PageWriter 10/10i
Agilent M2662A
Interpretive Cardiograph
Physician's Guide
Interpretive Cardiograph Physician's Guide
Manufacturer

Agilent Technologies, Inc.
Healthcare Solutions Group
3000 Minuteman Road
Andover, MA. 01810

Medical Device Directive

This product complies with the requirements of the Medical Device Directive 93/42/EEC and carries the $\text{CE}_{0123}$ mark accordingly.

Authorized EU-Representative
Agilent Technologies Deutschland GmbH
Herrenbergerstr.130
D71034 Boeblingen
Germany
Notice

The information in this document may change without notice.

Agilent makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Agilent shall not be liable for errors herein or for incidental or consequential damages in connection with furnishing, performance or use of this material.

This document contains or refers to proprietary information which is protected by copyright. All rights are reserved. Copying or other reproduction of this document without prior written permission of Agilent Technologies Inc. is prohibited.

© Copyright 2000 Agilent Technologies Inc. All rights reserved.
About This Guide

This guide explains how the clinical ECG reports are analyzed by an Agilent interpretive cardiograph. It also shows how an Agilent interpretive cardiograph ensures reliable results.

**NOTE**

No automated analysis is completely reliable. Computerized ECG analysis should always be reviewed by a qualified physician.

Who Should Read This Guide?

This guide is intended for physicians who read or review ECGs produced by an Agilent interpretive cardiograph. It also may be of interest to other health care professionals who want to know more about Agilent interpretive cardiographs.
Chapter 5 The Agilent Adult ECG Criteria Program

Understanding the Agilent Adult ECG Criteria Program ..................................................... 5-1
  Calibration Notice if Not Standard .................................................................................. 5-3
  Technical Quality Statements ....................................................................................... 5-3
  Electronic Pacemaker .................................................................................................... 5-3
  Basic Cardiac Rhythm .................................................................................................... 5-3
  Premature Beats (Short R-R) .......................................................................................... 5-4
  Pauses (Long R-R) ......................................................................................................... 5-4
  Miscellaneous Arrhythmias .......................................................................................... 5-5
  AV Conduction (PR Interval) ........................................................................................ 5-5
  QRS axis ....................................................................................................................... 5-6
  Ventricular Conduction Delays ..................................................................................... 5-7
  Right Atrial Abnormality .............................................................................................. 5-7
  Right Ventricular Hypertrophy ..................................................................................... 5-8
  Left Atrial Abnormality ................................................................................................ 5-9
  Left Ventricular Hypertrophy ....................................................................................... 5-9
  Chronic Pulmonary Disease .......................................................................................... 5-11
  Inferior Infarct .............................................................................................................. 5-11
  Posterior Infarct ......................................................................................................... 5-12
  Lateral Infarct .............................................................................................................. 5-12
  Anteroseptal and Anterior Infarct ............................................................................... 5-13
  Anterolateral and Extensive Anterior Infarct ............................................................... 5-13
  Tall T Waves ................................................................................................................. 5-14
  Drug and Electrolyte Effects ........................................................................................ 5-14
  T wave Abnormalities .................................................................................................. 5-14
  ST Segment Depression ............................................................................................... 5-15
  Combined ST and T Abnormalities .............................................................................. 5-16
  ST Segment Elevation .................................................................................................. 5-17
  Severity ......................................................................................................................... 5-17
Chapter 6 The Agilent Pediatric ECG Criteria Program

Understanding the Agilent Pediatric ECG Criteria Program ........................................... 6-1
Pediatric ECG Interpretation .......................................................................................... 6-3
Calibration Notice if Not Standard .............................................................................. 6-3
Technical Quality Statements ...................................................................................... 6-3
Electronic Pacemaker ................................................................................................. 6-3
Dextrocardia .................................................................................................................. 6-4
Basic Cardiac Rhythm .................................................................................................. 6-4
Sinus Rhythms .............................................................................................................. 6-4
Atrial Premature Complex ........................................................................................... 6-5
Ventricular Premature Complex .................................................................................. 6-5
PR Interval .................................................................................................................... 6-5
Wolff-Parkinson-White Syndrome .............................................................................. 6-5
Ventricular Conduction Delay ..................................................................................... 6-6
Right Bundle Branch Block .......................................................................................... 6-6
Left Bundle Branch Block ............................................................................................ 6-6
Right Atrial Abnormality .............................................................................................. 6-6
RVH: QRS Voltage Criteria ......................................................................................... 6-6
Right Axis Deviation ..................................................................................................... 6-7
RVH: T Wave Criteria .................................................................................................. 6-7
Right Ventricular Hypertrophy .................................................................................... 6-7
Left Atrial Abnormality ............................................................................................... 6-7
LVH: QRS Voltage Criteria ......................................................................................... 6-7
Left Axis Deviation ....................................................................................................... 6-8
LVH: ST Segment and T Wave Criteria ....................................................................... 6-8
Left Ventricular Hypertrophy ....................................................................................... 6-8
Biventricular Hypertrophy ........................................................................................... 6-9
Anterior ST Elevation ................................................................................................. 6-9
Inferior ST Elevation .................................................................................................... 6-9
Anterolateral ST Elevation .......................................................................................... 6-9
Anterior ST Depression ............................................................................................... 6-9
Inferior ST Depression ............................................................................................... 6-9
Anterolateral ST depression ....................................................................................... 6-10
Anterior T Wave Changes ......................................................................................... 6-10
Inferior T Wave Changes ........................................................................................... 6-10
Why Use an Interpretive Cardiograph?

While a computer-interpreted ECG report is not a substitute for overreading by a qualified physician, computerized interpretation is a very useful tool in improving physician and staff productivity. The program's basic measurements and interpretation can help the physician save time when overreading reports.

The Agilent ECG Analysis Program is highly effective at screening normal ECGs. ECGs requiring comment already have the initial computerized commentary on them, so the physician has a head start on the final interpretation.

The Agilent ECG Analysis Program makes quick and consistent measurements of the ECG. It makes detailed measurements over the entire ECG, providing more data for a more accurate interpretation. The program can help identify problem areas for the physician. This saves time for the physician or editing technician who may only need to add, delete, or modify a few statements.

Those who read ECGs infrequently may find the interpreted reports to be useful training tools. They can refer to reasons associated with each statement for the rationale for why a particular condition was suggested.

What You Can Expect of the Agilent ECG Analysis Program

The Agilent ECG Analysis Program provides an analysis of the amplitudes, durations and morphologies of the ECG waveform. The ECG waveform analysis is based upon standards of interpretation of these parameters as well as upon calculations of the electrical axis and relationship between leads.

Just as cardiologists may disagree on interpretations, occasionally there is some disagreement between an interpretation given by the computer program and that made by a cardiologist. The interpreted ECG is a tool to assist the physician in making a clinical diagnosis. It is best used in conjunction with the physician's knowledge of the patient, the results of the physical examination, the ECG tracing, and other findings.
How Computerized ECG Interpretation has Developed

Development of computer-assisted ECG analysis began in the 1960s. Initially only used in research facilities, computer interpretation has developed into an accepted tool for physicians.

Agilent Technologies (formerly HP) entered the computerized ECG analysis field in 1968 when it obtained and offered several existing analysis programs. In 1975 Agilent Technologies introduced one of the first commercially available systems to provide long-term ECG storage. ECG were stored, retrieved and managed on this first Agilent 5600C ECG Management system. The system analyzed ECGs using the existing analysis programs. Agilent Technologies was able to identify some unique contributions it could make to the field of ECG analysis, which resulted in the 1978 introduction of the ECG Criteria Language (ECL). ECL enabled Agilent Technologies to write the Agilent Adult Criteria program, which replaced all of the earlier programs.

In 1980 Agilent Technologies introduced the Agilent 4700 PageWriter cardiograph, which digitally acquired ECGs. In 1983 it became possible to transmit ECGs digitally over phone lines to the Agilent 5600C ECG Management system.

Computerized ECG interpretation became available on the cardiograph in 1983 when Agilent Technologies introduced the Agilent 4760AI PageWriter Intelligent cardiograph. The proven ECG analysis program from the Agilent 5600C was implemented on the Agilent 4760AI cardiograph. Agilent's Pediatric Criteria program was also introduced in 1983 for both the Agilent ECG Management system and the cardiograph.

Your Agilent interpretive cardiograph continues the tradition of improving the performance of the analysis program. The ECG Measurement program has been enhanced and is now in its seventh revision. Simultaneous twelve-lead acquisition allows detection of waveform onsets and offsets more accurately. The additional waveform information helps to define each beat's components better in the measurements section of the analysis. This increased definition produces more consistent results overall.

The Criteria program continues to evolve. Since its initial release, the program has undergone several changes. The current release is the ninth revision of the Adult analysis criteria and the fourth revision of the Pediatric analysis criteria. Suggestions made by an advisory group of respected electrocardiographers are evaluated regularly for inclusion in subsequent releases.
Understanding Simultaneous 12-Lead Acquisition

Computer-assisted ECG analysis begins with acquiring high quality, accurate ECG waveforms. Your Agilent interpretive cardiograph simultaneously acquires up to 12 ECG leads and analyzes 12 leads. Although the printed recording doesn't show it, the Agilent ECG Analysis Program uses the full ten second recording in each lead. Figure 3-1 shows how the auto 3x4 format displays consecutive 2.5 second segments of 12 leads, three leads at a time. Figure 3-2 shows how the auto 6x2 format displays consecutive 5 second segments of 12 leads, six leads at a time.

Figure 3-1. Ten Seconds of 12 Leads on an Auto 3 x 4 Report
Digitizing the ECG

The continuous, analog ECG signal at the body surface is digitized at the input to the cardiograph. The ECG waveform data is captured at a sample rate of 1000 samples per second at 5 µV resolution. It is also fast enough to accurately detect pacemaker pulses.
Reducing Artifact

As the ECG is converted to digital form, it is digitally filtered. Not only is this approach more flexible, it provides superior results when compared to analog filtering. The Agilent cardiograph’s digital signal processing ensures the most accurate reproduction of the patient's ECG waveforms.

The American Heart Association’s 1989 Recommendations for standardization and specifications in automated electrocardiography: bandwidth and digital signal processing, extended the recommended bandwidth for adult ECGs to 125 Hz and for infant ECGs to 150 Hz. These recommendations are met by the data acquisition scheme in all Agilent interpretive cardiographs.

The Agilent interpretive cardiograph’s input circuitry has a dynamic range that meets or exceeds current AAMI standards.

Reducing Artifact

Electrical interference, patient respiration, patient movement and muscle tremors can add noise and artifact to the ECG signal. Poor quality electrodes or inadequate patient preparation can also degrade the ECG signal. Your Agilent interpretive cardiograph has been carefully designed to substantially reduce artifact and accurately record the ECG signal.

Common Mode Rejection

Some of the noise sources that interfere with the ECG signal are common to each electrode attached to the patient. To the extent that they have an identical effect on the ECG signal in each lead, they are removed from the ECG by the cardiograph’s input circuitry as the signal is acquired and digitized. The amount of reduction of these common mode signals is referred to as the common mode rejection ratio. The common mode rejection ratio of your Agilent interpretive cardiograph’s input circuitry meets or exceeds current AAMI standards.
The effects of AC interference on the ECG are twofold, common mode and differential mode. The interference which is common to all electrodes (common mode) is removed in the Agilent interpretive cardiograph's input circuitry. Even though this circuitry greatly reduces common mode noise, good ECG technique is still important. In the case of differential mode, the magnetic fields associated with electrical power interact with the lead wires. This induces electrical signals which appear as high frequency noise on the ECG. How much distortion there is depends on the size of the loop created by the lead wire and its orientation. A good way to prevent this distortion is to align the lead wires with the patient's body.

