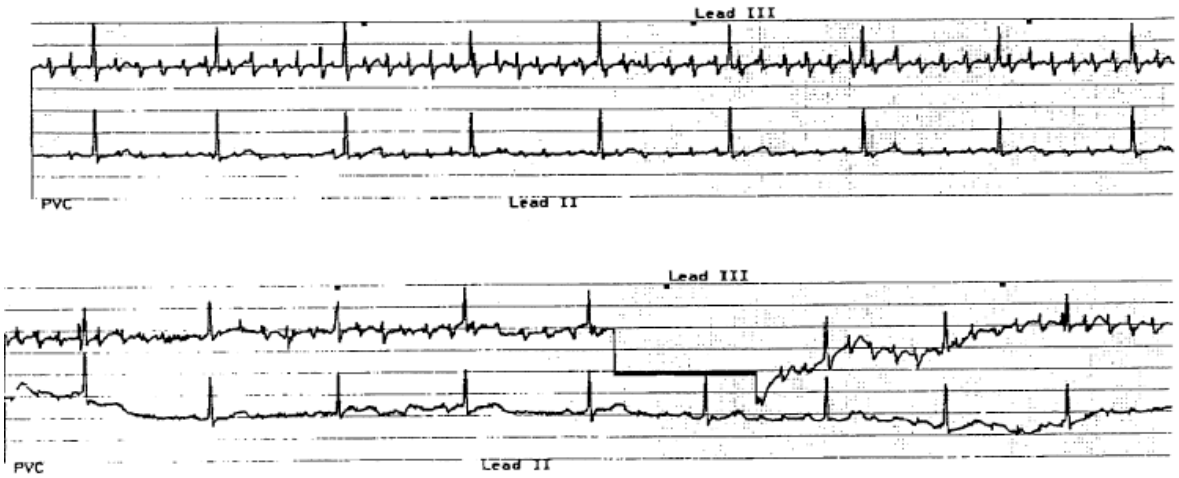


Fig. 98. Example 4 - Excessive Muscle Artifact due to Parkinson's

All information contained herein is subject to the rights and restrictions on the title page.

3. Electrode Contact Noise

If the path from the patient's skin to the ECG transceiver is broken or disturbed, then it can cause noise that may completely obscure the ECG waveform. This is usually due to poor contact between the electrode and the patient's skin (dangling electrodes), poor skin preparation, or dry electrode gel. If all of these conditions have been addressed, and the noise persists, then check for a broken lead wire or poor contact between the lead wire clip and the electrode. This may look very similar to the false pacer activity that may occur with poor skin preparation. Always make sure that the pacer process is OFF on patients without pacemakers.

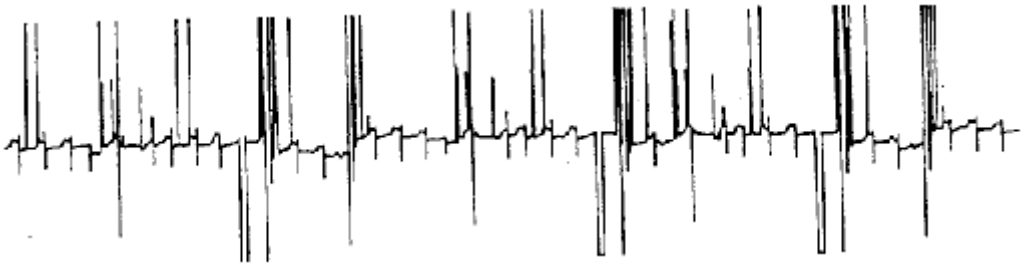


Fig. 99. Example 4 - Electrode Contact Noise

4. Baseline Wander

Baseline wander, or motion artifact, is characterized by large baseline shifts. This may be caused by patient movement. This type of artifact is reduced by proper skin preparation and by placing electrodes in areas less prone to movement (the chest instead of the arms and abdomen).

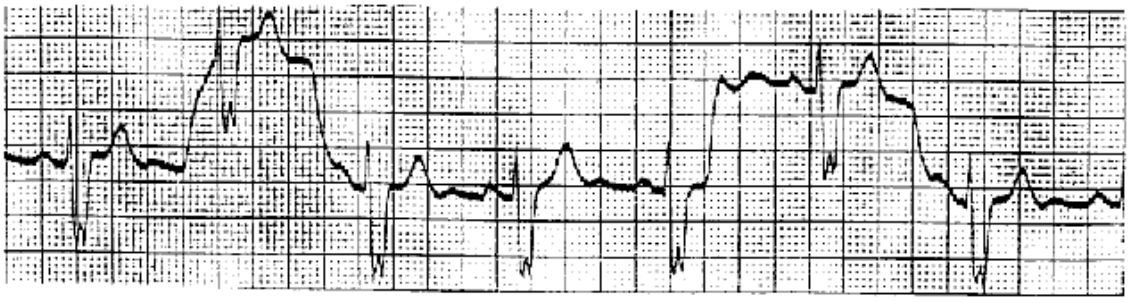


Fig. 100. Example 4 - Baseline Wander

All information contained herein is subject to the rights and restrictions on the title page.

Example 5 - Missed Supraventricular Tachycardia

Problem

The alarm was not called after a six-beat episode of SV-TACH.

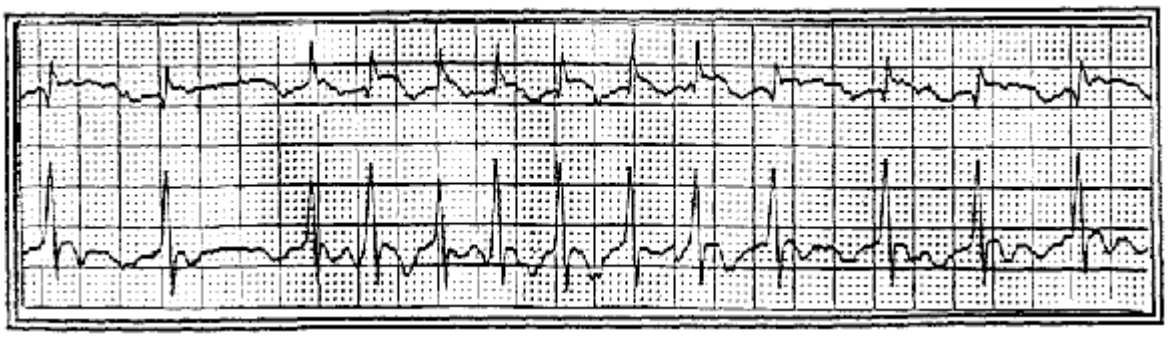


Fig. 101. Example 5 - SV-TACH Episode Alarm

Correction

For an alarm to be called for SV-TACH, the episode must consist of 8 Supraventricular ectopic beats at a rate of 150 BPM or greater. Remember the arrhythmia system does 6 beat averaging.

All information contained herein is subject to the rights and restrictions on the title page.

Example 6 - Repeated High PVC Alarms

Problem

PVCs are present and counted correctly, but the “High PVC” alarm keeps going off.

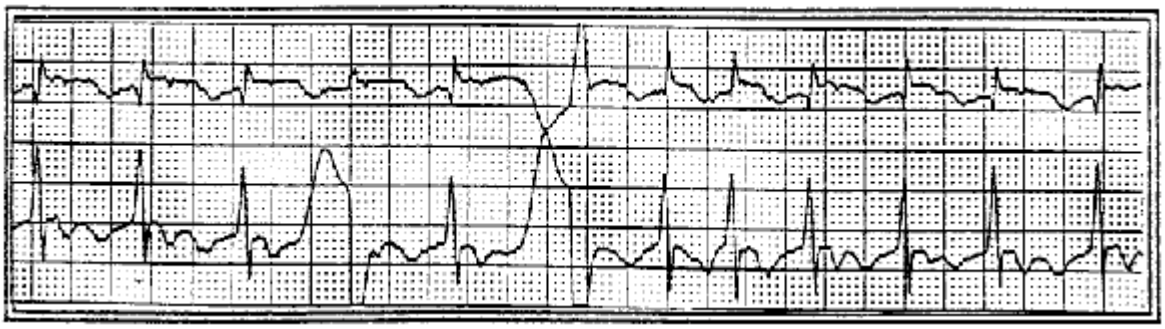


Fig. 102. Example 6 - High PVC Alarm

Correction

Increase the number of PVCs per minute limit on the High PVC Alarm Configuration screen.

Example 7 - PVCs Not Called

Problem

PVCs are present, but no counts are shown.

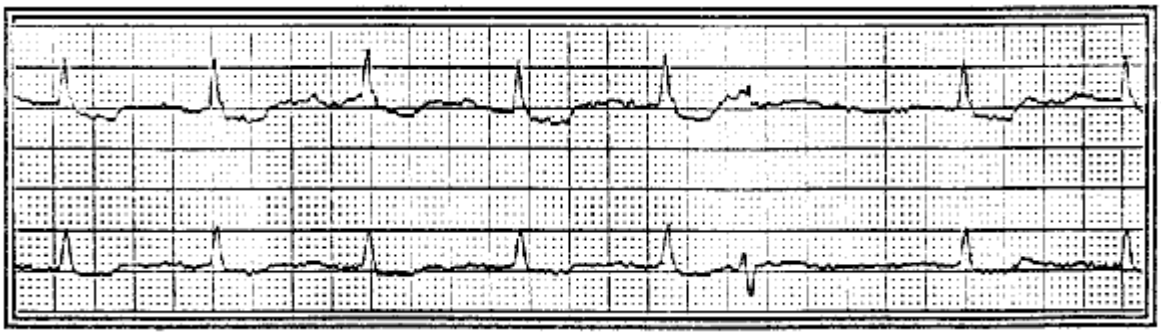


Fig. 103. Example 7 - Present PVCs Not Counted

Correction

1. If the PVCs are similar in shape to the patient’s normal QRS, then press the Re-learn button.
2. If the PVCs are very small in relation to the patient’s normal QRS, then try different electrode placements on the patient for a lead that has clearer QRS morphology differentiation.

All information contained herein is subject to the rights and restrictions on the title page.

Example 8 - Alarms Turned Off

Problem

Rhythm not accompanied by an audio alarm.

You can see on the full disclosure that the alarm is turned OFF.

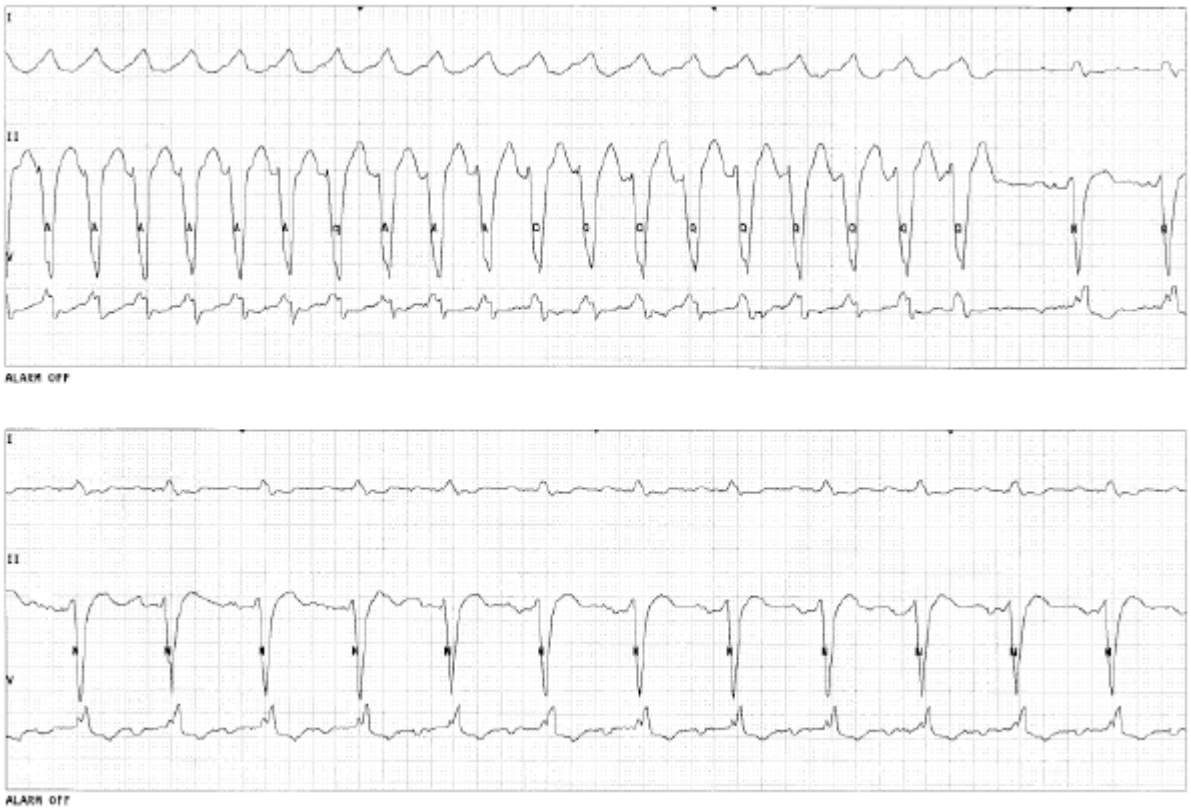


Fig. 104. Example 8 - Audio Alarm Not Activated

All information contained herein is subject to the rights and restrictions on the title page.