Using Filters

Computerized signal processing in the Agilent interpretive cardiograph removes noise and artifact while minimizing distortion of the ECG waveform. A sophisticated set of digital filters can be selected by the operator (or during configuration) to optimize the ECG waveform. Digital filters have the advantage over traditional analog filters in their ability to be finely tuned to selected frequencies. Unlike analog filters, digital filters are very stable over time and temperature, meaning that ECGs taken under various conditions will receive the same high quality filtering.

With the exception of the AC filter, which is very selective, there is always some trade-off in filtering between fidelity and clarity of the ECG trace. The more filtering applied to the signal, the greater the possibility of removing details of the ECG signal with noise of the same frequency.

There are a variety of noise sources which can potentially degrade the reproduction of the ECG signal. Several types of filters can be used in your Agilent interpretive cardiograph to counteract them and reduce the artifact in the ECG. In the lower right-hand corner of the Agilent interpretive ECG report is a box containing information about the filtering options used on each ECG. Note that your PageWriter may or may not have all of these filters.
Frequency Response Filters

These filters suppress frequencies at the high and low ends of the ECG signal spectrum. The available high frequency response filter settings are 40, 100, and 150 Hz. In 1989, the American Heart Association recommended that frequencies up to 125 Hz be recorded for adult ECGs and that frequencies up to 150 Hz be recorded for pediatric ECGs (American Heart Association’s 1989 Recommendations for standardization and specifications in automated electrocardiography: bandwidth and digital signal processing). Your Agilent interpretive cardiograph records and analyzes all ECGs with frequencies up to 150 Hz. The 40 and 100 Hz filters only affect the printed report. They result in a smoother-looking ECG waveform, at the expense of eliminating some of the fine detail in the signal. Small deflections, notches, and slurs may be distorted or may disappear altogether if one of these filters is selected for the Auto frequency response. The available low frequency response filter settings are 0.05, 0.15, and 0.5 Hz. The 0.5 Hz filter is also the baseline wander filter. The low frequency response filter settings affect analyzed and printed ECGs. The frequency response of the ECG is indicated in the ECG report’s filter box.

AC Filter

The AC filter adaptively detects the AC interference in the ECG signal and very selectively removes it without affecting the ECG. This filter affects analyzed and printed ECGs.
The AC filter removes interference created by the magnetic fields associated with electrical power interacting with the lead wires. The frequency of the AC interference is very stable at 60 or 50 Hz, so the AC filter can remove the AC noise and leave the ECG signal intact.

The line power, or AC, filter is indicated in the second position of the ECG report filter box by the symbol "~" (your cardiograph may also report the configured line frequency 50 or 60). If the filter box does not contain this symbol, the AC filter was not used for the ECG.

**Baseline Wander Filter**

Baseline wander is the term used to describe the slow (typically 0.1-0.2 Hz) drifting of the ECG baseline up or down during the ECG recording. Baseline wander may result from patient respiration or from other sources. Severe baseline wander can make it difficult to determine the true wave shapes in the ECG.

Early analog attempts to suppress the effects of baseline wander resulted in "smearing" the QRS complex into the ST segment. In 1975, the American Heart Association addressed this problem by recommending that frequencies as low as 0.05 Hz be preserved in the ECG signal to prevent the then common ST segment distortion. (American Heart Association's 1975 Recommendations for standardization of leads and of specifications for instruments in electrocardiography and vectorcardiography.)

Since the advent of digital ECG acquisition in the 1980's, effective baseline wander suppression techniques that do not distort the ST segment have been a part of Agilent Technologies' cardiographs. While the lower frequency limit of 0.15 Hz, which we recommend for normal use, eliminates baseline wander from most ECGs, you may occasionally need extra suppression. The filter can be configured to allow the operator to turn on the baseline wander filter when needed. The baseline wander filter is represented by a "W" in the ECG report's filter box.
Because of the 1-minute recording of the ECG in rhythm mode, a different 0.5 Hz (baseline wander) filter that may distort the ST segment must be used. Therefore, do not attempt to interpret the contour aspects of rhythm ECGs at this setting. If contour analysis is important in Manual mode, use the 0.05 Hz Manual frequency response setting which minimizes the ST segment distortion. Regardless of the low frequency setting in rhythm mode, the rhythm characteristics of the ECG are accurately recorded.

Artifact Filter

The Artifact filter removes skeletal muscle artifact. This source of noise is the most difficult to eliminate because it has the same frequencies as the ECG signals. The Artifact filter, while eliminating skeletal muscle artifact, also removes low amplitude, high frequency components from the ECG.

Specifically, the filter removes up to 50 µV of signals in the frequency range from 5 Hz to 150 Hz which can affect P waves as well as the entire QRS-T complex. Use the Artifact filter only as a last resort for ECGs which would otherwise be unreadable due to significant levels of muscle artifact. The Artifact filter only affects ECG data on the printed ECG report and not ECG data that is analyzed.

The letter "F" in the far left position in the filter box indicates that the Artifact Filter was applied to this ECG.

Monitoring ECG Quality

The Agilent interpretive cardiograph monitors ECG trace quality throughout the lead attachment, ECG acquisition and analysis process to ensure that you receive the highest possible quality ECG trace. There are two possible ways that trace quality problems are indicated, depending on how your cardiograph is equipped:

• on the preview screen before recording the ECG
• in the analysis statements on the printed report

In most cases, the operator can use these cardiograph features to eliminate noise quality problems by modifying lead placement or improving patient preparation.
**Monitoring ECG Quality**

While attaching lead wires to the patient, the operator receives constant feedback about leads with poor contact and noisy lead wires on the preview screen. Electrodes that are off are denoted by "Leads Off" or dotted line on the preview screen. With this immediate feedback, the operator can correct problems before the ECG trace is acquired, analyzed and printed. This saves the operator time and paper.

The real-time ECG traces in all leads can be viewed on the preview screen before any analysis and printing. Three leads are displayed at one time and the operator can scroll through all configured leads in groups of three to check the quality of the actual ECG tracings visually. When an Auto ECG is requested, the preview screen will display the Auto 3x4 ECG tracing that will be analyzed and printed. The operator can press the key and correct visible noise problems.

The Agilent interpretive cardiograph attempts to pre-acquire ECG data by immediately using the data from the most recent ten seconds if there is good electrode contact for all leads. Pre-acquisition saves operator time if good ECG signals are available prior to requesting the Auto ECG.

During analysis, the cardiograph further checks to determine if the trace quality is adequate for good ECG measurements. The ECG is analyzed for muscle artifact, AC noise, baseline wander, and leads-off. Any noise problems not corrected by the operator are detailed in the interpretive statements on the ECG analysis report.

If the noise conditions are sufficient to prevent ECG analysis, the ECG will be printed without analysis. The operator must then correct the noise problem and retake the ECG.

The quality checks available on the Agilent interpretive cardiograph aid the operator in eliminating noise problems encountered throughout the process of taking an ECG. They allow the operator to correct noise problems by modifying ECG technique before the ECG is printed. The operator can use these features to ensure that a high quality ECG is recorded.
The Agilent ECG Analysis Program

The Agilent ECG Analysis Program produces precise, accurate and consistent ECG measurements. The PageWriter 10i further provides interpretive statements which highlight key areas of concern for your review. However, these tools are more helpful if you understand how and why they work and how you can best use their capabilities. Figure 4-1 shows this process.

Understanding the Agilent ECG Analysis Program

The analysis process begins with the simultaneous acquisition of the ECG's 12 conventional leads. It then proceeds through four steps before producing the interpreted ECG report. These steps are:

1. **Quality Monitor** - examines the technical quality of each ECG lead.
2. **Pattern Recognition** - locates and identifies the various waveform components.
3. **Measurement** - measures each component of the waveform and performs basic rhythm analysis, producing a comprehensive set of measurements.
4. **Interpretation** - uses the extended measurements, with the information about the patient such as age and sex, to select those interpretive statements from the criteria program which summarize the findings for the ECG.

Agilent Technologies provides two standard criteria programs, adult and pediatric, for your Agilent interpretive cardiograph.

Patient information, including age, sex are used by the criteria programs in selecting the interpretive statements.

---

**How the Agilent Interpretive Cardiograph Measures ECGs**

The Agilent interpretive cardiograph calculates measurements for all the waveforms that you see on the Auto 3 x 4 report. In the Agilent interpretive cardiograph, representative group, lead and global measurements are calculated from combinations of the comprehensive set of measurements for each beat. The ECG criteria program can use any combination of these three types of measurements, which enhances the flexibility and power of its interpretive capabilities.
Waveform Recognition

The first step of the measurement program involves waveform recognition and beat detection. A boundary indicator waveform in which QRS complexes and pacemaker spikes are enhanced is derived from all leads over the ten-second analysis period. After the approximate QRS complex and pacemaker spike locations are known, another boundary indicator waveform that enhances P and T wave detection is derived. Approximate P wave, QRS complex and T wave regions are then determined for each beat in the ECG.

Comprehensive Measurements

After the approximate waveform locations are known, they are further refined to determine precise onsets and offsets for each waveform. Once onsets and offsets are known, amplitude, duration, area and shape are calculated for every P wave, QRS complex, T wave and ST segment in every lead that you see on the Auto 3 x 4 report. Waveform irregularities such as notches, slurs, delta waves and pacemaker spikes are also noted for every beat. A table of all these measurements is created, from which the representative measurements are calculated.
Atrial Rhythm Analysis

Atrial Rhythm Analysis is determined by examining leads V1,aVF, II and III in succession until the program can report conclusively that there are multiple P waves, that there are no P waves, or that there is one P wave per QRS complex. If a conclusive result is achieved, then the last lead analyzed will be used to calculate group and global atrial rhythm parameters. If no conclusive result is achieved, no atrial rhythm parameters are calculated.

Global Measurements

The global measurements for the ECG, including the frontal and horizontal plane axis measurements, are reported on the left corner of the report.

Axis Measurements

Although when making axis measurements manually, it is most convenient to use waveform amplitudes, using areas yields more accurate results. The Agilent interpretive cardiograph uses the waveform areas from the lead measurements in calculating the P, QRS and T axes, while the sum of the ST onset, middle and end amplitudes is used in calculating the ST axis. For the frontal plane axis measurements, which use the limb leads, nine lead pairs, all at least 60 degree apart, are used to estimate the axes. The resulting estimates are examined to ensure that they converge to a single result. If so, they are averaged to form the representative axis measurement. The horizontal plane axis measurements, which use leads V1 -V6, are calculated similarly from seven lead pairs.

The ECG Criteria Language (ECL)

The ECG Criteria Language (ECL) is a medically-oriented computer language developed specifically by Agilent Technologies for the definition of electrocardiographic criteria. First introduced in 1978, the Agilent ECG Analysis Program, using ECL, was the first commercially-available expert systems.

The primary objective of ECL is to allow criteria definition by physicians with little or no knowledge of computer programming. Basically, it provides a way through
which ECG criteria may be expressed in a form that both a cardiologist and a
computer can read. Consistently-used terminology was chosen to describe ECG
criteria for the foundation of ECL. This terminology was chosen from a broad base
of users as well as electrocardiography texts.

**Categories**

At the highest level, criteria expressed in ECL are broken into medically significant
categories that are like the chapters of an electrocardiography textbook.

**Sentences**

Within each category is a series of sentences in which the criteria are expressed.
These sentences allow the program to PRINT an interpretive statement when the
criteria are met, to SUPPRESS a statement in the presence of a higher-priority
statement, to GOTO another point in the program, or to perform calculations and
assign (SET) the result to a variable for use later in the program. The PRINT
sentence has this form:

`PRINT<interpretive statement>IF<medical criteria>:`

For example, the following statement causes an inferior infarct statement to be
printed on the report if the criteria are met:

```
PRINT # IMI10 BO
"Consider inferior infarct"
"Small Q waves in II, III, aVF"
IF (Q: DURATION...`
```

Where IMI10 is the statement code corresponding to the statement enclosed in
quotation marks and BO stands for a severity of borderline significance for this
statement. In this example the interpretive statement is "consider inferior infarct".
The reason statement, "Small Q waves in II, III, aVF", summarizes the detailed
criteria which follow the IF.

Interpretive statements on the report are preceded by either a ".", as shown in this
example, or a "$" or a "#". Statements preceded by a "$" or a "#" call attention to
certain technical aspects of the ECG which are of interest to the overreader, but not essential to the final report.

A cardiologist reading an ECG can immediately discount many classes of interpretation. However, the computer-based program must check them all sequentially. Within a category, the criteria for interpretive statements become more and more restrictive from beginning to end. Consequently, criteria met for any given ECL statement in a category automatically suppress any previous statements (in that category) that had been selected for printing. Thus, each category can only be represented on the final report by one statement at most. This statement is the last one encountered whose medical criteria were true based on the measurements, earlier decisions, and patient ID information.

**Overall Severity**

Each statement selected for the interpretive report has an associated severity. The severities of all selected statements are considered by a set of rules in the criteria program to determine the ECG's overall severity. This severity is printed on each page of the interpretive report.
The Agilent Adult ECG Criteria Program

Development of the Agilent Technologies' Adult ECG Criteria Program began in 1971 as a combined effort between Agilent Technologies and a worldwide panel of cardiologists. The program is written in the ECG Criteria Language (ECL), which was created by Agilent Technologies to follow the logical process used by skilled physicians to analyze ECGs.

The adult ECG program was first introduced into the clinical environment in 1978 as part of the Agilent 5600C ECG Management System. It has evolved through the years into the sophisticated program available today. The program has also been available as part of the Agilent PageWriter intelligent cardiograph family since 1983. Now in its ninth release, the Agilent adult ECG program has been used worldwide to analyze millions of ECGs annually.

Understanding the Agilent Adult ECG Criteria Program

The criteria used to select the interpretive statements in this program use the full range of measurements in the measurement matrix. These include ECG waveform durations, amplitudes, areas, and other parameters. For clarity and conciseness, the following summaries are not comprehensive. Rather, when describing the criteria logic where the significant values vary, only one measurement value is mentioned and it is labeled "(typical)". The typical value is the one that is most generally applied in the logic. You will then be better able to use Agilent’s computer-assisted ECG analysis effectively in your daily ECG overreading activities.

The following new order of categories represent clinically relevant statements and some technical statements and disclaimers for ECL09.

- Pediatric Age Disclaimer
- Calibration Notice if not Standard
- Technical Quality Statement
- Electronic Pacemaker
- Basic Cardiac Rhythm
- Premature Beats (Short R-R)
- Pauses (Long R-R Interval)
- Miscellaneous Arrhythmias
- AV Conduction (PR Interval)
- Right Atrial Abnormality
- Left Atrial Abnormality
• QRS Axis
• Ventricular Conduction Delay
• Chronic Pulmonary Disease
• Right Ventricular Hypertrophy
• Left Ventricular Hypertrophy
• Inferior Infarct
• Posterior Infarct
• Lateral Infarct
• Anterior Septal and Anterior Infarct
• Anterolateral and Extensive Anterior MI
• ST Segment Depression
• T Wave Abnormalities
• Combined ST and T Abnormalities
• ST Segment Elevation
• Tall T Waves
• QT Prolongation, Drug, and Electrolyte Effects
• Severity

**Pediatric Age Disclaimer**

The Agilent Adult ECG criteria program is intended for use on ECGs of adults. The Pediatric ECG criteria are selected for use on ECGs of patients under 16 years old. If adult criteria are selected and if the patient is less than 16 years old, a statement is printed to remind you that no attempt will be made to interpret signs of infarction or ST-T abnormalities.

On the cardiograph, the patient's age can be entered in units of years.

---

**NOTE**

If the age is entered improperly, or not at all, the patient is assumed to be 50 years old. Also, a patient age of less than 16 years automatically invokes pediatric criteria.
Calibration Notice if Not Standard

This category checks the calibration pulse in each channel of the ECG. Except for the case where both the limb leads and the precordial leads are at standard calibration (10 mm/mV), a statement describing the calibration for the ECG is included in the report.

Table 5-1. Calibration

<table>
<thead>
<tr>
<th>Calibration</th>
<th>Nominal Value</th>
<th>Allowed Range</th>
<th>± %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half standard</td>
<td>5mm/mV</td>
<td>4.75-5.25mm/mV</td>
<td>5%</td>
</tr>
<tr>
<td>Standard</td>
<td>10mm/mV</td>
<td>9.5-10.5mm/mV</td>
<td>5%</td>
</tr>
<tr>
<td>Double standard</td>
<td>20mm/mV</td>
<td>19.0-21.0mm/mV</td>
<td>5%</td>
</tr>
</tbody>
</table>

Technical Quality Statements

This category contains non-clinical statements which are intended to identify ECG with technical problems and prevent them from being interpreted by the medical criteria.

Electronic Pacemaker

This category relies on the ECG measurements to detect paced ECGs. For ECG which are predominantly-paced there is no further consideration of medical criteria. For demand-paced ECGs in which there are enough non-paced beats, no further rhythm analysis is attempted. However, the non-paced beat measurements are used in the remaining categories to check for other abnormalities in the ECG.

Basic Cardiac Rhythm

One statement describing the basic cardiac rhythm is selected from this category based on the morphology and rhythm measurements made from the ECG.

Interpretive statements regarding the basic cardiac rhythm are generated based on the interrelationships of the various measurements and determinations. These statements include those related to:

• Tachycardia, bradycardia, and varying rate
• Sinus, atrial, supraventricular, junctional and ventricular rhythms

• Second and third degree AV block (first degree block is addressed in the AV Conduction category)

• AV dissociation

• Atrial fibrillation

• Atrial flutter

• Bigeminy and Trigeminy pattern

A normal P axis measurement (-30 to 120 degrees in the frontal plane) is assumed to indicate a sinus-originated P wave while an abnormal P axis signifies an atrial or a junctional origin.

Tachycardia is generally defined as a rate of 100 beats per minute (bpm) or higher; bradycardia as slower than 50 bpm. For a more definitive discussion of tachycardia and bradycardia see the recommendations of the "Task Force on Standardization of Terminology and Interpretation " as published in the American Journal of Cardiology January 1978.

Premature Beats (Short R-R)

Interpretive statements in this category relate to premature beats. These are recognized when the preceding R-R interval is shorter than the average R-R interval of a background ventricular rate that is basically regular. A 15% (typical) or greater reduction in R-R interval is considered significant.

Premature beats with normal QRS duration (QRSD) are considered to be atrial or junctional in origin depending on the presence or absence of a P wave. Those with longer than normal QRSD are considered to be either ventricular in origin or to be aberrant supraventricular in origin.

Pauses (Long R-R)

Long R-R intervals are significant if they are more than 140% (typical) of the average R-R in a background ventricular rate that is basically regular. They are considered to indicate either a sinus arrest or an intermittent AV block. Interpretive
statements in this category indicate either escape beats or types of second degree AV block.

The presence or absence of a P wave as well as the duration of the QRS indicates the origin of an escape beat. Atrial and supraventricular escapes will show a P wave and a normal QRSD. Junctional escape will show no P wave, but a normal QRSD. A prolonged QRSD indicates a ventricular origin of the escape beat.

Different second degree AV blocks are indicated on the basis of more P waves than QRS complexes. A statement indicating Mobitz I (Wenckebach) second degree AV block depends on progressively longer PR intervals preceding the long R-R interval.

**Miscellaneous Arrhythmias**

This category provides interpretive statements related to arrhythmias that are not covered in the preceding Basic Cardiac Rhythm, Premature Beats, or Pauses categories.

Statements relating to interpolated beats depend on the measurement program recognizing that such beats are present. It recognizes the beats if there are consecutive R-R intervals that are approximately one half the average R-R of a background ventricular rate that is basically regular.

Aberrant complexes are recognized when the R-R interval is only slightly decreased but the QRSD is prolonged, as if it were of ventricular origin.

**AV Conduction (PR Interval)**

All statements in this category are based on the measurement of a prolonged PR interval, with the exception of one statement which identifies ECGs with accelerated AV conduction.
The PR interval varies slightly according to age and heart rate. The following table defines the limits:

Table 5-2. Borderline and Abnormally Prolonged PR Intervals (ms)

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Heart Rate (bpm)</th>
<th>1-50</th>
<th>51-90</th>
<th>91-120</th>
<th>over 120</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15</td>
<td></td>
<td>200-210</td>
<td>190-200</td>
<td>185-195</td>
<td>180-190</td>
</tr>
<tr>
<td>16-60</td>
<td></td>
<td>210-220</td>
<td>200-210</td>
<td>195-205</td>
<td>190-200</td>
</tr>
<tr>
<td>over 60</td>
<td></td>
<td>220-230</td>
<td>210-220</td>
<td>205-215</td>
<td>200-210</td>
</tr>
</tbody>
</table>

Left Value = PR Interval Upper Limit (Borderline)

Right Value = PR Interval Upper Limit (1st degree AV Block)

QRS axis

The mean electrical vector (mean QRS axis) is calculated in the frontal and horizontal planes. The normal frontal axis range varies with age and body build. The frontal QRS axis in young persons will tend to the right. The frontal QRS axis in old persons will tend to the left. In addition, the QRS axis in thin persons will tend to be more to the right than in heavy persons. A frontal QRS axis between -30 and +90 degrees is considered normal, generally subject to modification by age and build. Frontal QRS axis measurements counterclockwise from -30 will be considered to be deviated to the left and those clockwise from +90 will be considered to be deviated to the right.

Interpretive statements based on frontal QRS axis measurements are made describing left and right deviation as well as superior, horizontal, and vertical directions.

Statements involving posterior axis, arm lead reversal and dextrocardia are based on the horizontal plane axis measurements as well as the frontal plane measurements.

These statements are skipped if the ECG is paced, if the patient is in a ventricular rhythm or if the mean QRS axis is well within the normal range (30 to 80 degrees, clockwise, in the frontal plane).
Ventricular Conduction Delays

A QRS duration (QRSD) greater than 100 ms is common to all of the interpretation in this category except for isolated Left Anterior Fascicular Block (LAFB) and Left Posterior Fascicular Block (LPFB) which are present in the absence of a prolonged QRS. Otherwise, any definitive block interpretation requires that the QRSD exceed 120 ms. A QRSD between 110 and 120 ms is considered incomplete block and between 100 and 110 ms is considered marginal intraventricular conduction delay.

LAFB interpretations are associated with leftward deviation of the mean frontal QRS axis between -40 and 240 (typical) degrees counterclockwise.

LPFB interpretations are associated with rightward deviation of the mean frontal QRS axis between 110 and 210 (typical) degrees clockwise.

RBBB interpretations are always associated with the terminal portion of the QRS being directed to the right, i.e. dominant negative (Q, S) forces in I, aVL, and V6 and positive forces in V1.

LBBB interpretations are always associated with the terminal portion of the QRS being directed to the left, i.e. dominant positive (R, R') forces in I, aVL and V6 and negative forces (Q, S) in V1.

LAFB and LPFB may be recognized in combination with RBBB.

The Wolff-Parkinson-White conduction abnormality is also recognized in this category based on the occurrence of delta waves in multiple leads and QRS duration more than 100 ms. A short PR (PR segment <55 ms or PR interval <120 ms) reduces the required number of leads with delta waves required to detect this condition.

Right Atrial Abnormality

Large P waves are considered suggestive of RAA. The minimum voltage considered significant is 0.24 mV (typical). P wave duration and amplitude are examined in all leads.

Large P waves lead to more severe interpretive statements regarding the likelihood of RAA.
Right Ventricular Hypertrophy

Right ventricular hypertrophy statements are made on the basis of the presence of several findings:

- The presence of a prominent R or R’ in lead V1
- The presence of a prominent negative voltage in either of leads I or V6
- Right atrial abnormality
- Right axis deviation in the frontal plane
- ST-T changes characteristic of RVH

The statements to be printed regarding RVH are determined by the combinations of the above findings. Stronger statements result when multiple findings are present.