Example 9 - Asystole Alarm Not Called

Problem

There is a pause of 2.837 seconds, but the system did not call an Asystole alarm. The arrhythmia software algorithm detects asystole after a period of 3.0 seconds during which no QRS has been noted. This example is below that 3.0 second threshold.

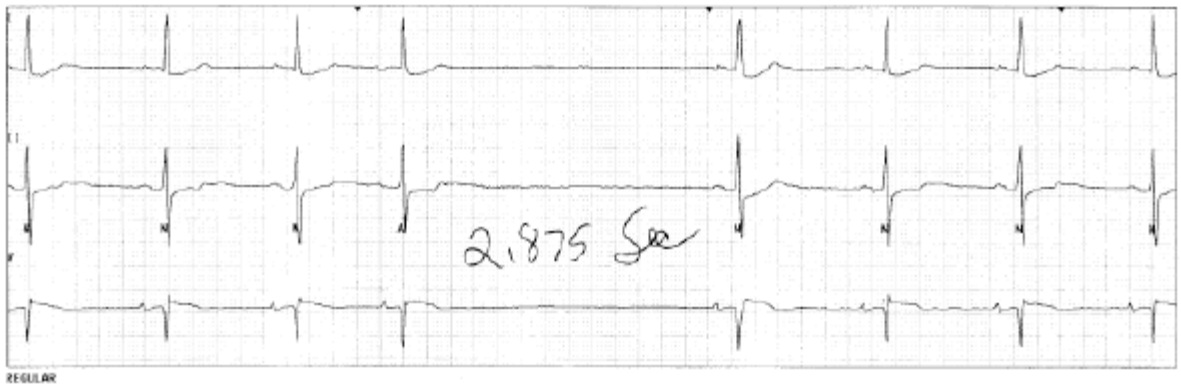


Fig. 105. Example 9 - No Asystole Alarm Called

Example 10 - V-TACH Alarm Not Called

Problem

The patient had an episode of V-TACH, but the system did not call a V-TACH alarm. The laser output with Lead I, II, and V shows that the system was learning when this event occurred. That is the reason why this event did not alarm. ASYSTOLE and V-FIB are the only events that supersede the Learn mode to create Level 1 alarms.

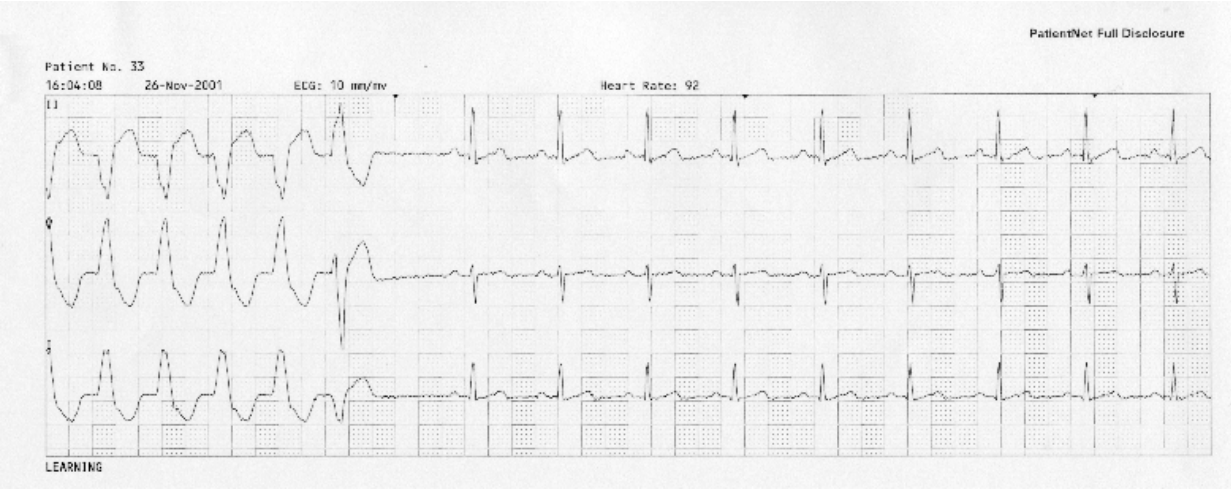


Fig. 106. Example 10 - No V-TACH Alarm Called

Note: In the event of a sustained run of Ventricular Tachycardia, with a sufficiently high rate, the high heart rate alarm may be called during the learn.

All information contained herein is subject to the rights and restrictions on the title page.

Example 11 - Possible Problems Related to Tall P and T-Waves

Problem

The algorithm is designed to selectively recognize the P and T waves and to emphasize detection of the R-wave, so as to prevent classifying the former as Beats.

1. Large P-waves may be detected and classified incorrectly as R-waves, causing the algorithm to generate incorrect high heart rate, or PVC related, false alarms. For example, you manually count 70 BPM, but the computer counts 140 BPM. The system is double counting due to the size of the P-wave in relation to the R-wave.
2. The T-wave may be detected and incorrectly classified as a PVC or high heart rate alarm.

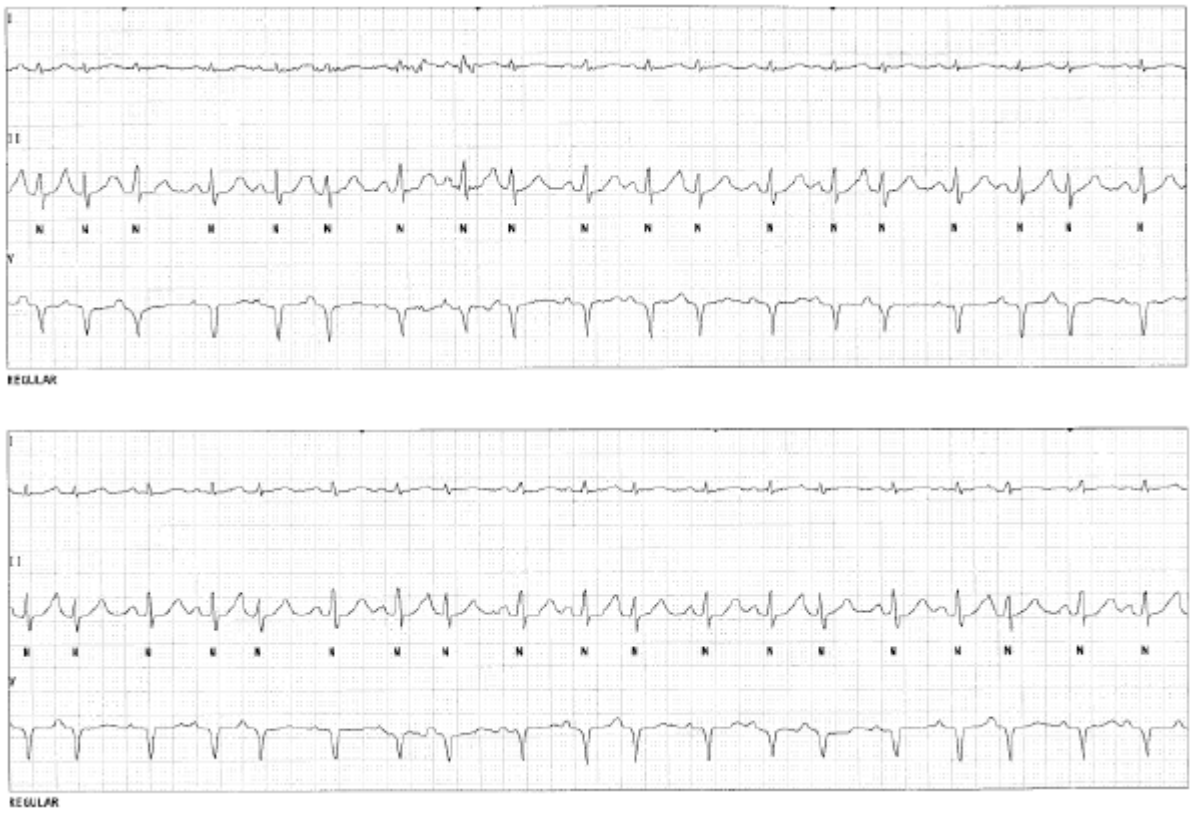


Fig. 107. Example 11 - Tall P and T-Waves

Correction

In most cases, large T and P waves may be addressed by reconfiguring different lead placement. In some conditions, such as extreme atrial hypertrophy, hyperkalemia, or decreased ventricular voltage, the P and T waves might be as large as the R-wave, despite careful lead selection.

Despite a small R-wave and large T-wave, the system is counting the heart rate accurately (fig. 107).

All information contained herein is subject to the rights and restrictions on the title page.

Example 12 - False Asystole Alarm

Problem

Small R-Wave Voltage

1. When R-waves are small, the system might not see the signal. A false positive asystole call and alarm may occur.

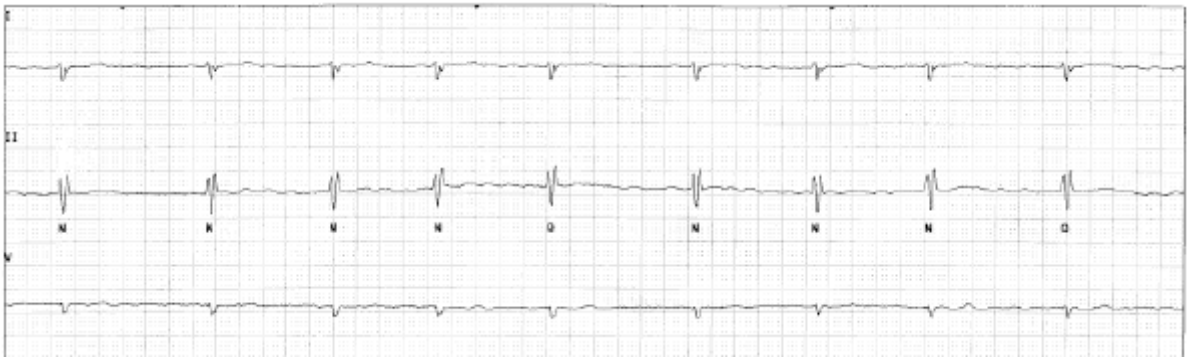


Fig. 108. Example 12 - Small R-Wave Voltage

Correction

1. Resolve this by moving the electrodes to a different lead configuration, such as closer to the heart, to achieve a stronger signal. Increasing the size on the waveform display will not remedy this situation.

Note: In this situation, the arrhythmia system is using Lead II for analysis and, although it is of small amplitude, the system is working well.

Example 13 - Excessive Pacer Pulses

The strip has a “picket fence” appearance. Note the pulses on the ECG waveform.

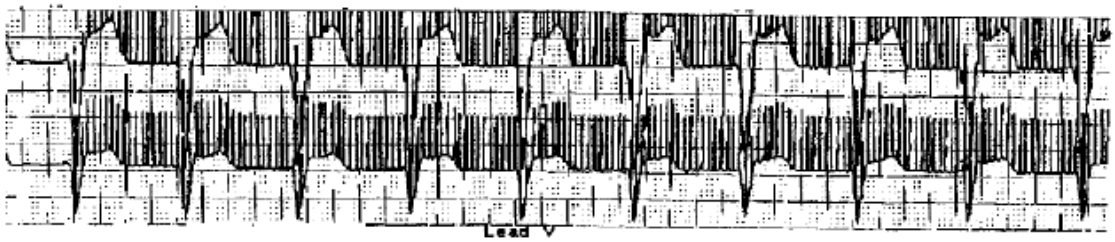


Fig. 109. Example 13 - Picket Fencing

This is more easily noted on real-time strips or in the history.

Telectronics manufactures an impedance-based pacemaker that measures the respiration rate and adjusts the pacemaker accordingly. This type of pacemaker emits impedance pulses (18-20 Hz) for adjusting the pacemaker rate based on the patient’s respiration rate. The front-end device may detect such impedance pulses as pacemaker

All information contained herein is subject to the rights and restrictions on the title page.

spikes and display them in very short, regular intervals that are superimposed on the patient's waveform. The actual pacemaker pulse voltage is typically a minimum of ten times the impedance pulse voltage. Repositioning the electrodes a minimum of three to four inches from the pacemaker will typically minimize the likelihood of the impedance pulse being deleted as a pacemaker spike.

Problem

False Pacer Spikes

The appearance of random, and sometimes frequent, pacemaker spikes may occur in some of the patients' ECG strips.

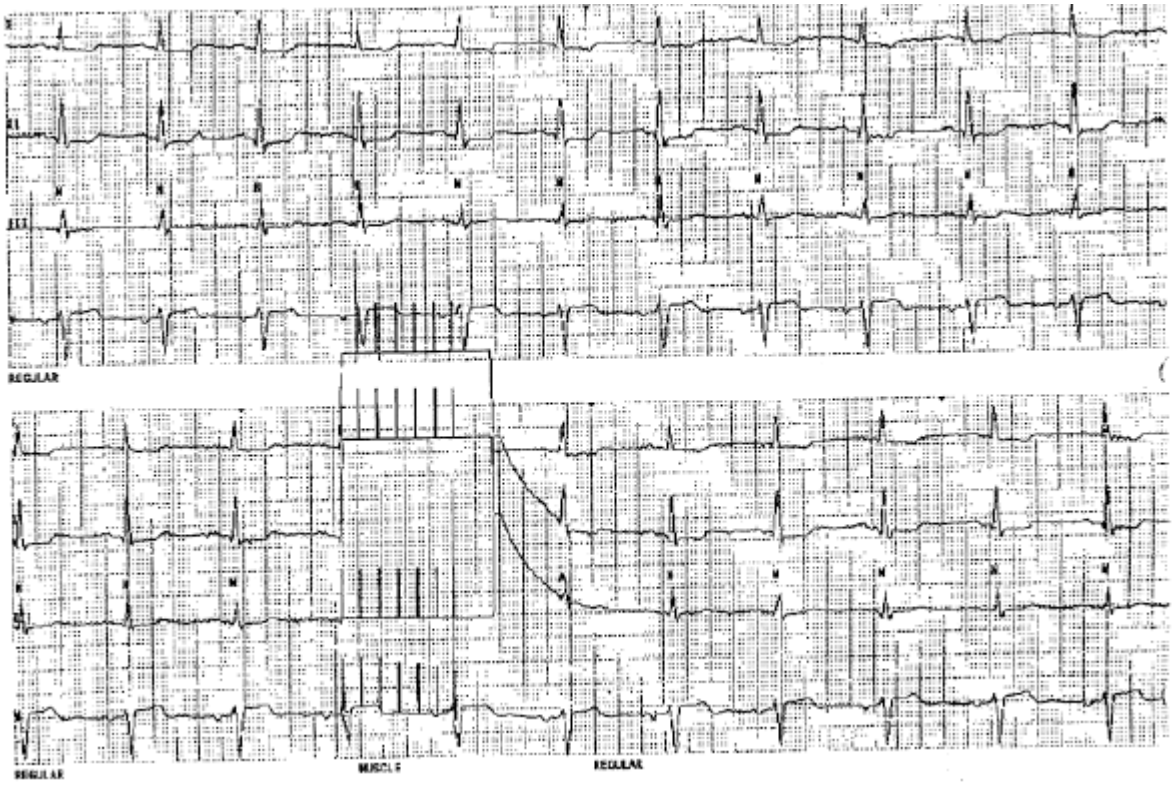


Fig. 110. Example 13 - False Pacer Spikes

Correction

1. Turn the pacer process off if the patient has no pacemaker rhythm.
2. Always follow the recommended skin preparation procedure, as much of the false pacemaker activity originates from patients where poor preparation is present.
3. Make sure that all lead wires are connected to the electrodes securely. If you are intentionally leaving lead wires disconnected so that you only have to place three electrodes on the patient, then change to a three lead wire set.
4. Position electrodes at least three to four inches away from the pacer implant area.

All information contained herein is subject to the rights and restrictions on the title page.

Example 14 - False Asystole Alarms with Paced Rhythms

Problem

False Asystole Alarms on Fused Beats

The following figure demonstrates one situation with pacemaker rhythms which may result in a false positive asystole call. Note the absence of the N-beat annotations on the lower strip. Remember, the pacer filter is enabled when the Process is set to Pacer. The pacer filter setting controls the blanking interval that is applied before and after the pacer flag to remove residual pacer artifact from the ECG signal. The default pacer filter is 25 msec, which should be adequate for the majority of pacemaker signals from the transceivers. In some cases, it may be necessary to increase or decrease the pacer filter. If the pacer filter is changed from 25 msec, an increased level of surveillance should be instituted.

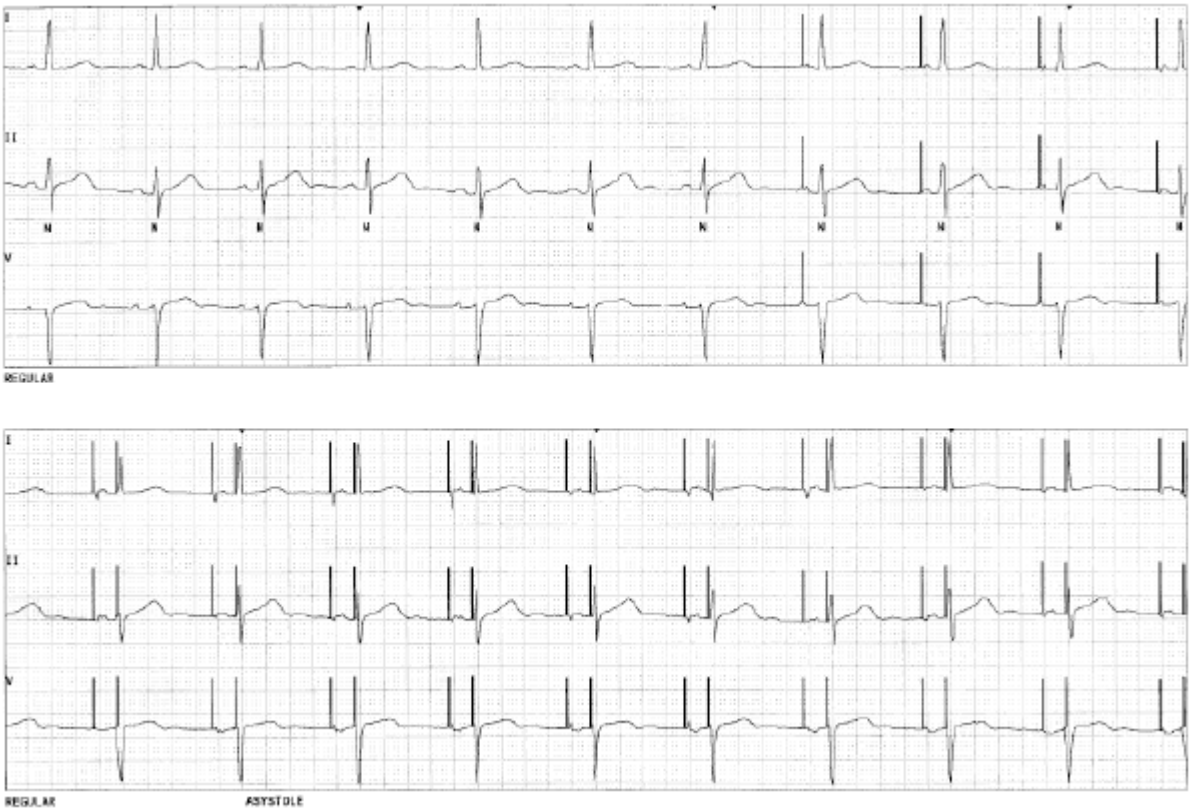


Fig. 111. Example 14 - False Asystole Alarms

Annotated disclosure review can help differentiate which beat detection performance issues may be attributed to pacer artifact or pacer filter problems. There should be one, and only one, beat annotation associated with every QRS complex. In general, if the system is calling false low rates or false asystole due to fused pacer rhythms (missing beat annotations), then the pacer filter should be decreased to allow more of the QRS complex through to the arrhythmia processor.

All information contained herein is subject to the rights and restrictions on the title page.

Example 15 - High Heart Rates with Paced Rhythms

Problem

False High Rates Due to Detection of Beats on Pacer Artifact

The following figure shows the opposite situation of the false Asystole calls. Here, the system is double counting and the false high rates are due to detection of beats on pacer artifact. When the system called false high rate alarms due to this situation (more than one annotation per beat), the pacer filter should be increased. This will result in more of the artifact being blanked, which reduces the likelihood of the artifact being detected as a beat.

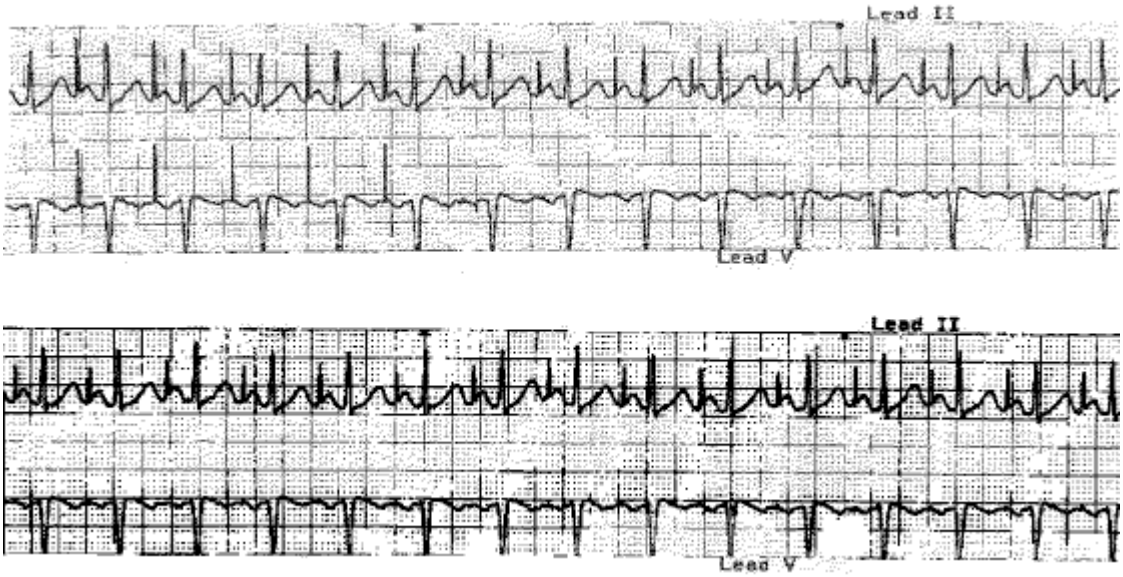


Fig. 112. Example 15 - False High Rates Due to Pacer Artifact

Conclusion

If you question the system performance in an arrhythmia call, review history entries then follow the directions and complete the “Event Information Form” on page 223. We can evaluate this information to assist with future situations.

All information contained herein is subject to the rights and restrictions on the title page.

Reporting

If the problem persists, then please contact your technical support representative.

When reporting a condition, please include the following information:

- Pacemaker/AICD/PCD
- Type
- Make
- Model Number
- Manufacturer
- Attach a pacer report if applicable

Note: Please print and attach an annotated zoomed-in printout of the Full Disclosure with Leads I, II, and V. Ideally, start recording ten seconds prior to the event and continue through the event in question. Please print the Full Disclosure report, with Lead I and II, of the time in question.

Use the Event Information Form on page 223 to report the issue.

All information contained herein is subject to the rights and restrictions on the title page.

Event Information Form

1. Date and time of event
   _____
2. Event description
   _____
   _____
3. SMART ALARM Yes___ No___ ALARM ON___ OFF___ Arrhythmia ON___ OFF___ Arrhythmia Lead Selection AUTO___ MANUAL___
4. Provide as much information as possible such as position and impedance of the electrodes_____
   _____

Complete the following:

Alarm	Status	Record	Store	Assign	Level	Limit
HIGH HR		Yes/No	Yes/No	Yes/No		
LOW HR		Yes/No	Yes/No	Yes/No		
ASYSTOLE		Yes/No	Yes/No	Yes/No		
V FIB		Yes/No	Yes/No	Yes/No		
V TACH		Yes/No	Yes/No	Yes/No		
HIGH PVC		Yes/No	Yes/No	Yes/No		
S V TACH		Yes/No	Yes/No	Yes/No		
COUPLET		Yes/No	Yes/No	Yes/No		
BIGEMINY		Yes/No	Yes/No	Yes/No		
TRIGEMINY		Yes/No	Yes/No	Yes/No		
V RHYTHM		Yes/No	Yes/No	Yes/No		
PVC		Yes/No	Yes/No	Yes/No		

5. Pacemaker

Type _____
Make _____
Model No._____
Manufacturer_____
Attach pacer report if available

Note: Please print and attach the following:

- **an annotated zoomed-in printout of the Full disclosure with Leads I, II and V. Ideally, start recording ten seconds prior to the event and continue through the event in question (see Figure 113 on page 224).**
- **24-Hour Full Disclosure report, for the hour in question (see Figure 114 on page 225).**
- **Print Zoomed-In Full Disclosure, with Leads I, II, and V, for the time immediately following the most recent learn.**

All information contained herein is subject to the rights and restrictions on the title page.

Zoomed-In Full Disclosure

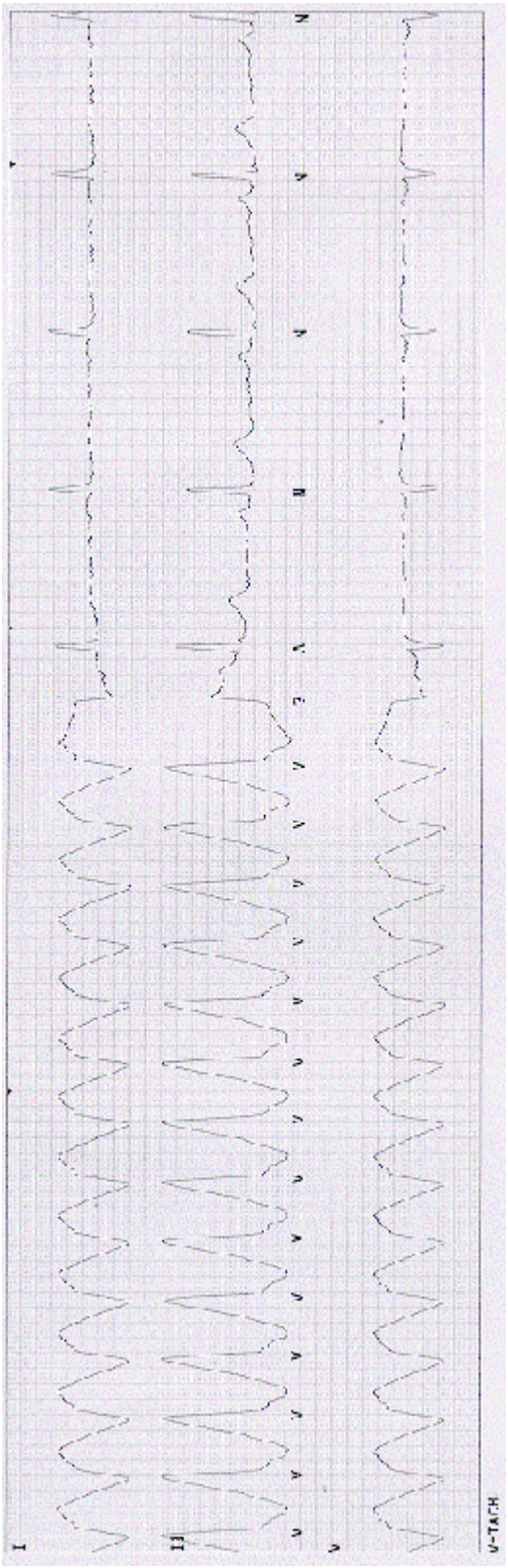


Fig. 113. Zoomed-In Full Disclosure Example

All information contained herein is subject to the rights and restrictions on the title page.