Prominent R or R’ in V1

An R that is more than 75% the size of the Q or S is significant. An R’ larger than 20 ms and 0.30 mV is significant. A QRS with a positive component larger than the negative component (i.e., a positive QRS area) is highly significant.

Prominent Q or S in I or V6

A Q, S, or S’ larger than 40 ms and 0.20 mV is significant. A QRS with a negative component larger than the positive component (i.e., a negative QRS area) is highly significant.

Right Atrial Abnormality

This finding is determined by the presence of RAA.

Right Axis Deviation in the Frontal Plane

This finding is determined by a frontal QRS axis between 111 and 269 degrees (clockwise).
**ST-T Changes Characteristic of RVH**

This finding is determined by an examination of leads II, aVF, V1, V2, and V3 for the presence of negative ST and T values typical of the right ventricular strain pattern.

**Left Atrial Abnormality**

All leads are examined for the duration and the amplitude of both the initial and terminal portions of a biphasic P wave. Durations over 110 ms combined with amplitudes over 0.10 mV are considered significant though not necessarily abnormal unless they are present in multiple leads. A notched P wave adds to the significance of the other values.

Lead V1 is specifically examined for duration, amplitude and area of the negative component of the T wave. Though durations of over 30 ms and amplitudes over 0.09 mV can be considered significant, the area of this negative component must be greater than 0.60 Ashman units to be considered LAE. An Ashman unit is the area of 1 square millimeter at normal speed (25 mm/sec) and normal sensitivity (10 mm/mV). An Ashman unit equals 40 ms x 0.1 mV.

**Left Ventricular Hypertrophy**

Left Ventricular Hypertrophy statements are made on the basis of a point score derived from several findings:

• High voltage in QRS components

• Left axis deviation in the frontal plane

• Left atrial abnormality

• ST-T changes characteristic of LVH

• Prolonged QRS duration or ventricular activation time (VAT)

Higher point scores result in more severe statements regarding the likelihood of LVH.
High Voltage in QRS Components

Voltage values for the QRS components that are considered excessively high vary with the leads involved and whether the deflection is positive or negative. In frontal leads the minimum value that is considered excessive is a positive deflection of more than 1.20 mV in lead aVL.

Precordial leads V1 and V2 are examined for negative deflections (Q or S) and V5 and V6 are examined for positive deflections (R or R’). These values are considered individually and any value greater than 2.50 mV is considered significant. In addition, the negative values in V1, V2 and the positive values in V5, V6 are added together. Any total for Q or S in V1 plus R or R’ in V5 or V6 that exceeds 3.50 mV is significant. A total of Q or S in V2 plus R or R’ in V5 or V6 must exceed 4.0 mV to be significant.

Higher voltages will result in more points for qualifying statements regarding LVH.

Because higher voltages are normal for young persons, age is given consideration in the recognition of LVH. The younger the patient, the more stringent are the requirements for an LVH statement.

Left Axis Deviation in the Frontal Plane

This finding is determined by a frontal QRS axis between -31 and -90 in the absence of any statement indicating either anterior fascicular block or inferior infarct.

Left Atrial Abnormality

This finding is determined by a statement from the Left Atrial Abnormality category indicating the presence of LAA. This feature is ignored in the presence of mitral valvular disease, atrial flutter, or atrial fibrillation.

ST-T Changes Characteristic of LVH

This finding is determined by an examination of leads I, aVL, V4, V5, and V6 for the presence of negative ST and T Values typical of the left ventricular strain pattern.
A Prolonged QRS Duration or Ventricular Activation Time

This finding is determined by a QRS duration of 95 to 120 ms, and a VAT longer than 55 ms. It is ignored if any bundle branch block statement has been made.

The statements to be printed regarding LVH are determined by the combinations of the above findings that are present.

Chronic Pulmonary Disease

All frontal leads are examined for QRS peak-to-peak voltage. If no lead has a value exceeding 0.60 mV the ECG is considered borderline low voltage. If no value exceeds 0.50 mV the ECG is considered definite low voltage, an abnormal finding.

All precordial leads are examined for QRS peak-to-peak voltage. If no lead has a value exceeding 1.00 mV the ECG is considered definite low voltage, an abnormal finding.

Combinations of low voltage statements, and the presence of rightward deviation of the frontal P and QRS axes and right atrial abnormality, may lead to statements suggesting the likelihood of chronic pulmonary disease.

Inferior Infarct

Leads II, III, and aVF are examined for Q wave presence and size (amp x dur), the relative amplitudes of the Q and R, the presence of T wave changes (flattened or inverted), and the presence of an elevated or depressed ST segment.

As the Q waves become larger and / or show in more leads, and the R waves become less prominent the interpretive statements become stronger.

For inferior Q waves to be considered significant, at least one of them must be longer than 25 ms in duration and more than 1/6 the amplitude of the associated R. For any infarct statement to qualify, at least one Q wave must be longer than 35 ms and more than 1/5 the amplitude of the R wave.

A leftward direction of the axis of the initial portion of the QRS adds to the likelihood of an inferior infarct statement.
T wave and ST changes are used to estimate the age of the infarct. Increased T wave inversion and larger ST segment deviations will generate statements indicating more recent infarction.

Gender and age influence the detection of inferior infarct in that being male and/or young makes normal Q waves more likely in the inferior leads.

**Posterior Infarct**

Leads V1 and V2 are examined for the relative and absolute sizes of the R and S waves, an absent or insignificant Q wave (less than 10 ms and 0.05 mV), and a positive T wave. A prominent R (typical is three times the size of the S), in the presence of an insignificant Q (typical is <10 ms, <0.05 mV), and an upright T, might generate a statement suggesting the likelihood of a posterior infarct (PMI). There are no statements definitely indicting the presence of a PMI. In evaluating the significance of the R wave, the duration is given more emphasis than the amplitude.

Indications of LVH or RVH will decrease the likelihood of a PMI statement.

Gender and age influence the detection of a posterior infarct in that being male and/or young makes prominent R waves more likely in V1 and V2.

**Lateral Infarct**

Leads I, aVL, V5 and V6 are examined for Q wave presence and size (amp x dur), the relative amplitudes of the Q and R, the presence of T wave changes (flattened or inverted), and the presence of an elevated or depressed ST segment.

For lateral Q waves to be considered significant there must be at least one that is longer than 35 ms and more than 0.10 mV in amplitude. In addition it must have an amplitude that is at least 20% as large as that of the R wave.

As the Q waves become larger and/or show in more leads, and the R waves become less prominent, the interpretive statements become stronger.

T wave and ST changes are used to estimate the age of the infarct. Increased T wave inversion and larger ST segment deviations will generate statements indicating more recent infarction.
Gender and age influence the detection of lateral infarct in that being male or young or both makes normal Q waves more likely in the lateral leads.

**Anteroseptal and Anterior Infarct**

Leads V1, V2, V3, and V4 are examined for Q wave presence and area, the relative and absolute sizes of the R and S, whether the QRS area is negative or positive, the presence of T wave changes (flattened or inverted), and the presence of an elevated or depressed ST segment.

For any anteroseptal or anterior Q wave to be considered significant, it must be longer than 30 ms (typical) in duration and over 0.07 mV in amplitude.

Positive findings that occur in V1 and V2 will tend to be reported as anteroseptal statements while those that occur in V3 and V4 will tend to be reported as anterior statements.

As the Q waves become larger and/or show in more leads, and the QRS progression from negative to positive becomes more shifted laterally, the interpretive statements become stronger for infarction in the anterior region.

T wave and ST changes are used to estimate the age of the infarct. Increased T wave inversion and larger ST segment deviations will generate statements indicating more recent infarction.

**Anterolateral and Extensive Anterior Infarct**

Leads V3, V4, V5, and V6 are examined for Q wave presence and size (amp x dur), the relative and absolute sizes of the R and S, whether the QRS area in V3 is negative or positive, the presence of T wave changes (flattened or inverted), and the presence of an elevated or depressed ST segment.

For any anterolateral Q wave to be considered significant it must be longer than 30 ms (typical) in duration and over 0.07 mV in amplitude.

As the Q waves become larger and/or show in more leads, the interpretive statements become stronger for infarction.

Positive findings in all six precordial leads will lead to statements describing extensive anterior infarct conditions.
Gender and age influence the detection of anterolateral infarct in that being male and/or young makes normal Q waves more likely in the anterolateral leads.

T wave and ST changes are used to estimate the age of the infarct. Increased T wave inversion and larger ST segment deviations will generate statements indicating more recent infarction.

**Tall T Waves**

All leads are examined for the presence of positive T waves with amplitudes that exceed 1.20 mV, or for positive T waves that exceed 0.50 mV and are also more than half the size of the peak-to-peak QRS voltage. The presence of such T wave can lead to statements calling attention to the possibility of metabolic, electrolyte or ischemic abnormalities.

**Drug and Electrolyte Effects**

Measurements of QT interval as corrected for heart rate, and measurements associated with ST segment depression and T wave changes are examined for values characteristic of the effects of quinidine, procainamide, digitalis and abnormal calcium and potassium levels.

Interpretive statements are made calling attention to the possible correlation between the findings and clinical conditions.

**T wave Abnormalities**

All leads are examined for T wave amplitude, the relative amplitude of the T and the QRS, and whether the T is negative or positive. The frontal axis of the T wave and its relation to the frontal QRS axis is also measured.

Reduced T wave amplitude, both absolute and relative to the QRS, as well as negative T waves, are considered to be abnormal findings. Minimal changes in one or a few leads will lead to less severe statements. As the changes become more prominent in magnitude and the number of affected leads increase, the statements become more severe.
A frontal T axis that is not between -10 and 100 degrees or a QRS-T angle greater than 90 degrees may result in a statement indicting nonspecific T wave abnormalities.

ECGs for persons younger than 16 years are excluded from the least severe statements because such T wave findings can be considered normal.

Whenever possible the location of T wave abnormalities will be indicated as part of the interpretive statements. Though not rigidly defined, the localization will generally fit the following:

Table 5-3. T wave Abnormality Localization

<table>
<thead>
<tr>
<th>Location</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>aVR</th>
<th>aVL</th>
<th>aVF</th>
<th>V1</th>
<th>V2</th>
<th>V3</th>
<th>V4</th>
<th>V5</th>
<th>V6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterolateral</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inferior</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A concurrent statement regarding RVH, LVH, LBBB, RBBB, any infarct, or any statement associated with electrolyte imbalance will impact this category by tending to suppress T wave statements. This is more true for the less severe T wave statements than for the more severe T wave statements.

**ST Segment Depression**

All leads are examined for negative values in the ST segment. The values examined include the following points in the ST segment:

- The onset of the ST segment (the J point)
- The point midway between the onset and the end of the ST segment
- 80 ms past the J point
- The end of the ST segment (the beginning of the T wave)

Besides negative values in the ST segment, other features are examined:
• The slope of the ST segment in degrees

• The shape of the ST segment (straight, concave up or concave down)

The smallest negative ST deflection considered significant is 0.03 mV.

As the negativity of the ST segment increases, more severe statements are generated. Minor depression of the segment produces statements with a severity code of Otherwise Normal. Increasing depression produces statements progressing through Borderline to Abnormal.

Whenever possible the location of ST abnormalities will be indicated as part of the interpretive statements. Though not rigidly defined, the localization will generally fit the following:

Table 5-4. ST Segment Depression Localization

<table>
<thead>
<tr>
<th>Location</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>aVR</th>
<th>aVL</th>
<th>aVF</th>
<th>V1</th>
<th>V2</th>
<th>V3</th>
<th>V4</th>
<th>V5</th>
<th>V6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterolateral</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inferior</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A concurrent statement regarding RVH, LVH, LBBB, RBBB, any new infarct, or any statement associated with drug therapy or electrolyte imbalance will impact this category by tending to suppress ST depression statements. This is more true for the less severe ST depression statements than for the more severe ones.