24-Hour Full Disclosure - 1 Hour Report

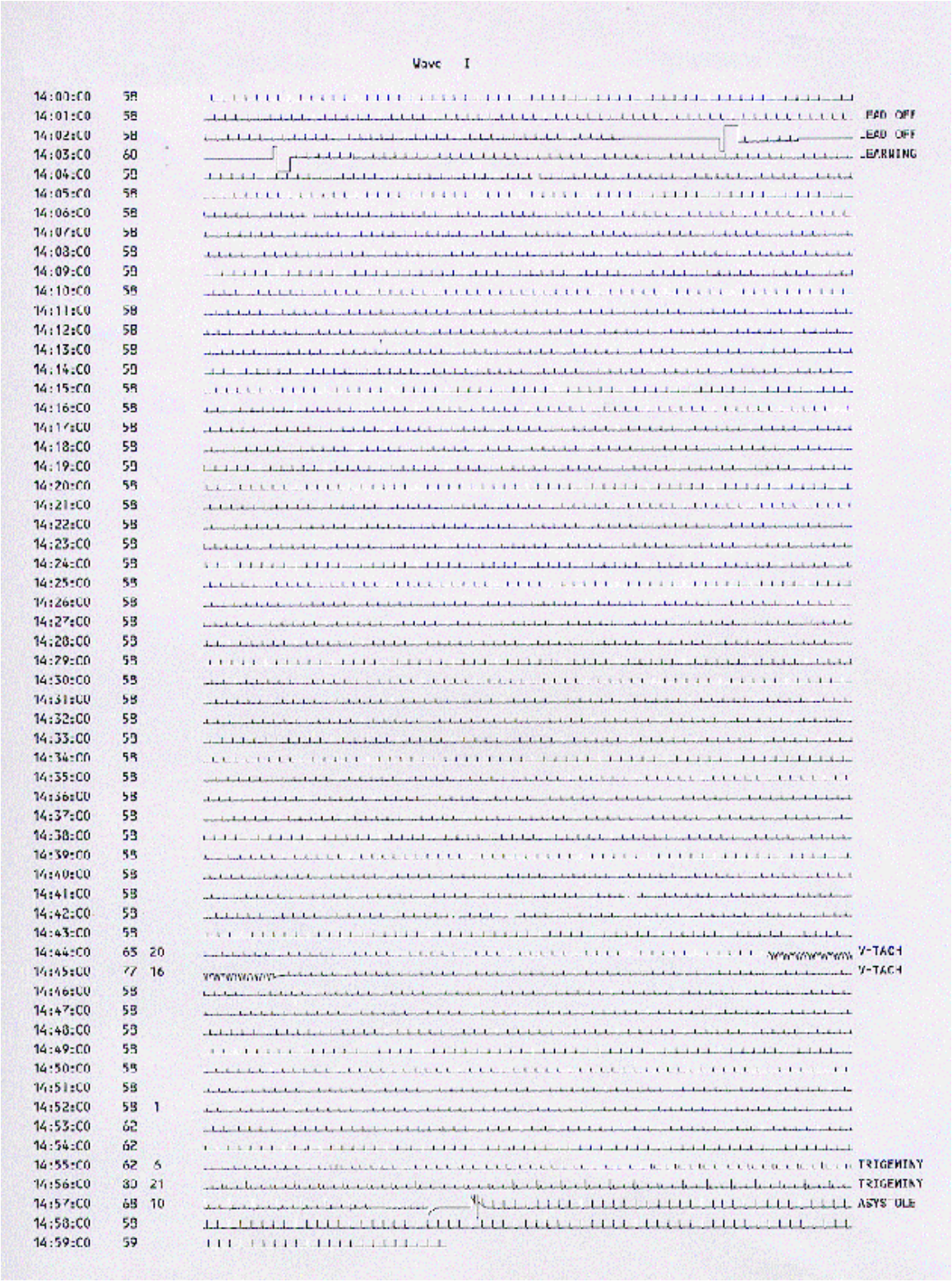


Fig. 114. 24-Hour Full Disclosure Example

All information contained herein is subject to the rights and restrictions on the title page.

Commonly Asked Questions

1. **How much change in the shape of the QRS complex is tolerated by the algorithm?**

   Subtle changes in the QRS will be tolerated by the algorithm if the new beat continues to match the stored template. The reference QRS is a snapshot of the dominant beat at the time the system was "learning." If the patient's ECG changes due to ischemia or infarction (the resultant ST, T-wave changes). then the system may look at the beat as an abnormal beat, resulting in false calls.

2. **How often should a new reference be learned?**

   Each individual unit will decide on their protocol for frequency of relearning. Some suggestions:

   - At the start of each shift.
   - Whenever there are rhythm changes, such as the morphology of the dominant normal beat (amplitude, width, or polarity) changes significantly (and persists) from the learned dominant normal beat.
   - Whenever a current learn was performed during an extremely noisy segment, a re-learn should be performed when the noise subsides.
   - If the system learned an abnormal morphology as normal.
   - When the electrodes are changed.
   - When the Rhythm Indicator in the Patient Tile turns from green to yellow or red.

3. **Which alarms are on during the LEARN process?**

   Only the alarms for Asystole, Ventricular Fibrillation, and High/Low Heart Rates are enabled during the learn mode. Do NOT initiate a LEARN or RELEARN during an episode of ectopy.

4. **If I change the lead placement, does the monitor automatically RELEARN?**

   No, you must manually initiate a RELEARN whenever the lead's configuration (placement) is changed.

5. **How should the monitor be set to notify the clinician when a patient who is in Atrial Fibrillation converts to Normal Sinus Rhythm?**

   For a patient in Atrial Fibrillation, the heart rate is usually faster than the patient's normal rate. The LOW HR alarm and recording should be set just below the rate of Atrial Fibrillation, so that when the patient converts, the slower rate (although not a true Bradycardia) may result in an alarm and recording. The time of the recording will be printed on the strip. The time will be stored as a history event and may be recalled if the STORE function was enabled.

All information contained herein is subject to the rights and restrictions on the title page.

6. **What are false positive calls?**

   A false positive call is one where an event was labelled as an arrhythmia when it was not. It is most often seen when artifact appears to be an arrhythmia and is called such by the computerized detector.

7. **What are false negative calls?**

   A false negative call is one where the algorithm misses an actual arrhythmia event.

8. **Why are arrhythmia events annotated in different leads on different full disclosure printouts?**

   After the dominant normal beat is identified, the primary analysis lead is determined. The software always monitors both leads, however, for most decisions, *only the primary lead is used*.

Note: The primary analysis lead is indicated on the full disclosure display as the annotated lead.

9. **How does the beat classifier work?**

   The beat classifier has two modes of operation: learning and analysis. In the analysis mode, the beat classifier compares incoming beats to the learned dominant "normal" template and decides if the beat is normal, premature atrial beat, or ventricular complex.

10. **How are pacemaker beats annotated by the detector?**

    The arrhythmia software looks at the location of the pacer flag in relation to the detected beats to determine if a beat is paced. Paced beats will always be called normal (N) or aberrant normal (q or Q) by the detector. The arrhythmia software performs best when the patient's dominant rhythm is learned as the normal beat.

11. **Can the ECG signal be improved for better arrhythmia detection by increasing the size or gain?**

    No. Increasing the size of the ECG will not improve the signal. The gain increase only serves to help the clinician better see the ECG. The only way to improve signal quality *is to change the lead you are monitoring, or move the electrodes closer to the patient's heart (the signal source)*.

All information contained herein is subject to the rights and restrictions on the title page.

Error Messages

General PatientNet System Error Messages

The following table lists the possible error messages that may occur with the PatientNet System. Contact your service representative for additional information.

Error Message	Cause	Corrective Action
Laser Off-Line	The laser printer is not connected or is not responding.	Make sure the printer is turned on, connected to the system, and that the **On Line** indicator is illuminated.
Laser Out of Paper	The laser printer is out of paper.	Add paper to the printer paper tray.
Recorder: Door Open/ Out of Paper	The Central Station's strip chart recorder is either out of paper or its door is open.	Replace the paper roll and/or close the recorder door.
There is no visible device.	The Show Device field is set to No.	Select one or more devices to be displayed in the Device popup. Set the Show Device field to Yes.
WARNING: Demo only - not for clinical use	This text is displayed on Central Station's with the demonstration software version loaded. It indicates that all displays are using simulated data as opposed to live data from patients.	None required.
WARNING: Multiple Time Masters	More than one Central Station has been configured as the Time Master. Only one Central Station on a network can be the Time Master.	Reconfigure the Central Stations so that there is exactly one Time Master.
Multiple Page Masters in Network	There are multiple Central Stations configured to be Page Masters with the same ID.	Reconfigure the Central Stations so that there is exactly one Page Master per ID.
Network Page Master is Undefined	There is no Page Master defined on the Network.	Select a Central Station on the Network and configure it to be the Page Master.
Multiple Page Popups in POD.	More than one Central Station has been configured to be the Page Popup for the current pod.	Reconfigure the Central Station so that there is exactly one Page Popup for the pod.
Pod's Page Popup is Undefined	No Central Station in the current pod has been configured to be a Page Popup.	Configure one of the Central Stations in the pod to be a Page Popup.
Popup Queue Full	There are too many unacknowledged Page Popups on the Page Master's screen.	Acknowledge the pending Page Popups on the Page Master screen.

All information contained herein is subject to the rights and restrictions on the title page.

Error Message	Cause	Corrective Action
Page Queue Full	There are too many paging requests currently pending.	This condition should resolve itself in a few minutes as the pages are sent. If this situation continues, then contact your technical support representative.
A Pager number must be entered prior to admitting a patient	This is a configurable setting.	When enabled behind the passcode screens, this feature forces the operator to enter a pager number. This feature can be enabled or disabled.
Invalid Passcode. Please Try Again.	A passcode was entered that is not in the authorized passcode list.	Enter a correct passcode.
No room for new alarming patient	This is displayed on Remote Viewing Stations (RVS) when every channel on the RVS is alarming and a "new" channel is trying to be displayed because it was assigned to the network.	Do not allow every channel on a RVS to alarm at the same time. Respond to, and clear off, some alarms to make new for new alarming patients.
Invalid format in eng_lang.txt file	A system text file has been modified or damaged.	Re-load the PatientNet Central Station software on the Central Station.
Missing data in eng_lang.txt file	A system text file has been modified or damaged.	Re-load the PatientNet Central Station software on the Central Station.
Duplicate Channel Numbers	More than once Central Station on the same network has the same base channel numbers.	Check the base channel numbers on each Central Station to locate the duplicate. Enter your passcode to change the base channel to the appropriate number.
No Network Traffic	No packets have been received on the PatientNet Real-Time Network for 121 seconds.	Verify station network connectivity and verify that there is a Time Master present on the network.
LAN Protocol Mismatch	One or more Central Station(s) is running with different software versions and/or options.	Update mismatched Central Stations to the same software version and/or options.

All information contained herein is subject to the rights and restrictions on the title page.

WMTS Specific

Multiple Device Masters	There is more than one Central Station configured to be a Device Master.	Reconfigure the Central Stations so that there is exactly one Device Master.
No Device Master	There is no Central Station on the Network that is configured to act as the Device Master.	Configure one of the Central Stations on the Network to be the Device Master.
Access Point Error. IP - nnn.nnn.nnn.nnn	An Access Point on the Network is using an incompatible version of the Access Point Firmware. The IP Network address of the offending Access Point is displayed.	Locate the Access Point and update it with the current firmware. The error message can then be cleared by pressing the **Clear AP Error** button the `System/Service/OpenNet/Diagnostics/AP Diag` screen.
Default IP Address	The Central Station IP Address has not been set.	Set the IP Address of the Central Station to a value other than its default.
No Sync on Access Point	Access Point status message reports that there is no access point synchronization.	Determine which AP is not synchronized by reviewing the AP Diagnostic screen. Check the synchronization hardware connection at the specific AP. Call your technical support representative.
No Response from Access Point	Access Poin status message reports that there is no response from an Access Point.	Determine which AP is not responding by reviewing the AP Diagnostic screen. Verify that the AP that is not responding is powered up - cycle power on the AP if necessary. Call your technical support representative.
AP not Configured	Access Point status message reports that an AP is not configured in the Device Master database.	Add the Access Point to the Device Master database, or remove the AP from the network. Call your technical support representative.
Device Master Version Mismatch	The local Device Master database version does not match the network Device Master database version.	Call your technical support representative.

All information contained herein is subject to the rights and restrictions on the title page.

GLOSSARY OF TERMS

This glossary of terms includes clinical definitions of ECG monitoring terms, as well as definitions and features of the arrhythmia detection system. Clinical definitions may vary; however, these are presented as representative of generally accepted explanations in current practice. PatientNet specific terms will be denoted by (PN) after the definition.

Aberrancy - abnormal conduction through the ventricles resulting in a wide bizarre QRS complex usually due to a bundle branch block.

Agonal Rhythm - cardiac arrhythmia present in a dying heart, ventricular escape rhythm.

Algorithm - a mathematical pathway or program used by the computer to analyze and classify ECG complexes.

Amplitude (voltage) - with respect to ECG recordings, the height or depth of a wave or complex measured in millivolts (mV).

Analog - original state of the ECG signal.

Annotations - beat labels presented by the arrhythmia computer to indicate what the software program classified or called a particular ECG complex. (PN)

Arrhythmia - also known as dysrhythmia. Any disturbance in rate, regularity, site or origin, or conduction of the cardiac electrical impulse. This is a clinical rather than a system definition.

Artifact - mechanically or electrically produced extraneous spikes and waves recorded on an ECG recording; noise.

Artificial Pacemaker - an electronic device used to stimulate the heart to beat when the electrical system of the heart malfunctions causing bradycardia or ventricular asystole. An artificial pacemaker consists of an electronic pulse generator, a battery, and a lead wire that senses the electrical activity of the heart and delivers electrical impulses to the atria, the ventricles, or both when it senses an absence of electrical activity.

Asynchronous Pacemaker - fixed-rate pacemaker, either ventricular or atrial, or both.

Asystole - absence of contractions of the ventricles or the entire heart.

Atrial and Ventricular Demand Pacemaker - an artificial pacemaker that paces either the atria or the ventricles when there is no appropriate spontaneous underlying atrial or ventricular rhythm.

Atrial Arrhythmias - arrhythmias originating in the atria such as atrial tachycardia, paroxysmal atrial tachycardia (PAT), atrial fibrillation, atrial flutter, premature atrial contractions (PACs), and wandering atrial pacemaker.

Atrial Pacemaker - a pacemaker that triggers the atria when a natural impulse does not occur.

All information contained herein is subject to the rights and restrictions on the title page.

Atrial Fibrillation - an arrhythmia arising in numerous ectopic pacemakers in the atria characterized by very rapid atrial fibrillation waves, and an irregular, often rapid ventricular response.

Atrial Flutter - an arrhythmia arising in an ectopic pacemaker in the atria characterized by abnormal atrial flutter waves with a sawtooth appearance and usually a regular ventricular response.

Augmented Limb Leads - also called the frontal plane leads. Measures the electrical potential between one limb lead electrode and the midpoint between the remaining limb electrodes. Consists of **aVL**, **aVR**, and **aVF**. Views the anterior and lateral walls of the heart.

AV Sequential Pacemaker - a dual chamber pacemaker that can sense and/or pace both the atria and the ventricles.

Bidirectional Tachycardia - ventricular tachycardia characterized by two distinctly different forms of QRS complexes alternating with each other, indicating the presence of two ventricular ectopic pacemakers (**Torsades De Pointes**).

Bigeminy - an arrhythmia in which every other beat is a premature contraction.

Bipolar - means two leads. In the case of ECG, bipolar means two electrodes: a negative and a positive. In pacemakers, bipolar means two leads: the (+) and (-) both in the heart.

Bipolar Limb Leads - Leads I, II, and III.

Bradycardia - an arrhythmia with a rate of less than 60 beats per minute.

Bundle Branch Block - defective conduction of electrical impulses through the right or left bundle branch from the bundle of HIS to the Purkinje network causing right or left bundle branch block. It may be complete/incomplete and intermittent/permanent.

Capture - refers to the ability of a pacemaker's electrical impulse to depolarize either the atria, ventricles, or both.

Couplet - two consecutive premature contractions.

Demand Pacing - refers to the mode of artificial pacing in which the pacemaker is turned on when an appropriate underlying spontaneous atrial or ventricular rhythm is absent.

Depolarization - the process by which a cardiac cell discharges electrically causing cardiac contraction.

Digitized - analog signal is transformed to a digital or computerized signal for use in the algorithm for beat analysis.

Dysrhythmia - arrhythmia, a rhythm other than normal sinus rhythm.

ECG - electrocardiogram, recording of the heart's electrical activity.

ECG Grid - the grid on the ECG paper that is formed by the light and dark horizontal and vertical lines.

All information contained herein is subject to the rights and restrictions on the title page.

Ectopic Beat - contraction that occurs from an impulse generated from a site other than the sinoatrial node. e.g. premature atrial contraction, premature junctional contraction, and premature ventricular contraction.

Electrocardiogram (ECG) - the graphic display of the electrical activity of the heart generated by the depolarization and repolarization of the atria and ventricles. The ECG includes the QRS complex, the P, T, and U waves, the P-R, ST, and T-P segments, and the P-R, Q-T, and R-R intervals.

Electrode - a sensing device that detects electrical activity such as that of the heart.

Escape Beat - a QRS complex arising in an escape, or secondary, pacemaker when the underlying rhythm slows to less than the escape, or secondary, pacemaker's inherent firing rate.

Failure to Capture - the pacemaker fires, but no QRS follows.

Failure to Sense - the pacemaker is unaware of the patient's intrinsic electrical activity and is firing on its own.

Feature Extraction - an aspect of arrhythmia analysis. Similar to template matching, feature extraction compares beats based on a series of characteristics. This algorithm measures a set of features: height, width, polarity, the area under the curve, and the fiducial point for each new beat and compares these features to those of the template.

Full Disclosure - this feature stores all of the transmitted waveforms and digital data for up to 24 hours for all ambulatory and bedside monitored patients. From the View screen, the stored waveforms and data are available for review. The full disclosure may be printed in a 1-hour report, 24-hour report, 24-hour summary report, and zoomed-in report format. These reports contain the time, clinical data, and available waveforms. The full disclosure may be annotated with alarm violations and beat annotations. (PN)

Fusion Beats - a ventricular complex unlike the QRS complexes of the underlying rhythm and those of the ventricular arrhythmia in a given ECG lead, having features of both. This results from the stimulation of the ventricles by two electrical impulses, one originating in the SA node or an ectopic focus in the atria, or AV junctions and the other an ectopic focus in the ventricles. A fusion beat can occur in accelerated idioventricular rhythm (AIVR), a pacemaker rhythm, a premature ventricular contractions (PVCs), and ventricular tachycardia. (PN)

History - the events stored in the files of admitted patients, each file can store up to 100 events for the entire length of stay. Whenever an event is stored either manually or automatically, all vital information and the available waveforms are saved in the patient's history file. The History Blackboard screen lists the stored events, which the operator may view, measure, archive, and print. (PN)

Infarct - death (necrosis) of tissue caused by the interruption of the blood supply to the affected cardiac tissue, myocardial infarction.

Ischemia - starvation of the myocardium for blood (oxygen) due to occlusion of a coronary blood vessel.

Isoelectric Line - the flat line in an ECG recording during which electrical activity is absent.

All information contained herein is subject to the rights and restrictions on the title page.

Learned Reference - the template of the patients “normal” or dominant ECG complex to which every incoming beat is compared. (PN)

Modified Chest Lead MCL1 - the bipolar lead closely resembling lead V1, views the anteroseptal wall of the heart.

Multifocal - (multiform) PVCs that have different QRS complexes as a result of their originating in different ectopic ventricular sites.

Noise - extraneous spikes, waves, and complexes in the ECG signal caused by muscle tremor, 60-cycle AC interference, improperly attached electrodes, and biomedical telemetry-related events such as out-of-range ECG transmission and weak transceiver batteries.

Normal Sinus Rhythm - normal rhythm of the heart, originating in the SA node with a rate of 60 to 100 beats per minute.

Pacemaker, artificial - an electronic device used to stimulate the heart to beat when the electrical conduction system of the heart malfunctions causing bradycardia or ventricular asystole. An artificial pacemaker consists of an electronic pulse generator, a battery, and a wire lead that sense the electrical activity of the heart and deliver electrical impulses to the atria, ventricles, or both when the pacemaker senses an absence of electrical activity.

Pacemaker Filter - a blanking interval set by the system operator. The system presets it at 25 msec and the operator may adjust it from 5 msec to 80 msec. The appropriate setting of this interval enables the arrhythmia software to avoid false asystole calls and/or double counting of QRS complexes. (PN)

Pacemaker Spike - the narrow sharp wave of the ECG caused by the electrical impulse generated by an artificial pacemaker.

Pacemaker Rhythm - a rhythm that is produced by an artificial pacemaker.

Precordial Leads (unipolar) - the precordial leads record currents moving away from the anterior and the left surface of the chest. The unipolar chest leads are Leads V1 to V6.

R-R Interval - the section of the ECG complex between the onset of one QRS complex and the onset of the adjacent QRS.

R-on-T Phenomenon - an ominous type of premature ventricular contraction that falls on the T wave of the preceding QRS-T complex. It may cause repetitive firing and result in ventricular tachycardia or ventricular fibrillation.

Rate - term used to quantify the number of heart beats per minute.

Repolarization - the electrical process by which a depolarized cell returns to its polarized, resting state.

Rhythm - term used to describe the regularity or irregularity of the component aspects of the ECG.

Sense - the term used to describe a pacemaker’s ability to generate a contraction with every spike.

All information contained herein is subject to the rights and restrictions on the title page.

Standard Limb Leads (bipolar) - these are the ECG Leads I, II, and III.

Tachycardia - a heart rate exceeding 100 beats per minute.

Template - a template stores information about the shape of a beat. Templates serve as a reference to which all incoming beats will be compared. Beats either match or do not match the reference beat. The algorithm determines if the patient has had that type of beat before, if it is occurring more frequently, or if the shape (morphology) has changed. The technical name for this process is template matching. (PN)

Trigeminy - a series of groups of three beats usually consisting of two normally conducted QRS complexes followed by a premature contraction.

Torsades De Pointes - a form of ventricular tachycardia at rates of 150-250 beat per minute. The complexes appear to rotate around the isoelectric axis, some are positively deflected and some are negatively deflected, changing their axis and amplitude.

Unifocal (uniform) - PVCs that have the same QRS complexes because they originate in the same ectopic ventricular site.

Unipolar - means one pole. In the case of ECG, only the positive lead is used. The negative lead is mathematically computed. In pacemaker, a unipolar lead is a single lead with the positive electrode on the heart and the negative one on the generator. The unipolar limb leads are ECG leads **aVR**, **aVL**, and **aVF**.

Ventricular Arrhythmia - an arrhythmia originating in an ectopic pacemaker in the ventricles.

Ventricular Ectopic (VE, PVC) - a single irritable site in the ventricle that fires prematurely and overrides the SA and AV nodes. Because the beat originates in the ventricles, its shape is wide and bizarre.

Ventricular Fibrillation - an arrhythmia originating in multiple ectopic pacemakers in the ventricles characterized by numerous ventricular fibrillatory waves and no QRS complexes.

Ventricular Tachycardia - an arrhythmia originating in an ectopic pacemaker in the ventricles with a rate between 110 and 100 beats per minute.

Voltage - amplitude, with respect to ECGs, the height or depth of a wave or complex measured in millimeters (mm).

Ventricular Pair - couplet, two PVCs in a row, may be from the same focus or varied sites.

All information contained herein is subject to the rights and restrictions on the title page.

This page is intentionally left blank.

All information contained herein is subject to the rights and restrictions on the title page.

OPTIONAL FEATURES AND EQUIPMENT

Touch Screen

The touch screen lets you select buttons and perform other functions by touching the screen directly with your finger rather than by clicking with the mouse. With this feature you can:

- press all screen buttons
- highlight an item in a list (for example, an alarm in the list of alarms shown on the Alarm Config screen)
- set the calipers on the Expand screen
- operate the sliders on the System Volume Setup screen

A **Touch Off** button in the upper left corner of the Main screen indicates that your system has the touch screen feature.

The touch screen may need recalibration if you make adjustments to the vertical or horizontal position of the screen. Consult your system administrator to perform recalibration.

CAUTION: Do not tape or stick anything onto the face of the touchscreen display; it may cause the system to receive a false touch signal.

Touch Off Button

The **Touch Off** button inactivates the touch screen. It is a security feature that lets you point to the screen without accidentally changing the display.

Press the **Touch Off** button to inactivate the touch screen for *three minutes* or until you press it a second time. At the end of three minutes, the screen reactivates automatically. This button is on when its lettering flashes red.

The **Touch Off** button does not affect the mouse pointer; you can always use the mouse to select buttons.

Note: Pressing the Touch Off button will not affect the Silence button and the Touch Off button itself. These two buttons are always sensitive to touch and will remain active even in Touch Off mode.

Local Area Network

The optional PatientNet Real-Time Network allows patient data on the network to be distributed to any PatientNet Viewer (also known as the IRVS or RVS) in the facility. Physicians and caregivers thus have access to current, continuous patient information anywhere there is a PatientNet Viewer or Interactive-PatientNet Viewer.