**Combined ST and T Abnormalities**

This category contains statements calling attention to the presence of both ST segment and T wave changes. None of these statements involve any new examination of measurements. All statements in this category are determined by the qualification of a combination of statements in the T Wave Abnormalities and ST Segment Depression categories. The severity of the statements in this category are dependent on the severity of the qualifying ST and T wave changes.
**ST Segment Elevation**

All leads are examined for positive values in the ST segment and for negative T waves. The ST segment measurements examined include the deflection at the onset of the ST segment (the J point), and the deflection at a point 80 ms after the J point. The slope of the ST segment in degrees is also examined.

The smallest positive ST deflection considered significant is 0.05 mV.

When ST elevation is small (0.05 mV to approximately 0.25 mV) the statements are considered of Borderline severity while larger deflections are considered to be Abnormal.

When inverted T waves are associated with ST elevation, the statement will include subepicardial injury as a possibility.

If many leads show ST elevation, the statement will include pericarditis as a possibility.

Whenever possible, the location of ST elevation and subepicardial injury will be indicated as part of the interpretive statements. Though not rigidly defined, the localization will generally fit the following:

<table>
<thead>
<tr>
<th>Location</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>aVR</th>
<th>aVL</th>
<th>aVF</th>
<th>V1</th>
<th>V2</th>
<th>V3</th>
<th>V4</th>
<th>V5</th>
<th>V6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterolateral</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inferior</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

**Severity**

This is the final category of the ECL program. The overall severity for the entire ECG is determined based on the severity of the statements which have been selected.
for the report. Each statement which appears on the ECG report carries one of the following severities:

- NO - Normal
- ON - Otherwise Normal
- BO - Borderline
- AB - Abnormal
- DE - Defective
- NS - No Severity Assigned

The severity that is assigned to the ECG interpretive report as a whole is generally the same as the most severe statement in the report. The severity may be advanced one level from Otherwise Normal to Borderline or from Borderline to Abnormal if three or more statements on the report have the lesser severity.
The Agilent Pediatric ECG Criteria Program

Pediatric ECG interpretation criteria are particularly well-suited for computer-assisted analysis because of their complex, age-dependent nature. Development of the Agilent Pediatric ECG Criteria Program began in 1975 as a natural adjunct to the adult program. The program is written in ECG Criteria Language (ECL) which was created by Agilent to follow the logical process used by skilled physicians to analyze ECGs. The design of the program and a complete development environment allow it to be modified easily on the Agilent ECG Management System.

The Pediatric ECG program was first introduced into the clinical environment in 1983 as part of the Agilent ECG Management System and the PageWriter cardiograph.

Understanding the Agilent Pediatric ECG Criteria Program

This chapter contains brief descriptions of the major categories of interpretive statements in the Agilent Technologies' Pediatric ECG program. Reviewing these descriptions will help you understand the program's breadth of scope and depth of analysis in various areas of ECG interpretation. You will then be better able to use Agilent Technologies' computer-assisted ECG analysis effectively in your daily ECG overreading activities.

The criteria used to select the interpretive statements in this program use the full range of measurements in the measurement matrix, including durations, amplitudes and areas. For clarity and conciseness in the summaries that follow, the detailed logic of the program will not be described. Rather, when describing the criteria logic where the significant values vary, only one measurement value will be mentioned and it will be labeled "(typical)". The typical value is the one that is most generally applied in the logic.

In the criteria logic there are many situations in which an interpretive statement that is otherwise qualified to be printed, is suppressed by other qualifying conditions that override the initial statement. These suppressive conditions generally are not addressed in the categories discussed in this chapter.
The following categories, representing clinically relevant statements and some technical statements and disclaimers, are described in the following sections.

- Pediatric ECG Interpretation
- Calibration Notice if not Standard
- Technical Quality Statements
- Electronic pacemaker
- Dextrocardia
- Sinus Rhythms
- Atrial Premature Complex
- Ventricular Premature Complex
- PR Interval
- Wolff-Parkinson-White Syndrome
- Ventricular Conduction Delay
- Right Bundle Branch Block
- Left Bundle Branch Block
- Right Atrial Enlargement
- RVH: QRS Voltage Criteria
- Right Axis Deviation
- RVH: T Wave Criteria
- Right Ventricular Hypertrophy
- Left Atrial Enlargement
- LVH: QRS Voltage Criteria
- Left Axis Deviation
- LVH: ST Segment and T Wave Criteria
- Left Ventricular Hypertrophy
- Biventricular Hypertrophy
- Anterior ST Elevation
- Inferior ST Elevation
- Anterolateral ST Elevation
- Anterior ST Depression
- Inferior ST Depression
- Anterolateral ST Depression
- Anterior T Wave Changes
- Inferior T Wave Changes
- Anterolateral T Wave Change
- Anatomical Diagnoses
- Severity
Pediatric ECG Interpretation

The Agilent Technologies Pediatric ECG criteria program is intended for use on ECGs of children from birth to age 15. If an age is entered that is invalid, the interpretation will be based on an assumed age of 15 years. A special statement noting this assumption is printed instead of the standard notice that the ECG is being interpreted with pediatric criteria.

The patient's age can be entered at the cardiograph in units of years. It is not possible to enter an age less than 1 year.

Calibration Notice if Not Standard

This category checks the calibration pulse in each channel of the ECG. Except for the case where both the limb leads and the precordial leads are at standard calibration (10 mm/mV), a statement describing the calibration for the ECG is included in the report.

Table 6-1. Calibration

<table>
<thead>
<tr>
<th>Calibration</th>
<th>Normal Value</th>
<th>Allowed Range</th>
<th>± %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half standard</td>
<td>5mm/mV</td>
<td>4.75-5.25mm/mV</td>
<td>5%</td>
</tr>
<tr>
<td>Standard</td>
<td>10mm/mV</td>
<td>9.5-10.5mm/mV</td>
<td>5%</td>
</tr>
<tr>
<td>Double standard</td>
<td>20mm/mV</td>
<td>19.0-21.0mm/mV</td>
<td>5%</td>
</tr>
</tbody>
</table>

Technical Quality Statements

This category contains non-clinical statements which identify ECGs with technical problems and prevent them from being interpreted by the medical criteria program.

Electronic Pacemaker

This category relies on the ECG measurements to detect paced ECGs. For ECGs which are predominantly-paced there is no further consideration of medical criteria. For demand-paced ECGs in which there are enough non-paced beats, no further rhythm analysis is attempted. However, the non-paced beat measurements are used in the remaining categories to check for other abnormalities in the ECG.
**Dextrocardia**

Dextrocardia is suggested if the frontal P axis is between 90 and 180 degrees, and either lead I or V6 has a small negative P wave, and both leads I and V6 have a large S wave ( > 0.6 mV), and the P wave is larger in lead II than in lead III.

**Basic Cardiac Rhythm**

One statement describing the basic cardiac rhythm is selected from this category based on the morphology and rhythm measurements made from the ECG.

Interpretive statements regarding the basic cardiac rhythm are generated based on the interrelationships of the various measurements and determinations.

**Sinus Rhythms**

Sinus versus atrial rhythm statements are based on the frontal P axis. If the P axis is between 0 and 90 degrees the rhythm is considered to be of sinus origin. Outside this range the rhythm is considered to be either atrial or supraventricular.

Sinus arrhythmia is detected when there is a minor but significant variation in rate within the ten second period analyzed, and the P axis is normal.

Heart rates slower than the normal range are considered bradycardia and those higher are considered tachycardia as shown in the table below:

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Bradycardia</th>
<th>Normal</th>
<th>Tachycardia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2 yr.</td>
<td>≤ 97</td>
<td>98-163</td>
<td>≥ 164</td>
</tr>
<tr>
<td>3-4 yr.</td>
<td>≤ 64</td>
<td>65-132</td>
<td>≥ 133</td>
</tr>
<tr>
<td>5-7 yr.</td>
<td>≤ 64</td>
<td>65-1</td>
<td>≥ 116</td>
</tr>
<tr>
<td>8-11 yr.</td>
<td>≤ 59</td>
<td>60-107</td>
<td>≥ 108</td>
</tr>
<tr>
<td>12-15 yr</td>
<td>≤ 59</td>
<td>60-102</td>
<td>≥ 103</td>
</tr>
</tbody>
</table>
Atrial Premature Complex

If there is a beat with essentially the same morphology as the basic background beat but with a rate that is faster (thus, premature), an interpretive statement is made for a premature atrial complex. More than one of this type beat within the ten seconds analyzed will produce a statement regarding multiple premature atrial complexes.

Ventricular Premature Complex

An interpretive statement is made for premature ventricular complex if there is a beat that has a longer QRS duration than the background complex, has an aberrant shape and a faster rate (thus, premature). More than one of this type beat within the ten seconds analyzed will produce a statement regarding multiple premature ventricular complexes.

PR Interval

Upper limits for a normal PR interval vary from 130 ms in a newborn to 180 ms in a 15 year old. PR intervals longer than the upper limit for the patient's age will produce a statement regarding prolonged PR interval for age. However, a PR interval of 210 ms or longer will, in all age groups, produce a statement regarding first degree AV block.

Wolff-Parkinson-White Syndrome

The presence of delta waves along with a shortened PR interval (less than 120 ms) and a QRS duration longer than 90 ms will produce a statement regarding Wolff-Parkinson-White syndrome.

Ventricular Conduction Delay

A QRS duration between 100 ms and 190 ms in a patient less than one year, or a QRS duration between 110 ms and 190 ms in a patient 1 to 15 years old will produce a statement regarding ventricular conduction delay for age.

Right Bundle Branch Block

The presence of a ventricular conduction delay for age and either an RSR' or no negative component at all (no Q or S) in V1 will produce a right bundle branch
block statement. In order for the RSR’ to be significant, the R’ must be at least 20 ms in duration and 0.15 mV in amplitude.

**Left Bundle Branch Block**

A statement indicating left bundle branch block will be made in the presence of:

- a ventricular conduction delay for age,
- a QRS axis for the terminal 40 ms between -90 and +90 degrees (clockwise),
- a short (< 20 ms) or absent S in I, aVL, V5, V6, and
- a small or absent R wave in V1, V2, V3.

In the absence of a statement regarding LBBB, a mean QRS axis between -60 and -90 degrees will result in a left anterior superior fascicular block statement.

**Right Atrial Abnormality**

High amplitude P waves will produce a right atrial enlargement statement. Leads I, II, III, aVF, V1 and V2 are examined. At least one must have a P wave larger than 0.25 mV in amplitude with a P wave larger than 0.20 mV in another lead a confirmation.

**RVH: QRS Voltage Criteria**

Six different age groups are established with appropriate voltage criteria for each group. A total of 24 different conditions meet the criteria for the presence of adequate RVH voltage in the varying age groups. Factors considered in meeting these conditions are:

- the absolute size of R and R’ in V1 and/or V2
- the absolute size of S in V6
- the relative sizes of R and S in V1 and/or V6
- the presence of a QR pattern in V1
This category is bypassed in the presence of any RBBB statement.

**Right Axis Deviation**

The mean QRS axis is considered in making the determination of right axis deviation (RAD).

- 1 month to 15 years: 135 to 269 degrees clockwise

**RVH: T Wave Criteria**

RVH T wave criteria are met as follows:

- 5 days to 4 years: V1 T wave amplitude >0.10 mV, and both V5 and V6 T wave amplitude >0.01 mV, and no T’ in either V1, V5 or V6;
- 5 to 8 years: V1 T wave amplitude >0.15 mV, and both V5 and V6 T wave amplitude > 0.01 mV, and no T’ in either V1, V5 or V6

**Right Ventricular Hypertrophy**

The detection of RVH is made on the basis of the presence of qualifying statements in the RVHVoltage, RAD, and RVH T Wave Criteria categories. Various combinations of statements from these categories will produce statements varying in severity from borderline to abnormal. The likelihood of RVH increases as the severity of the qualifying statements increases.