All information contained herein is subject to the rights and restrictions on the title page.

Paging

Alarm Paging

The optional paging system allows system operators to page caregivers, groups of caregivers or paging devices when an alarm occurs. The Central Station sends the room number, the text of the alarm, and the time to the paging device.

Patient alarms must be enabled for paging (see page 239). When an alarm enabled for paging occurs, the operator is prompted either to send the page to the pager number(s) associated with the patient or to cancel the page. This feature works with a variety of hospital paging systems with alphanumeric-paging devices.

Enabling paging for alarms that require paging can be done at the system level by a system administrator or at the patient settings level by a caregiver.

Paging Hardware

Page Master

All pages are sent via the page master, a Central Station or Interactive-PatientNet Viewer (IRVS), which is then physically connected to the hospital's paging system. In a network, pages that originate from systems other than the page master are routed to the page master and disbursed via the network. Each network must have at least one page master, and can have multiple page masters that are connected to different paging systems.

Your facility's system administrator can set up a page master unit.

Page Popup

In a paging system each pod must have one **page popup**, a monitor that displays a popup window on the screen when an alarm is triggered. The popup displays all currently triggered pages and prompts you to send or cancel the page. As the pages are cleared, the highest priority alarm pages appear at the top of the list, even if there are older, lower priority pages in the list.

Your system administrator can configure a page popup.

Parallel Paging

Parallel paging sends a page *automatically* when an alarm occurs. When parallel paging is disabled, you must respond by either sending or canceling the page when an alarm occurs. Consult the system administrator to enable this option.

Retransmitting Pages Until Acknowledged

You can ensure that all pages are acknowledged having the system administrator enable the "close loop" option that re-displayed pages repeatedly at intervals of 1, 2 3, 5 or 5 minutes until you cancel the page. When you cancel the page, it is removed from the page queue forever.

Note: When parallel paging is on, the close loop feature is not available.

All information contained herein is subject to the rights and restrictions on the title page.

Assigning a Pager Number to a Patient

To assign a pager number or telephone extension to a patient for notification in case of alarms:

1. Press **Pager #** on the Patient Settings screen to bring up the on-line numeric keypad.
2. Enter the pager number or telephone extension (maximum 7 characters) to be assigned to this patient and press **Enter**.
3. If the patient belongs to a zone (a group of up to ten different pager numbers), enter **Z** and then the zone number. Alarms enabled for paging will be sent to all pagers in the zone. Zone group paging is set up by the system administrator.
4. Select **None** if you wish no page to be sent.

Note: Pagers may also be set-up by group, where a number of pagers belong to a single group.

Note: Pager numbers may be configured to be retained per channel at the time of discharge.

Enable Paging for an Alarm Triggered Event

To generate automatic pages when an alarm occurs:

1. Press **Setup** on the Main screen and select the patient.
2. Press **Alarm Config** on the Patient Settings screen to display the Alarm Config screen.
3. Highlight the alarm in the Assign list and toggle the **Page** button to On.

Sending a Manual Page

You can send a manual page only from the page popup unit.

1. Press **System** on the Main screen.
2. Press the **Page** button on the Passcode screen to display the page popup.
3. From the external keyboard, enter the pager number and press Enter.
4. Enter the message (14 character maximum). The asterisk (*), right bracket (]), and left bracket ([) characters are not allowed as part of the message.
5. Press Enter to send the page or Esc on the keyboard to return to the Passcode screen without generating a page. If a failure occurs, the technical alarm sounds and a popup appears. Select the **Cancel** button at the top of the popup to cancel the alarm.

   If a failure occurs, the system re-enters the page into the paging queue and automatically prompts you to re-page or cancel the failed page. This prompt occurs when parallel paging is either enabled or off. When failed pages accumulate in the queue and you do not process new pages, the queue will eventually meet the maximum of 20 entries. The system cannot process new pages until you reduce the queue size to 19 or fewer entries.

All information contained herein is subject to the rights and restrictions on the title page.

Testing the Paging System

To ensure that pages are sent by the page popup unit and that the pagers configured on the system are receiving the information correctly, perform a paging system test, typically once per shift. When this test is performed, all persons with pagers should call in to confirm that they have received the page.

This test can only be performed from the page popup unit.

1. Press **System** on the Main screen.
2. Press the **Shift Test** button on the Passcode screen.

Note: Even if there is more than one pod present on the network, only one shift test is required for the same network.

3. Select **Yes** to send the page to all pagers or **No** to cancel the shift test.
4. If a failure occurs, the technical alarm sounds and a popup appears. Make a note of pagers that failed this test and press the **Cancel** button at the top of the popup to cancel the alarms.

   If a failure occurs, the system re-enters the page into the paging queue and automatically prompts you to re-page or cancel the failed page. When failed pages accumulate in the queue and you do not process new pages, the queue will eventually meet the maximum of 20 entries. The system cannot process new pages until you reduce the queue size to 19 or fewer entries.

Multi-Mouse

The multi-mouse permits the control of up to seven monitors—six Central Stations, plus one Interactive-PatientNet Viewer connected together in a pod—with one mouse.

By moving the mouse pointer beyond the screen area of one monitor, you can access other monitors.This section explains how each Central Station reacts when the multi-mouse is moved off the screen (table 1, “Multi-Mouse movement directions and pointer reactions for a Pod Configuration,” on page 241 for details).

Note: Right-click the mouse to send the mouse pointer to the upper left screen.

All information contained herein is subject to the rights and restrictions on the title page.

Table 1 Multi-Mouse movement directions and pointer reactions for a Pod Configuration

Mouse Direction	Channels 1-8	Channels 9-16	Channels 17-24	Channels 25-32	Channels 33-40	Channels 41-48	Interactive-PatientNet Viewer
Upper Left	Remains on this Screen	Remains on this Screen	Remains on this Screen	Moves to (1-8)	Moves to (1-8)	Moves to (9-17)	Moves to (25-32)
Upper Middle	Remains on this Screen	Remains on this Screen	Remains on this Screen	Moves to (1-8)	Moves to (9-16)	Moves to (17-24)	Moves to (33-40)
Upper Right	Remains on this Screen	Remains on this Screen	Remains on this Screen	Moves to (9-16)	Moves to (17-25)	Remains on this Screen	Moves to (41-48)
Left	Remains on this Screen	Moves to (1-8)	Moves to (9-16)	Remains on this Screen	Moves to (25-32)	Moves to (33-40)	Remains on this Screen
Right	Moves to (9-16)	Moves to (17-24)	Remains on this Screen	Moves to (25-32)	Moves to (41-48)	Remains on this Screen	Remains on this Screen
Lower Left	Moves to (25-32)	Moves to (25-32)	Moves to (33-40)	Moves to IRVS	Moves to IRVS	Moves to IRVS	Remains on this Screen
Lower Middle	Moves to (25-32)	Moves to (33-40)	Moves to (41-48)	Moves to IRVS	Moves to IRVS	Moves to IRVS	Remains on this Screen
Lower Right	Moves to (33-40)	Moves to (41-48)	Moves to (41-48)	Moves to IRVS	Moves to IRVS	Moves to IRVS	Remains on this Screen

All information contained herein is subject to the rights and restrictions on the title page.

This page is intentionally left blank.

All information contained herein is subject to the rights and restrictions on the title page.

SYSTEM COMPLIANCE

Compliance Statement

Table 22 Device UL and FCC Compliance

Device	UL Compliance	FCC Compliance	Other
Central Station, Remote Viewing Station	UL 544, UL 1950	Part 15	CISPR 11 Class A and IEC 802-2, 802-3, 802-4, 802-5
DT-4500 Ambulatory Transceiver	UL 2601-1	Part 15.242, Part 95 Subpart H (WMTS)	IPX7 Compliant/CISPR 11/ EN60601-1-2
DT-7000/7001 Instrument Transceiver	UL 2601-1	Part 15.242, Part 95 Subpart H (WMTS)	IPX1 Compliant/CISPR 11/ EN60601-1-2
DR-10000	UL 1950	Part 15.242, Part 95 Subpart H (WMTS)	N/A
V-Pak (DT-4000)	UL 544	Part 15	N/A
V-Link (DT-5000), V-Link II (DT-5100)	UL 544	Part 15	N/A

PatientNet equipment complying with part 15 of the FCC rules: Operation is subject to the following conditions: (1) this device may not cause harmful interference, and (2) this device must not accept any interference received, including interference that may cause undesired operation.

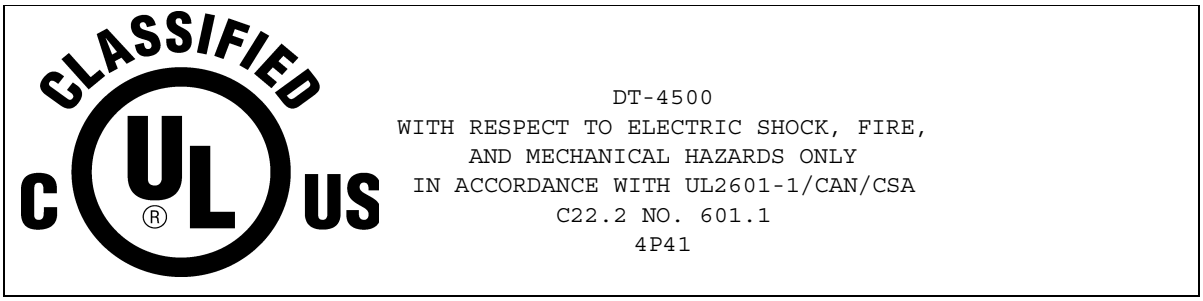
PatientNet equipment complying with part 95 of the FCC rules: Operation requires the prior coordination with a frequency coordinator designated by the FCC for the Wireless Medical Telemetry Service.

WARNING: Accessory equipment connected to the analog or digital interfaces of the PatientNet System must be certified according to UL Electrical Safety Standards (UL 1950 for data processing equipment and UL 2601-1 for medical equipment). You are responsible for making sure that devices you connect to the PatientNet System comply with UL standards.

All information contained herein is subject to the rights and restrictions on the title page.

DT-4500 Ambulatory Transceiver

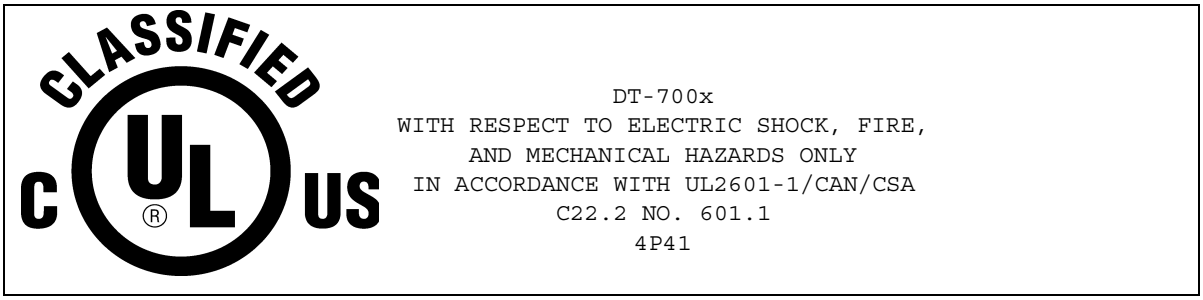
UL Classification



The DT-4500 transceiver is classified in accordance with UL 2601-1, Type BF with Defibrillator Proof (5000V per AAMI EC-13-1992), and IPX7 (according to IEC 529-1989). The DT-4500 has been designed to withstand the effects of EMI and meets the EMC requirements of EN60601-1-2 (April 1993) and CISPR 11. However, extremely high levels of electromagnetic energy (above the levels of EN60601-1-2) may still produce interference.

DT-7000/7001 Instrument Transceiver

UL Classification



The DT-7000/7001 transceiver is classified in accordance with UL 2601-1 and IPX1 (according to IEC 529-1989) on non-patient equipment. The DT-7000/7001 has been designed to withstand the effects of EMI and meets the EMC requirements of EN60601-1-2 (April 1993) and CISPR 11. However, extremely high levels of electromagnetic energy (above the levels of EN60601-1-2) may still produce interference.

All information contained herein is subject to the rights and restrictions on the title page.

DR-10000 Access Point

UL Classification

The DR-10000 Access Point is classified in accordance with UL 1950, Information Technology Equipment (including Electrical Business Equipment), and CAN/CSA C22.2 No. 950-95 (Third Edition).

FCC Compliance in the 174-216 MHz and 608-614 MHz bands

1. The marketing and operation of intentional radiators, under the provisions of 15.242 of the FCC rules, is restricted to biomedical telemetry devices that are employed on health care facilities premises.
   a. A health care facility includes hospitals and other establishments that offer services, facilities, and beds for use beyond 24 hours in rendering medical treatment, as well as institutions and organizations that are regularly engaged in providing medical services through clinics, public health facilities, and similar establishments, including governmental entities and agencies for their own medical activities.
   b. This authority to operate does not extend to mobile vehicles, such as ambulances, even if those vehicles are associated with a health care facility.
2. The user and the installer of a biomedical telemetry device, which is operating within the frequency range 174-216 MHz, 470-608 MHz, or 614-668 MHz, shall ensure that the following minimum separation distances are maintained between the biomedical telemetry device and the authorized radio services that are operating on the same frequencies:
   c. At least 5.5 km outside of the Grade B field strength contour (64 dBuV/m) of a TV broadcast station or an associated TV booster station that is operating within the 470-608 MHz or 614-668 MHz bands.
   a. At least 10.3 km outside of the Grade B field strength contour (56 dBuV/m) of a TV broadcast station or an associated TV booster station that is operating within the 174-216 MHz band.
   b. At least 5.1 km outside of the 68 dBuV/m field strength contour of a low power TV or a TV translator station that is operating within the 174-216 MHz band.
   c. At least 3.1 km outside of the 74 dBuV/m field strength contour of a low power TV or a TV translator station that is operating within the 470-608 MHz or 614-668 MHz bands.
   d. Whatever distance is necessary to protect other authorized users within these bands.

All information contained herein is subject to the rights and restrictions on the title page.

3. The user and the installer of a biomedical telemetry device that is operating within the frequency range 608-614 MHz, and that will be located within 32 km of the very long baseline array (VLBA) stations or within 80 km of any of the other radio astronomy observatories noted in footnote US311 of 2.106 of this chapter, must coordinate with, and obtain the written concurrence of, the director of the affected radio astronomy observatory before the equipment can be installed or operated. The National Science Foundation point of contact for coordination is: Spectrum Manager, Division of Astronomical Sciences, NSF Rm 1045, 4201 Wilson Blvd., Arlington, VA 22230; tel: 703.306.1823.
4. Biomedical telemetry devices must not cause harmful interference to licensed TV broadcast stations or to other authorized radio services, such as operations on the broadcast frequencies under Subpart G and H of Part 74 of the FCC rules, land mobile stations that are operating in the 470-512 MHz band, and radio astronomy operation in the 608-614 MHz band. If harmful interference occurs, then the interference must either be corrected or the device must immediately cease operation on the occupied frequency. Further, the operator of the biomedical telemetry device must accept whatever level of interference is received from other radio operations. The operator, i.e., the health care facility, is responsible for resolving any interference that occurs subsequent to the installation of these devices.
5. The manufacturers, installers, and users of biomedical telemetry devices are reminded that they must ensure that biomedical telemetry transceivers, which are operating under the provisions of this section, avoid operating in close proximity to authorized services using this spectrum. Sufficient separation distance, which is necessary to avoid causing or receiving harmful interference, must be maintained from co-channel operations. These parties are reminded that the frequencies of the authorized services are subject to change, especially during the implementation of the digital television services. The operating frequencies of the Part 15 devices may need to be changed, as necessary and in accordance with the permissive change requirements of this section, in order to accommodate changes in the operating frequencies of the authorized services.

All information contained herein is subject to the rights and restrictions on the title page.

SPECIFICATIONS

Specifications are provided to help you determine the space, ventilation, air conditioning, and power requirements to ensure proper operation of your monitoring system.To provide adequate cooling of the equipment, you must maintain at least two inches of air space at the top, rear, and both sides of computers and display monitors.

Ensure that the PatientNet Central Station is kept free of fumes, dirt, and electrical interference.

Specifications are approximate and may change with the actual unit shipped. Call your service representative if precise specifications are required.

Note: Specifications are subject to change without notice

Central Station and PatientNet Viewers

Table 23 Motherboard Components

	Intel Pentium® III
Processor	500 MHz Pentium III with integrated 512 KB cache RAM
System Memory	32 MB, SDRAM-ECC, PC100-pin DIMM with gold-plated contacts
System BIOS	Intel BIOS 4R4CBOXA.86A.0015.PO9
PCI Chip Set	Intel 440 BX
Expansion Slots (full length)	3 dedicated PCI slots 3 dedicated ISA slots 1 shared slot for either ISA or PCI

Table 24 Computer Chassis

	Intel Pentium III
Type	ATX Mini-Tower form factor Chassis
Height	14.76 in. (37.5 cm)
Width	8.94 in. (22.7 cm)
Depth	17.00 in. (43.2 cm)
Weight	35 lb. (15.9 kg) maximum

Table 25 System Environment

	Intel Pentium III
Operating Temperature	+10° C to +35° C +50° F to +95° F
Storage Temperature	-20° C to +60° C -4° F to +140° F

All information contained herein is subject to the rights and restrictions on the title page.

	Intel Pentium III
Relative Humidity	90% maximum @ 35° C (non-condensing)

Table 26 Regulations

	Intel Pentium III
Safety	UL 544 listed CSA certified to CSA 22.2, no. 125
EMC	Meets CISPR II Class A and IEC 802-2, 802-3, 802-4, 802-5

Table 27 Power

	Intel Pentium III
AC Input Power	115 V/60 Hz or 230 V/50 Hz switchable
Power Consumption	135 W
Measured Current Draw @ 115 V, amps RMS	1.07
VA @ 115 V	123
BTU/hr.	299

All information contained herein is subject to the rights and restrictions on the title page.

CRT and LCD Displays

Table 28 Display Specifications

	15” (Color CRT)	19” (Color CRT)
Part Number	Z40903 Non-Touch Z40309 Touch Screen	Z40902 Non-Touch Z40308 Touch Screen
Dimensions	14.7 x 14.2 x 15.4 in. 374 x 360 390 mm	18.1 x 18.2 x 18.8 in 460 x 461 x 475 mm
Type	15 in. (14 in. diagonal viewable area) 0.27 mm dot pitch, 90 deflection	48.2 cm/19 in. (18 in. viewable area) diagonal 0.26 dot pitch mm
Glass Surface	tint (TM=46%) ARAG screen treatments	--
Weight	26.4 lb. (12 kg) net	57.3 lb. (26 kg)

Table 29 Connectors

	15” (Color CRT)	19” (Color CRT)
Signal	15-pin mini D-sub (attached cable)	--
Power	3-pin plug (IEC320)	--
Rear	--	mini D-sub 15-pin
Video Input Bandwidth	110 MHz (typical)	--

Table 30 Display System Environment

	15” (Color CRT)	19” (Color CRT)
Operating Temperature	0° C to +40° C +32° F to +104° F	0° C to +40° C +32° F to +104° F
Relative Humidity	5% to 95% (non-condensing)	20% to 80%

Table 31 Power

	15” (Color CRT)	19” (Color CRT)
Voltage	AC 100-240VAC (auto switch) 50-60 Hz	100 to 120VAC/220 to 240VAC 50-60 Hz
Consumption	70 W (typical)	130 W max
Measured Current draw @ 115 V, amps RMS	0.87	0.80
VA @ 115 V	87.4	92
BTU/hr.	212	223

All information contained herein is subject to the rights and restrictions on the title page.

System Components

WMTS Transceivers

DT-4500

The DT-4500 is an internally powered device and is suitable for continuous operation.

Table 32 DT-4500 Environmental Specifications

	Operating	Storage
Temperature	+41° F to +104° F +5° C to +40° C	-4° F to +158° F -20° C to +70° C
Humidity	15% to 95% non-condensing	10% to 95% non-condensing
Pressure/Altitude	1060 hPa to 700 hPa -1,252’ to 9,840’	1060 hPa to 500 hPa -1,252’ to 18,280’

Table 33 Device Specifications

Component	Requirements
Environmental Protection	IPX7
Input Configuration	5, electrodes, 1 spare, selectable
Pacemaker Detection	Analog on each lead, independent of sample rate ± 2 mV to ± 700 mV Max (per AAMI EC-13-1992)
Battery	9-Volt alkaline or 9-Volt lithium-Use Kodak Ultralife U9VL or Energizer L522 Only. Use of another Lithium battery may present a risk of fire or explosion. See Warning Section.
Battery Life	9-Volt Alkaline-Minimum, 28.8 hours
Frequency Range Programmable	608-614 MHz
Modulation	Digital encoded FM (FSK)
Dimensions	5.75 in. x 2.50 in. x 1.25 in.
Defibrillator Recover Time	8 Seconds

All information contained herein is subject to the rights and restrictions on the title page.

DT-7000 and DT-7001

The DT-7000 is an externally powered Class 1 device and is suitable for continuous operation.

The DT-7001 is an externally and internally powered Class 1 device and is suitable for continuous operation.

Both devices are intended for non-patient connection use.

Table 34 DT-7000/7001 Environmental Specifications

	Operating	Storage
Temperature	+41° F to +104° F +5° C to +40° C	-4° F to +158° F -20° C to +70° C
Humidity	15% to 95% non-condensing	10% to 95% non-condensing
Pressure/Altitude	1060 hPa to 700 hPa -1,252’ to 9,840’	1060 hPa to 500 hPa -1,252’ to 18,280’

Table 35 DT-7000/7001 Device Specifications

Component	Requirements
Environmental Protection	Transceiver is IPX1, Power Supply is IPX0
Power Supply	input 120V, 60Hz, 35 VA Output 6VOC @ 1.6 A
Frequency Range Programmable	608 - 614 MHz
Modulation	Digital Encoded FM (FSK)
Dimensions	3.0 in. x 1.25 in. x 7.0 in. (11.0 in. tall with antenna up)

DR-10000 Access Point

The DR-10000 is an externally powered device and is suitable for continuous operation.

DR-10000 Environmental Specifications

	Operating	Storage
Temperature	+41° F to +104° F +5° C to +40° C	-4° F to +122° F -20° C to +50° C
Humidity	15% to 90% non-condensing	up to 90% non-condensing

All information contained herein is subject to the rights and restrictions on the title page.

Uninterruptible Power System and Power Conditioning Systems

Note: It is recommended that you charge the battery before the first use of your UPS. You may use the UPS without charging the battery first, but the backup time may be less than the rating.

The UPS charges the battery automatically when it is turned on and AC power is available.

Specifications are subject to change without notice

Table 36 Uninterruptible Power System

	OPTI-UPS SMT 420ES	OPTI-UPS SMT 650ES
Part Number	230830	230831
Maximum Capacity	420VA/420W	650VA/650W
Rated Capacity	--	--
Output Receptacles	4	4
Weight	8 kg (gross) 17.6 lb.	10.5 kg (gross) 23.1 lb.
Height	13.6 in. (345 mm)	13.6 in. (345 mm)
Width	5 in. (126 mm)	5 in. (126 mm)
Depth	6.7 in. (170 mm)	6.7 in. (170 mm)
Transfer Time (typical)	2 ms	2 ms
Run-time (typical)	1/2 load: 15 min. full load: 5 min.	1/2 load: 15 min. full load: 5 min.
Compliance	UL 1778	UL 1778
Operating Temperature	0° C to 40° C 32° F to 104° F	0° C to 40° C 32° F to 104° F
Humidity	0 to 90% (non-condensing)	0 to 90% (non-condensing)
Battery	one (7AH/12V)	one (7AH/12V)

All information contained herein is subject to the rights and restrictions on the title page.

CLINICAL REFERENCE TOOLS

Central Station Quick Reference

Admit a Patient

1. Touch[1] **Setup** at top of screen.
2. On top half of screen, touch patient's **waveform** box.
3. Touch **Admit** on lower half of screen.
4. Touch **Patient Data**, enter patient name, etc., using onscreen keyboard.
5. Touch **Exit** (at bottom) to return to main screen.

Record a Real-Time Strip

1. Touch **Strip** to right of patient information box. Recording will stop automatically.
2. For a continuous strip, touch **Cont**, in upper left corner of screen, while strip is running.
3. Touch **Strip** again to stop continuous strip recording.

View Alarmed Events

1. Touch **View** at top of screen.
2. On top half of screen, touch patient's **waveform** box.
3. Touch **History** at bottom of screen.
4. Use arrows to select an event for review or touch directly on event name.
5. Touch **Review** to see desired event.
6. To see an enlarged view, touch **Expand**. To measure interval point, touch at beginning and end.
7. Touch **Measure** and select desired label.
8. Touch **Back**, then touch **Exit** twice to return to main screen.

View Data from 24-Hour (72-Hour) Full Disclosure

1. Touch **View** at top of screen.
2. On top half of screen, touch patient's **waveform** box.
3. Touch **24-Hour** button at bottom.
4. Touch **Skip To** button, enter desired time using keypad.
5. Touch **Enter** on keypad.
6. To examine highlighted area in detail, touch anywhere on ECG waveform on bottom half of screen, then touch **Zoom-In**.
7. Touch **Exit** twice to return to main screen.

Discharge Patient

1. Touch **Setup** at top of screen.
2. On top half of screen, touch patient's **waveform** box.
3. Touch **Discharge** in left lower screen, and touch **YES** to print Discharge Report.
4. Touch **YES** to clear information.
5. Touch **Exit** to return to main screen.

1. Touch refers to touching a touchscreen display or clicking a mouse.

All information contained herein is subject to the rights and restrictions on the title page.

Central Station Clinical Calculations

Heart Rate Accuracy

Ambulatory Patients

The heart rate is based on a tracked six-beat average.

New heart rate = (current rate - current rate/6) + (instantaneous rate/6)

PVC Count

The PVC count is the number of PVCs (arrhythmia V calls) in the last 60 seconds.

Central Station Beat Annotations

PatientNet Arrhythmia Software V1.05 Annotations

Beat Label	Description
N	Normal or Dominant
Q	Aberrant Normal
q	First Occurrence of Aberrant Normal
A	Premature Normal or Premature Supraventricular (SVE)
V	Premature Ventricular Ectopic (PVC)
X	Not Classified Due to Bad Samples (RF drop out) in QRS Region
?	Unknown (Noise or First Occurrence of PVC Morphology)

All information contained herein is subject to the rights and restrictions on the title page.