**Left Atrial Abnormality**

A large negative component to the P wave in V1 is used to call attention to the likelihood of left atrial enlargement. Negative P waves longer than 40 ms in duration and larger than 0.08 mV in amplitude are significant when they combine to produce a negative area of more than 4.00 ms-mV.
LVH: QRS Voltage Criteria

Values considered significant as LVH voltages are:

- S amplitude more than 2.5 mV in V1
- S amplitude more than 3.5 mV in V2
- R amplitude more than 3.0 mV in V5
- R amplitude more than 2.3 mV in V6
- R amplitude more than 3.0 mV in I, II, aVL, or aVF
- S amplitude more than 2.5 mV in V1
- S amplitude in V1 plus R amplitude in V5 more than 4.5 mV
- A combination of a 0.40 mV Q and a 1.0 mV R in either V5 or V6

These LVH voltage criteria are used regardless of the patient's age. This category is bypassed in the presence of RBBB or LBBB.

Left Axis Deviation

The mean QRS axis is considered in making the determination of left axis deviation.

- 6 months to 15 years: -90 to 0 degrees clockwise

LVH: ST Segment and T Wave Criteria

Leads I, aVL, V4, V5, and V6 are examined for ST segment and T wave changes characteristic of LVH. Positive findings are of two types:

- A mid ST segment elevation, with a large positive T wave or:
- A slight mid ST segment depression that is upsloping, with a negative T wave.

Left Ventricular Hypertrophy

The determination of LVH is made on the basis of the presence of qualifying statements in the LVH Voltage, LAD, and LVH ST Segment and T Wave Criteria categories. Various combinations of statements from these categories will produce statements of varying severity and certainty regarding the presence of LVH.
Biventricular Hypertrophy

Associated RVH should be considered when any LVH statement is combined with a large R ( > 1.0 mV) in V1. Similarly, associated LVH should be considered when RVH statements are combined with both a significant Q wave ( > 10 ms and > 0.07 mV ) and a large R wave ( >1.0 mV) in V6. Biventricular hypertrophy should also be considered when the combined amplitudes of R and S exceed 6.0 mV in two of leads V2, V3, or V4.

Anterior ST Elevation

Leads V2, V3, V4, and V5 are examined for ST elevation. ST elevation of more than 0.15 mV in these leads produces a statement suggesting a normal variation.

Inferior ST Elevation

Leads II, III, and aVF are examined for ST elevation. ST elevation of more than 0.15 mV in these leads produces a statement suggesting nonspecific ST changes that are probably normal.

Anterolateral ST Elevation

Leads I, aVL, V2, V3, V4, V5, and V6 are examined for ST elevation. ST elevation of more than 0.15 mV in these leads produces one of two statements. One suggests normal variation; the other is of borderline severity and suggests probable association of ST changes with LVH.

Anterior ST Depression

Leads V2, V3, V4 and V5 are examined for ST depression. ST depression of more than 0.20 mV in these leads produces a statement suggesting possible subendocardial injury.

Inferior ST Depression

Leads II, III, and aVF are examined for ST depression. ST depression of more than 0.20 mV in these leads produces a statement suggesting possible subendocardial injury.
Anterolateral ST depression

Leads I, aVL, V2, V3, V4, V5 and V6 are examined for ST depression. ST depression of more than 0.20 mV in these leads produces one of two statements, each of borderline severity. One suggests possible subendocardial injury; the other is in association with LVH and suggests that the changes are probably secondary to LVH.

Anterior T Wave Changes

Leads V1, V2, V3, V4, and V5 are examined for negative T waves. As negative values increase from 0.10 mV to more than 1.0 mV, the statements change from "nonspecific" T wave changes with a severity of Normal, to "anterior ischemia" with a severity of Borderline.

Inferior T Wave Changes

Leads II, III, and aVF are examined for negative T wave values. As negative values increase from 0.10 mV to more than 1.0 mV, the statements change from "Nonspecific T wave changes" with a severity of Borderline, to "Consider Inferior Ischemia" with a severity of Abnormal.

Anterolateral T Wave Changes

Leads I, aVL, V2, V3, V4, V5, and V6 are examined for T wave values. Positive values more than 1.0 mV indicate a probably normal T wave variant. Negative values call attention to the possibility of ischemia, with increasing severity codes as the negative values increase from 0.01 mV to more than 1.0 mV. Statements range from those referring to "Nonspecific T wave changes" with a severity of Borderline to "Consider Anterolateral Ischemia" with a severity of Abnormal.

Anatomical Diagnoses

The likelihood of various congenital cardiac conditions is suggested on the basis of varying combinations of atrial enlargement, ventricular hypertrophy, conduction patterns, axis determinations, and QRS morphological features.
Severity

This is the final category of the ECL program where the overall severity for the entire ECG is determined based on the severity of the statements which have been selected for the report. Each statement which appears on the ECG report carries one of the following severities:

- NO - Normal
- ON - Otherwise Normal
- BO - Borderline
- AB - Abnormal
- DE - Defective
- NS - No Severity Assigned

The severity that is assigned to the ECG interpretive report as a whole is generally the same as the most severe statement in the report. The severity may be advanced one level from Otherwise Normal to Borderline or from Borderline to Abnormal if three or more statements on the report have the lesser severity.
Reading the Printed Report

This chapter describes the printed reports produced on the Agilent interpretive cardiograph. There are two types of clinical reports that the cardiograph can print:

**Interpretive Report** This report can include patient information, a ten-second ECG waveform, and a set of standard waveform measurements and interpretive statements.

**Rhythm Report** The Agilent interpretive cardiograph can also print a 60 seconds 1-Lead ECG waveform on standard A4/letter paper.
Auto Interpretive Reports

Interpretive reports show up to six blocks of information, as shown below.

Figure 7-1. A Typical Interpretive Report

A. Patient ID  
B. Patient Name  
C. Patient Age and Sex  
D. Data and Time  
E. Basic Measurement  
F. Interpretation  
G. Leads Off Status  
H. Calibration Signal  
I. Filter Setting  
J. Cardiograph setting for speed, and limb and chest lead sensitivity.
Patient Information

This information is entered (or updated) by the technician when the ECG is taken. A complete listing of patient information codes is listed in Appendix B, Patient ID Code Tables.

Basic Measurements

This block gives standard interval and duration measurements in milliseconds, and limb lead axis measurements in degrees. These are representative values for the dominant beat pattern in the ECG. For more information on how representative measurements are derived, refer to "How the Agilent Interpretive Cardiograph Measures ECGs" in Chapter 4.

Table 7-1. Basic Measurements

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>RATE</td>
<td>Heart rate</td>
<td>beats per minute</td>
</tr>
<tr>
<td>PR</td>
<td>PR interval</td>
<td>milliseconds</td>
</tr>
<tr>
<td>QRSD</td>
<td>QRS duration</td>
<td>milliseconds</td>
</tr>
<tr>
<td>QT</td>
<td>QT interval</td>
<td>milliseconds</td>
</tr>
<tr>
<td>QTc</td>
<td>QT interval corrected for rate</td>
<td>milliseconds</td>
</tr>
<tr>
<td>P</td>
<td>Frontal P axis</td>
<td>degrees</td>
</tr>
<tr>
<td>QRS</td>
<td>Frontal mean QRS axis</td>
<td>degrees</td>
</tr>
<tr>
<td>T</td>
<td>Frontal T axis</td>
<td>degrees</td>
</tr>
</tbody>
</table>
Interpretive Information

This block contains:

The interpretive statements which may be accompanied by "Reasons" statements summarizing the conditions that produced each interpretive statement.

This block can also include the following types of technical information:

• **Calibration statements** indicating the scaling of the ECG trace. For example:

  All leads HALF standard calibration.
  All channels =5 mm/mV.

• **Quality statements** indicating signal problems that occurred during the recording. For example:

  Artifact in lead(s) I, III, aVL

• **Severity statement** indicating the ECG's classification. The severity that is assigned to the ECG interpretive report is generally the same as the most severe statement in the report. This is always the last statement in this block. The criteria define five severity levels. In order of severity, they are:

  Normal ECG
  Otherwise Normal ECG
  Borderline ECG
  Abnormal ECG
  Defective ECG
Calibration Pulse

This is the rectangular waveform shown in each line of ECG trace. It shows how much the cardiograph deflected the trace in response to a 1 mV calibration pulse applied to the acquisition circuitry.

The shape of the calibration pulse reflects the scaling of the trace. If the calibration pulse is square, the chest leads and limb leads were recorded at the same scale. If the calibration pulse is stepped, the cardiograph recorded the chest leads at half the scale of the limb leads. The following table shows how the calibration pulse indicates ECG sensitivity.

Table 7-2. Calibration Signal

<table>
<thead>
<tr>
<th>Display Label</th>
<th>ECG Size (mm/mV)</th>
<th>Calibration Pulse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ECG Size (mm/mV)</td>
<td>Auto</td>
</tr>
<tr>
<td>0.5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>0.5 %V</td>
<td>5</td>
<td>2.5</td>
</tr>
<tr>
<td>1.0</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>1.0 %V</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>2.0</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>2.0 %V</td>
<td>20</td>
<td>10</td>
</tr>
</tbody>
</table>
Rhythm Strip

The Agilent interpretive cardiograph can print ten seconds of one lead or of three leads at the bottom of the Auto report. This additional trace is a rhythm strip. Rhythm strips show the same ten seconds of ECG data as in the Auto report.

Settings

Information about the settings at which the ECG was taken is listed at the bottom of the Auto report. Note that your PageWriter cardiograph may not have all these settings available.

**Speed**
Indicates the speed at which the ECG was printed. Auto reports can be printed at 25 mm/sec or 50 mm/sec.

**Filter box**
Indicates which filters were active when the ECG was recorded.

- **F**: Artifact filter
- **W**: Baseline wander filter
- **60 ~**: AC filter
- **0.15-100Hz**: Auto frequency filters

**Faulty Electrode**
Leads off indication.

**Agilent 709**
This is the measurements program (7) and criteria (09) versions used by the cardiograph.
Auto Interpretive Reports

Auto Report Formats

The ECG trace can be printed in any of the following formats.

Figure 7-2. An Auto 3 x 4 Report (3 x 4)

Figure 7-3. An Auto 3 x 4 Report with a Rhythm Strip (3 x 4 1R)
Auto Interpretive Reports

Figure 7-4. An Auto 3 x 4 Report with 3 Rhythm Strips (3 x 4 3R)

![Auto 3 x 4 Report with 3 Rhythm Strips]

Figure 7-5. An Auto 6 x 2 Report (6 x 2)

![Auto 6 x 2 Report]
Auto Interpretive Reports

Figure 7-6. An Auto 12 x 1 Report (12 x 1)
Rhythm Reports

When the operator starts a rhythm report, the Agilent interpretive cardiograph prints the ECG until the operator stops the recording.

Rhythm reports show up to three types of information:

Patient information

ECG trace

Setting information

Rhythm ECGs include the same patient information as on Auto ECGs. This information appears above the waveform. Rhythm reports are not analyzed, so they do not provide measurement information or interpretive statements. The calibration pulse appears at the beginning of the ECG trace.

Cardiograph Setting

The cardiograph settings appear above the waveforms on rhythm reports. Note that your PageWriter cardiograph may not have all these setting available.

**Speed:** Indicates the speed at which the ECG was printed. Rhythm reports can be printed at 5, 10, 25, or 50 mm/sec.

**Limb:** Limb lead sensitivity. Can be 5, 10, or 20 mm/mV.

**Chest:** Chest lead sensitivity. Can be 2.5, 5, 10, or 20 mm/mV.

**Filter box:** Indicates which filters were active when the ECG was recorded.

**F:** Artifact filter

**W:** Baseline wander filter

**60 ~:** AC filter

**0.15-150 Hz:** Rhythm frequency filters
Rhythm Reports

Rhythm Report Formats

Rhythm ECG reports may display any one of the 12-leads. Refer to Figure 7-7 for an example of Rhythm report format.

Figure 7-7. An Rhythm 1-Lead ECG
Questions and Answers

**How accurate is the cardiograph’s interpretation?**
The accuracy you perceive will be determined mainly by your style of reading ECGs. The typical overreading physician will agree with approximately 80% to 85% of the positive findings stated in the interpretation. A normal ECG will be correctly interpreted approximately 98% of the time. Though false positive errors (indicating features that do not exist) will intentionally outnumber false negative errors (missing features that do exist), both will occur, thus the necessity for overreading by a qualified physician of any computer-interpreted ECG. The computer interpretation indicates features of the ECG - it does not produce a definitive diagnosis.

**Why are different interpretations frequently made of ECGs taken on the same patient only a short time apart, or for repeat tests on the same ECG simulator?**
There are always small variations in the actual ECG characteristics from beat to beat. There are also variations in artifacts and noise in the signal. These variations, though possibly very small and not readily visible, result in measurement variations that either meet or do not meet threshold values of significance to the interpretive criteria. This can result in differing interpretive statements.

**ECG simulators should not be used to test the cardiograph’s interpretation.**
Simulators generally produce waveforms that emulate how certain ECG pattern look but which do not represent the full information content of genuine ECGs. In addition, simulators frequently store the waveform for only one lead and reconstruct all other leads from it. Because the cardiograph’s interpretation uses information from multiple leads, such fabricated information may confuse it. A simulated ECG is not an adequate substitute for a human ECG.

**Why do my axis value determinations differ from those calculated by the cardiograph?**
A person calculating axis values primarily looks at the amplitude (voltage) of the waveform components. The cardiograph computes the area under the waveform components to arrive at more accurate axis values.
Why is sinus bradycardia defined as a rate less than 50 beats per minute instead of less than 60?
Although there are different definitions of bradycardia, Agilent uses the definition recommended by the American College of Cardiology's Task Force on Standardization of Terminology and Interpretation as published in the American Journal of Cardiology, January 1978.

What are the advantages of the 0.15 Hz and 150 Hz filters?
The 0.15 Hz filter meets all of the standards for low frequency ECG signals and provides better baseline wander removal than a 0.05 Hz filter. The 150 Hz filter permits higher frequency ECG signals to be visualized in the tracing as well as to be available for computerized analysis.

What is "pre-acquisition"?
Whenever the cardiograph is turned on and the leads are connected to the patient it begins acquiring the incoming ECG signals in an internal buffer. The most recent ten seconds are kept in memory for immediate use in analyzing and printing the ECG when the "Auto" key is pressed.

How can I use the preview screen feature?
The preview screen tracing sweeps to show the immediate ECG signal. It retains the preceding six seconds on the screen for viewing. This gives the operator an opportunity to evaluate the quality of the signal from each of the 12 leads before beginning either an Auto or a rhythm ECG.

What patient ID information affects both Adult and Pediatric interpretations?
Age is factor considered by both criteria. Sex is factor considered in only the adult criteria. The cardiograph will use pediatric criteria for patients less than 16 year old. The adult criteria will be used for all other patients, including those for whom no age is entered.
Patient ID Code Tables

Table B-1 shows the fields in the sequence that they may appear during patient ID entry. The patient ID number is the only field that must be filled in for storage of an Auto ECG. Refer to your cardiograph’s User’s Manual for further information on patient ID.

Table B-1. Patient ID Fields

<table>
<thead>
<tr>
<th>Prompt</th>
<th>Comments</th>
<th>Entry</th>
<th># of char</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient ID?*</td>
<td>Type the patient ID number.</td>
<td>Numeric</td>
<td>16</td>
</tr>
<tr>
<td>Age (years)?</td>
<td>Type the age.</td>
<td>Numeric</td>
<td>3</td>
</tr>
<tr>
<td>Sex?</td>
<td>Choose male or female.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Refer to the User’s Manual for the specific fields available for your cardiograph.

Table B-2. Severity Codes

<table>
<thead>
<tr>
<th>Severity</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal ECG</td>
<td>NO</td>
</tr>
<tr>
<td>Otherwise Normal ECG</td>
<td>ON</td>
</tr>
<tr>
<td>Borderline ECG</td>
<td>BO</td>
</tr>
<tr>
<td>Abnormal ECG</td>
<td>AB</td>
</tr>
<tr>
<td>Defective ECG</td>
<td>DE</td>
</tr>
</tbody>
</table>
Glossary

AC filter:
The configurable filter which screens out ECG artifact caused by electrical interference.

adult criteria:
Interpretive rules used when analyzing ECGs of persons aged 16 years or older. (See ECG analysis, analysis criteria, and pediatric criteria.)

AHA leads:
ECG lead names and identifying colors recommended by the American Heart Association. Limb leads are labeled RA, LA, LL, RL. Chest leads are labeled V1-V6. (See IEC leads).

alternating current (AC):
Electrical current provided by wall outlets. AC may be either 60 or 50 Hz depending on country.

analysis criteria:
Rules used to interpret ECGs. (See adult criteria, pediatric criteria, and ECG analysis.)

artifact:
ECG waveform distortion that may diminish ECG quality. ECG artifact (or noise) may be caused by electrical interference, poor electrode connections, or patient movement.

artifact filter:
Agilent term for the filter which screens out ECG noise caused by muscle tremor.

Auto ECG:
Twelve-lead ECG which shows 10 seconds of heart activity and is printed in a preselected format.

baseline wander:
A slow upward motion on the baseline of any ECG waveform.

baseline wander filter:
The configurable filter which reduces baseline wander.

battery:
Agilent term for process cardiograph uses to turn off automatically after a preset time period to conserve power. The number of minutes before battery time-out and be set in configuration mode.

calibration pulse:
A 200 ms, 1mV square wave pulse which appears on the printed record. Calibration pulse shows the sensitivity at which the ECG was recorded and may show the effect of the filters.

configuration:
The manner in which the cardiograph is programmed to function. When the software is installed, the cardiograph defaults to a preset configuration which may be changed at any time.
cycle power:
To press the  button to off and then back to on.

Data Comm port:
The cardiograph connector into which the modem data cable or direct connection cable is inserted for ECG transmission.

ECG analysis:
Computerized process for measuring and interpreting an Auto ECG.

ECG report:
Paper copy produced by Agilent cardiographs when the operator presses one of the Auto start keys. This report includes a graphic representation of the heart's electrical activity (ECG waveforms) and identifying information and may also include interpretive information produced by the computerized analysis software. ECG reports must be overread by qualified physicians.

ECG-log:
Agilent term for the softkey function which accesses the list of the last 60 ECGs recorded on a cardiograph.

format:
The manner in which ECG waveforms are presented on the printed ECG report. ECG format is selected by the operator.

frequency response:
The range of frequencies in which the cardiograph records ECG data.

Hertz (Hz):
A unit of electrical frequency (cycles per second).

ID fields:
Agilent term for the areas where variable patient information can be entered. Using the ID fields, the operator can key in information such as patient identification number, name, and age.

IEC leads:
Lead names and identifying colors recommended by the International Electrotechnical Commission standard. IEC limb leads are labeled R, L, F, and N. Chest leads are labeled C1-C6. (See AHA leads).

jittery waveform:
Irregular up and down movement on the baseline of the ECG often caused by patient movement or muscle tremor.

measurements:
The amplitudes, durations, areas, and intervals which characterize the ECG waveform.

(Menu key):
Cardiograph key that changes the menu selections displayed on the cardiograph's front panel display.
modem:  
Device used to transmit data (ECGs) over phone lines.

morphology:  
Related to the shape of the ECG waveform.

operator:  
The person who records the ECG.

overread:  
To review an ECG report. This review must be completed by a qualified physician.

pediatric criteria:  
The interpretive rules used when analyzing ECGs of persons aged 15 years or younger. (See adult criteria, ECG analysis, and analysis criteria).

preliminary report:  
An ECG report that has not been reviewed by a qualified physician. (See overread).

preview screen:  
Agilent term for screen which, when installed on the cardiograph, shows the ECG traces as they will appear on the printed ECG report.

rhythm strip:  
Agilent term for ten second recording of a particular lead that is printed at the bottom of an Auto ECG report. (See Manual and Auto ECG).

Softkey:  
the labels or commands assigned to the function keys. The softkeys appear at the bottom of the front panel display, and are executed when the corresponding function key is pressed. These keys are noted in this manual as softkeys.

Store-Log:  
Agilent term for function which accesses list of all ECGs stored on the flexible disk.

transmission site:  
Agilent term for four preset, configurable transmission selections. Operators may select connection type, phone number (if appropriate), dialing type (if appropriate), and pausing length (if appropriate).

Welsh cup:  
Reusable electrodes held in place with suction cups.
Index

Special characters

0
- 0.05 Hz filter, 3-5
- Manual vs. Auto, 3-7
- 0.15 Hz filter, 3-5, A-2
- 0.5 Hz filter, 3-5

1
- 100 Hz filter, 3-5
- 12-Lead Acquisition simultaneous, 3-1
- understanding, 3-1
- 150 Hz filter, 3-5, A-2

2
- 40 Hz filter, 3-5

A
- AAMI standard, 3-3
- abnormalities, T waves, 5-15
- AC, Glossary-1
- and filter box, 3-6
- AC filter, 3-4, 3-6, Glossary-1
effects on ECGs, 3-6
status, 3-6
- AC interference, 3-3
- adult criteria, 4-2, Glossary-1
- and pacemaker, 5-3
- adult criteria categories, 5-1, 5-2
- Adult Criteria program, Agilent’s, 2-1
- Adult ECG bandwidth, 3-3
- Adult ECG Criteria Program, 5-1
- age and LVH, 5-10
- AHA leads, Glossary-1
- alternating current, Glossary-1
- analog filters vs. digital, 3-3, 3-4
- analysis
- ECG, Glossary-2
- analysis criteria, Glossary-1
- Analysis Program, Agilent ECG, 1-2
- analysis program steps, 4-1
- anterior
- infarct, 5-13
- infarct statements, 5-13
- Q waves, 5-13
- ST Depression, 6-9
- ST elevation, 6-9
- T wave changes, 6-10
- anterolateral
- infarct, 5-14
- Q waves, 5-14
- ST Depression, 6-10

T axis, 4-4
- calibration notice, 5-3, 6-
- calibration pulse, 7-5, Glossary-1
- and scaling, 7-5
- calibration statements, 7-4
- cardiac conditions
- congenital, 6-10
- cardiac rhythm
- basic, 5-3, 6-4
- sinus, 6-4
- Children’s ECG’s, 6-3
- chronic pulmonary disease, 5-11
- clinical reports, 7-1
- code, ECL statement, 4-5
codes
- patient diagnostic, B-2
- patient ID, B-1
- patient medical, B-2
- patient race, B-4
- severity, 5-18, B-4
- common mode rejection ratio, 3-3
- and error detection, 8-3
- computerized
- ECG interpretation, 2-1
- interpretation, 1-1
- concurrent statements, 5-16
- conditions, suppressive, 5-1, 6-1
- conduction delays, ventricular, 5-7, 6-5
- configuration, Glossary-1
global, Glossary-4
- congenital cardiac conditions, 6-10
criteria
- adult, 4-2, Glossary-1
- analysis, Glossary-1
- pediatric, 4-2, Glossary-3
- statements, ECL, 4-5
criteria categories
- adult, 5-1
- pediatric, 6-1, 6-2
- selecting, 4-6
cycle power, Glossary 2

B
- bandwidth, ECG, 3-3
- baseline wander, 3-6, Glossary-2
- baseline wander filter, 3-6, Glossary-2
- and "smearing", 3-6
- and ST segment distortion, 3-6
- basic cardiac rhythm, 5-3, 6-4
- basic measurements, 7-3,
- battery, Glossary-2
- beat detection, 4-3
- beats, interpolated, 5-5
- biventricular hypertrophy, 6-9
- bradycardia, 5-4, 6-4, A-2