PatientNet Arrhythmia Analysis Software V1.05

Alarm Label	Rhythm	Description
MUSCLE	Muscle	Muscle Artifact
ASYSTOLE	Asystole	No QRS Detected for 3.0 Sec
CHKSIGNAL	Check Signal	Intermittent no signal detected
NO SIGNAL	No Signal	No QRS Detected for 9.0 Sec
V-FIB	Ventricular Fibrillation	Rapid disorganized Ventricular Impulses, no QRS's
V-TACH	Ventricula r Tachycardia	Configurable. The number of consecutive PVCs can be set equal to, and between, 3 and 8. The Heart Rate can be set equal to, and between, 100 and 120 BPM. A V-TACH alarm is triggered when the consecutive PVC count is reached AND the heart rate is greater than or equal to the set Heart Rate Value.
V-RUN	Ventricular Run	V-RUN is triggered when the number of consecutive PVCs is greater than 2 and less than the V-TACH configured PVC value (i.e. when the V-TACH is configured at 3 PVCs, the V-RUN alarm is never triggered).
V-RHYTHM	Ventricular Rhythm	V-RHYTHM is triggered when the number of consecutive PVCs is greater than or equal to the V-TACH configured PVC value, but the Heart Rate is less than the V-TACH configured heart rate value.
BIGEMINY	Ventricular Bigeminy	N-PVC-N-PVC-N-PVC Sequence
TRIGEMINY	Ventricular Trigeminy	N-N-PVC-N-N-PVC-N-N-PVC Sequence
COUPLET	Ventricular Couplet	2 Consecutive PVCs
HIGH PVC	High PVC	PVC Count > High PVC Limit
PVC	PVC	Single PVC
SV-TACH	Supraventricular Tachycardia	8 Consecutive SVEs, HR 150 or More
HIGH HR	High Heart Rate	HR Greater than High Rate Limit
LOW HR	Low Hear Rate	HR less than Low Rate Limit
NO ARR	Arrhythmia unable to analyze	No good leads are available for analysis
CHK LEAD	Check Lead	One or more of the ECG leads has a poor connection and/or is causing significant baseline wander
REGULAR	**Normal**	**Dominant Rhythm**

All information contained herein is subject to the rights and restrictions on the title page.

PatientNet Viewer Quick Reference

Place a Patient on the Screen

1. Touch[1] **Network** at top of screen. (If 16 channels, select **First 8** or **Last 8** button at top to get to desired channel).
2. On top half of screen, select desired viewing position by touching that **waveform** box.
3. On lower half of screen, sort list of patients by selecting **CH**, **Patient Name**, **Room**, **Physician**, or **Pager** #.
4. Select patient by touching desired **Patient Name**.
5. Touch **Select**.
6. Touch **Exit** (at bottom) to return to main screen.

Record a Real-Time Strip

1. Touch **Strip** to right of patient information box. Recording will stop automatically.
2. For a continuous strip, touch **Cont.**, in upper left corner of screen, while strip is running.
3. Touch **Strip** again to stop continuous strip recording.

View Alarmed Events

1. Touch **View** at top of screen.
2. On top half of screen, touch patient's **waveform** box.
3. Touch **History** at bottom of screen.
4. Use arrows to select an event for review or touch directly on event name.
5. Touch **Review** to see desired event.
6. To see an enlarged view, touch **Expand**. To measure interval point, touch at beginning and end.
7. Touch **Measure** and select desired label.
8. Touch **Back**, then touch **Exit** twice to return to main screen.

View Data from 24-Hour (72-Hour) Full Disclosure

1. Touch **View** at top of screen.
2. On top half of screen, touch patient's **waveform** box.
3. Touch **24-Hour** button at bottom.
4. Touch **Skip To** button, enter desired time using keypad.
5. Touch **Enter** on keypad.
6. To examine highlighted area in detail, touch anywhere on ECG waveform on bottom half of screen, then touch **Zoom-In**.
7. Touch **Exit** twice to return to main screen.

Remove Patient's Tracing from Screen

1. Touch **Network**.
2. On top half of screen, touch patient's **waveform** box.
3. Touch **Channel Off** in right lower screen.
4. Touch **Exit** to return to main screen.

1. Touch refers to touching a touchscreen display or clicking a mouse.

All information contained herein is subject to the rights and restrictions on the title page.

Interactive-PatientNet Viewer Quick Reference

Place a Patient on the Screen

1. Touch[1] **Network** at top of screen. (If 16 channels, select **First 8** or **Last 8** button at top to get to desired channel).
2. On top half of screen, select desired viewing position by touching that **waveform** box.
3. On lower half of screen, sort list of patients by selecting **CH**, **Patient Name**, **Room**, **Physician**, or **Pager #**.
4. Select patient by touching desired **Patient Name**.
5. Touch **Select**.
6. Touch **Exit** (at bottom) to return to main screen.

Admit a Patient

1. Touch **Setup** at top of screen.
2. On top half of screen, touch patient's **waveform** box.
3. Touch **Admit** on lower half of screen.
4. Touch **Patient Data**, enter patient name, etc., using onscreen keyboard.
5. Touch **Exit** (at bottom) to return to main screen.

Record a Real-Time Strip

1. Touch **Strip** to right of patient information box. Recording will stop automatically.
2. For a continuous strip, touch **Cont**, in upper left corner of screen, while strip is running.
3. Touch **Strip** again to stop continuous strip recording.

View Alarmed Events

1. Touch **View** at top of screen.
2. On top half of screen, touch patient's **waveform** box.
3. Touch **History** at bottom of screen.
4. Use arrows to select an event for review or touch directly on event name.
5. Touch **Review** to see desired event.
6. To see an enlarged view, touch **Expand**. To measure interval point, touch at beginning and end.
7. Touch **Measure** and select desired label.
8. Touch **Back**, then touch **Exit** twice to return to main screen.

View Data from 24-Hour (72-Hour) Full Disclosure

1. Touch **View** at top of screen.
2. On top half of screen, touch patient's **waveform** box.
3. Touch **24-Hour** button at bottom.
4. Touch **Skip To** button, enter desired time using keypad.
5. Touch **Enter** on keypad.
6. To examine highlighted area in detail, touch anywhere on ECG waveform on bottom half of screen, then touch **Zoom-In**.
7. Touch **Exit** twice to return to main screen.

Discharge Patient

1. Touch **Setup** at top of screen.
2. On top half of screen, touch patient's **waveform** box.
3. Touch **Discharge** in left lower screen, and touch **YES** to print Discharge Report.
4. Touch **YES** to clear information.
5. Touch **Exit** to return to main screen.

1. Touch refers to touching a touchscreen display or clicking a mouse.

All information contained herein is subject to the rights and restrictions on the title page.

This page is intentionally left blank.

All information contained herein is subject to the rights and restrictions on the title page.

SUPPORTED BEDSIDE MONITORS AND DEVICES

Refer to the current Customer Release Notes, Part Number 10001022, for a list of the supported bedside monitors and devices.

All information contained herein is subject to the rights and restrictions on the title page.

This page is intentionally left blank.

All information contained herein is subject to the rights and restrictions on the title page.

SELECTED REFERENCES

Computerized Arrhythmia Detection

American national standard for cardiac monitor, heart rate meters, and alarms. Arlington, VA.: AAMI:1993; ANSI/AAMI EC13—1992 (Revision of ANSI/AAMI EC13-1983).

Recommended practice for testing and reporting performance results of ventricular arrhythmia detection algorithms (ECAR). In: AAMI Standards and Recommended Practices. Arlington, VA; Association for the Advancement of Medical Instrumentation, 1987; 1993; 2:649-672.

Arnold, J.M et al. Artifact rejection in a computer system for the monitoring of arrhythmias. pp. 163-7. In: *Computers in Cardiology.* Long Beach, Calif., IEEE Computer Society, 1975. WG 141 C736 1975.

ECRI, Ambulatory telemetry arrhythmia monitoring systems. *Health Devices,* Plymouth Meeting, 23(7): 263-82, July 1994.

Elghazzawi, Z. et al. Automated testing of arrhythmia monitors using annotated databases. *Biomedical Instrumentation and Technology,* 26(4): 319-24, July/August 1992.

Elghazzawi, Z. and F. Gehab. Critique of arrhythmia detections based on heuristic rules. *Biomedical Instrumentation and Technology,* 31(3): 263-71, June1997.

Jenkins, Janice. Automated Electrocardiogram and Arrhythmia Monitoring. *Progress in Cardiovascular Disease,* 25(5): 367-407, March/April 1983.

Kater, Susan and Gessler, Joan. Full-disclosure monitoring: A concept that will change the way arrhythmias are detected and interpreted in the hospitalized patient. *Heart and Lung* October/November 1993, 482-489.

MIT-BIH database, available from the Massachusetts Institute of Technology 77 Massachusetts Avenue, Room 20A-113, Cambridge, MA 02139.

Ripley, Kenneth and Murray, Alan. Introduction to Automated Arrhythmia Detection, *IEEE (Institute of Electrical and Electronic Engineers) IEEE Computer Society Press,* IEEE Catalog No.EHO171-9, Library of Congress No. 80-53634, Los Alamitos, CA.,71-87.

Romhilt, Donald, S. Bloomfiled, T. Chou, Unreliability of Conventional Electrocardiographic Monitoring for Arrhythmia Detection in Coronary Care Units, *American Journal of Cardiology,* 31: 1973, 457-461.

Telemetry Monitoring

Daly, BJ, Wilson, CA. The effect of fatigue on the vigilance of nurses monitoring electrocardiograms, *Heart and Lung,* 1983:12:384-388.

DeGasperis, Margaret and Bettie Jackson. Cost Effectiveness of a Monitor Technician Program: An Analysis. *Focus on Critical Care, 1987, 1490, 42-51.*

Drew, Barbara and Sparucno, Patricia. Bedside ECG Monitoring: Accuracy of bedside electrocardiographic monitoring: A report on current practice of critical care nurses. *Heart and Lung* 20(6): November 1991, 597-607.

ECG Interpretation Made Incredibly Easy! Springhouse Corp: Springhouse, PA. 1997.

Estrada, C A.et al. Outcomes of patients hospitalized to telemetry units. *American Journal of Cardiology.* 74(4): 357-62, August 15, 1994.

Estrada, C.A. et al. The role of telemetry monitoring in the non-intensive care unit. *American Journal of Cardiology.* 76(12): 960-5, November 1, 1995.

Feldman, J. M. Decentralization in cardiac services. *Nursing Management* 23(11), 80D, 80H, November 1992.

All information contained herein is subject to the rights and restrictions on the title page.

Ford, J. H.2d et al. Centralized telemetry monitoring: implementation and management. *Journal of the Society for Health Systems* 3(2):52-68, 1991.

Funk, M. Ask the experts: are dedicated monitor watchers necessary on the telemetry unit? *Critical Care Nurse* 16(5): 102-105, October 1996.

Stukshis, I. et al. Accuracy of detection of clinically important dysrhythmias with and without a dedicated monitor watcher. *American Journal of Critical Care* 6(4): 312-317, July 1997.

Funk, M. et al. Effect of dedicated monitor watchers on patients' outcomes. *Journal of Critical Care* 6(4): 318-23, July 1997.

Hitchens, M. Telemetry: who's watching the monitors? *Critical Care Nurse* 12(6): 100-2, August 1992.

Howie, S. and S. Vanriper. Redesigning work: the cardiac intervention nurse liaison. *Nursing Management* 23(6): 64J, 64N-64O, June 1992.

Jacobsen, C. Applying research at the bedside: bedside cardiac monitoring. *Critical Care Nurse* 18(3): 822-85, May/June 1998.

Jenkins, L.S. Heart watch: national survey of continuous electrocardiographic monitoring in U.S. hospitals. *Journal of Nursing Administration*, 1995: 4:38-44.

Krasover, T. A conceptual approach to the electrocardiogram. *Critical Care Nurse* 2(2): 66-75, March/ April 1982.

Moses, H.W. et al. *A Practical Guide to Cardiac Pacing.* Boston: Little, Brown, and Company, 1991.

Nottingham, A. and V. Camp. Remote cardiac monitoring: nurse collaboration IS the key. *Dimensions of Critical Care Nursing* 6(3): 176-80, May/June 1997.

Pelczarski, Kathyrn. Using Telemetry: Trends and Tips, *AJN*, January 1994, 56A-57A.

Pelczarski, K. Continuum of care monitoring- its time has come. ECRI Plymouth Meeting, PA. January 1998, 1-18

Perez, A. Cardiac monitoring: mastering the essentials. *RN* 59(8): 32-8, August 1996.

Potect, S. and J. Touloukian. Orientation of new RNs for telemetry. *Critical Care Management Edition/ Nursing Management* 23(4): 96A-96D, April 1992.

Smith, M. Rx for ECG monitoring artifact. *Critical Care Nurse* 4(1): 64-6, January/ February 1984.

Stukshis, I. et al. Accuracy of detection of clinically important dysrhythmias with and without a dedicated monitor watcher. *American Journal of Critical Care 6(4): 312-17,* July 1997.

Thaler, Malcolm S. *The Only ECG Book You'll Ever Need*. (3rd ed.) Philadelphia: Lippincott Williams & Wilkins. 1999

All information contained herein is subject to the rights and restrictions on the title page.

INDEX

All information contained herein is subject to the rights and restrictions on the title page.

All information contained herein is subject to the rights and restrictions on the title page.

All information contained herein is subject to the rights and restrictions on the title page.

All information contained herein is subject to the rights and restrictions on the title page.