C
- caculations
- axis value, A-1
- P axis, 4-4
- QRS axis, 4-4
- representative axis, 4-4
- ST axis, 4-4

D
- Data Common port, Glossary-2
detecting pacemaker pulses, 3-2
determining atrial rhythm, 4-4
development of ECG Analysis, 2-1
dextrocardia, 6-4
digital filters
- and stability, 3-6
- vs. analog, 3-3, 3-6
digitized ECG, 3-2
## Index

<table>
<thead>
<tr>
<th>Disk storage, ECG, A-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>drug effects, 5-14</td>
</tr>
<tr>
<td>dynamic range, input, 3-3</td>
</tr>
</tbody>
</table>

### E

- ECG
- and AC interference, 3-3
- Auto, Glossary-1
- Auto 3x4, 3-1, 7-7
- Auto 3x4, 1R, 7-7
- Auto 3x4, 3R, 7-7
- Auto 6x2, 3-1, 7-8
- children's, 6-3
- digitized, 3-2
- management, 8-1
- quality, 3-7
- receiving, 8-1
- storage, 8-1
- trace preview, 3-8
- transmitting, 8-1
- ECG analysis, Glossary-2
- ECG Analysis
- development, 2-1
- limitations, 1-2
- ECG Analysis Program, Agilent, 4-1
- ECG bandwidth, 3-3
- Adult, 3-3
- infant, 3-3
- ECG Criteria Language, 2-1, 4-7
- ECG interpretation computerized, 2-1
- ECG-Log, Glossary-2
- ECG report, Glossary-2
- formats, 7-6
- printed, 7-1
- ECGs
- repeating, A-1
- ECG settings statements, 7-6
- Faulty Electrode, 7-6
- filters, 7-6, 5-10
- Lamb, 7-10
- Speed, 7-6, 7-10
- ECG simulators and interpretation, A-1
- ECGs, measuring, 4-2
- ECL, 2-1, 4-4
- as an expert system, 4-4
- statement code, 4-5
- ECL criteria statements, 4-5
- electrolyte effects, 5-14
- elevation, ST segment, 5-17
- escape beats, 5-5
- and long R-R, 5-4
- extensive anterior infarct, 5-13

### F

- F and the filter box, 3-7
- feedback, lead quality, 3-8
- file, Glossary-3
- filter
  - 0.05 Hz, 3-5
  - 0.15 Hz, 3-5
  - 0.15 Hz, A-2
  - 0.5 Hz, 3-5
  - 100 Hz, 3-5
  - 150 Hz, 3-5, A-2
  - 40 Hz, 3-5
  - AC, 3-4, Glossary-artifact, 3-7, Glossary-1
  - baseline wander, 3-6, Glossary-1
  - high frequency, 3-6
  - low frequency, 3-6
  - status, 3-6
- filter box
  - and ~, 3-6
  - and F, 3-6
  - and W, 3-6
- filters
  - analog, 3-3, 3-4
  - digital, 3-3, 3-4
- effects on ECGs, 3-3, 3-4
- format, Glossary-2
- frequency response, Glossary-2
- frontal plane axis measurements, 4-4

### G

- global measurements, 4-4, A-7

### H

- heart rate ranges, pediatric, 6-4
- Hertz, Glossary-2
- high frequency filter, 3-5
- horizontal plane axis measurements, 4-4
- Agilent Adult Criteria program, 2-1
- Agilent ECG Analysis Program, 1-2, 4-1
- Agilent Pediatric Criteria program, 2-2
- Hz, Glossary-2

### I

- ID fields, Glossary-2
- IEC leads, Glossary-2
- infant ECG bandwidth, 3-4
- infarct
  - age estimates, 5-12, 5-13
  - anterior, 5-13
  - anterolateral, 5-13
  - anteroscapal, 5-13
  - extensive anterior, 5-13
- inferior, 5-11
- lateral, 5-12
- posterior, 5-12
- infarct, 5-11
- Q waves, 5-11
- ST Depression, 6-9
- ST elevation, 6-9
- T wave changes, 6-10
- interference, AC, 3-5
- interpolated beats, 5-5
- interpreting
  - P wave regions, 4-3
  - QRS complex regions, 4-3
  - T wave regions, 4-3
  - waveforms, 4-3
- interpretation, 4-2
- accuracy, A-1
- and ECG simulators, A-1
- and patient information, 4-2
- as a training tool, 1-1
- computerized, 1-1
- pediatric, 3-2
- interpretive criteria, changes to, A-3
- interpretive report, 7-1
- Auto, 7-2
- interpretive statements, 7-4

### J

- jittery waveform, Glossary-2
- J point, 5-21

### L

- LAA, 5-9, 5-10, 6-7
- LAD, 6-8
- limits, 6-8
- LAFB, 5-7
- lateral infarct, 5-12
- lateral Q waves, 5-12
- LBBB, 5-10, 6-6, 6-8
- lead quality feedback, 3-11
- leads
  - AHA, Glossary-1
  - IEC, Glossary-2
  - left atrial abnormality, 5-12, 5-14, 6-7
  - left axis deviation, 5-14, 6-8
  - left bundle branch block, 6-6
  - left ventricular hypertrophy, 5-9, 6-8
  - limits
    - low ECG voltage, 5-11
    - PR interval, 5-8, 6-5
    - long R-R
    - and AVblock, 5-5
<table>
<thead>
<tr>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>and escape beats, 5-5</td>
</tr>
<tr>
<td>low ECG voltage limits, 5-11</td>
</tr>
<tr>
<td>low frequency filter, 3-6</td>
</tr>
<tr>
<td>LPFB, 5-7</td>
</tr>
<tr>
<td>LVH, 5-9, 6-8</td>
</tr>
<tr>
<td>and age, 5-10</td>
</tr>
<tr>
<td>and ST-T changes, 5-10</td>
</tr>
<tr>
<td>QRS voltage criteria, 6-8</td>
</tr>
<tr>
<td>ST segment criteria, 6-8</td>
</tr>
<tr>
<td>T Wave criteria, 6-8</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>measurements, Glossary-2</td>
</tr>
<tr>
<td>basic, 7-</td>
</tr>
<tr>
<td>frontal plane axis, 4-4</td>
</tr>
<tr>
<td>global, 4-4</td>
</tr>
<tr>
<td>horizontal plane axis, 4-4</td>
</tr>
<tr>
<td>P, 7-3</td>
</tr>
<tr>
<td>PR, 7-3</td>
</tr>
<tr>
<td>QRS, 7-3</td>
</tr>
<tr>
<td>QRSD, 7-3</td>
</tr>
<tr>
<td>QT, 7-3</td>
</tr>
<tr>
<td>QTc, 7-3</td>
</tr>
<tr>
<td>RATE, 7-3</td>
</tr>
<tr>
<td>T, 7-3</td>
</tr>
<tr>
<td>waveform, 4-1</td>
</tr>
<tr>
<td>measuring ECGs, 4-2</td>
</tr>
<tr>
<td>Mobitz AV block, 5-5</td>
</tr>
<tr>
<td>modern, Glossary-3</td>
</tr>
<tr>
<td>monitoring ECG quality, 3-10</td>
</tr>
<tr>
<td>morphology, 4-2, Glossary-3</td>
</tr>
<tr>
<td>muscle artifact, 3-10</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>noise, 3-3</td>
</tr>
<tr>
<td>sources, 3-3</td>
</tr>
<tr>
<td>normal P axis, 5-5</td>
</tr>
<tr>
<td>notice, calibration, 5-4, 6-3</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>operator, Glossary-3</td>
</tr>
<tr>
<td>overread, Glossary-3</td>
</tr>
<tr>
<td>overreading, 5-2, 6-1</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>pacemaker, 5-3, 6-3</td>
</tr>
<tr>
<td>and adult criteria, 5-3</td>
</tr>
<tr>
<td>pulse detection, 3-1</td>
</tr>
<tr>
<td>spikes, 4-3</td>
</tr>
<tr>
<td>patient diagnostic codes, B-2</td>
</tr>
<tr>
<td>ID, 7-2</td>
</tr>
<tr>
<td>ID codes, B-1</td>
</tr>
<tr>
<td>information, 7-3</td>
</tr>
<tr>
<td>information and interpretation, 4-2, A-2</td>
</tr>
<tr>
<td>medical codes, B-2</td>
</tr>
<tr>
<td>race codes, B-4</td>
</tr>
<tr>
<td>patient age, 5-2, 6-3</td>
</tr>
<tr>
<td>default, 5-2, 6-3</td>
</tr>
<tr>
<td>patient module, 3-7</td>
</tr>
<tr>
<td>display, 3-8</td>
</tr>
<tr>
<td>pattern recognition, 4-1</td>
</tr>
<tr>
<td>P axis, normal, 5-5</td>
</tr>
<tr>
<td>Pediatric criteria, 4-2, Glossary-3</td>
</tr>
<tr>
<td>categories, 6-3</td>
</tr>
<tr>
<td>Pediatric Criteria, program, Agilents, 2-2</td>
</tr>
<tr>
<td>Pediatric ECG Criteria Program, 6-1</td>
</tr>
<tr>
<td>(period), 4-5</td>
</tr>
<tr>
<td>P measurements, 7-3</td>
</tr>
<tr>
<td>PMI, 5-11</td>
</tr>
<tr>
<td>and LVH, 5-9</td>
</tr>
<tr>
<td>and RVH, 5-9</td>
</tr>
<tr>
<td>posterior infarct, 5-12</td>
</tr>
<tr>
<td>preacquisition, 3-8, A-2</td>
</tr>
<tr>
<td>preliminary report, Glossary-3</td>
</tr>
<tr>
<td>premature atrial complex, 6-5</td>
</tr>
<tr>
<td>beats, 5-4, 6-5</td>
</tr>
<tr>
<td>ventricular complex, 6-5</td>
</tr>
<tr>
<td>previewing ECG traces, 3-8</td>
</tr>
<tr>
<td>preview screen, 3-7, A-2, Glossary-3</td>
</tr>
<tr>
<td>PR interval, 5-5, 6-5</td>
</tr>
<tr>
<td>adult limits, 5-6</td>
</tr>
<tr>
<td>limits, 5-6, 6-5</td>
</tr>
<tr>
<td>pediatric, 6-5</td>
</tr>
<tr>
<td>pediatric limits, 6-5</td>
</tr>
<tr>
<td>PR measurements, 7-3</td>
</tr>
<tr>
<td>pulse, calibration, 7-5</td>
</tr>
<tr>
<td>P wave regions, interpreting, 4-3</td>
</tr>
<tr>
<td>Q</td>
</tr>
<tr>
<td>QRS axis, 5-6</td>
</tr>
<tr>
<td>and pacemakers, 5-6</td>
</tr>
<tr>
<td>deviations, 5-6</td>
</tr>
<tr>
<td>QRS complex regions, interpreting, 4-3</td>
</tr>
<tr>
<td>QRSD measurements, 7-3</td>
</tr>
<tr>
<td>QRS measurements, 7-3</td>
</tr>
<tr>
<td>QRS voltage values, 5-13</td>
</tr>
<tr>
<td>QTc measurements, 7-3</td>
</tr>
<tr>
<td>QT measurements, 7-3</td>
</tr>
<tr>
<td>quality checks, 3-8</td>
</tr>
<tr>
<td>ECGs, 3-7</td>
</tr>
<tr>
<td>monitor, 4-1</td>
</tr>
<tr>
<td>statements, 5-5, 6-3</td>
</tr>
<tr>
<td>quality statements, 7-4</td>
</tr>
<tr>
<td>Q waves</td>
</tr>
<tr>
<td>anterior, 5-13</td>
</tr>
<tr>
<td>anterolateral, 5-13</td>
</tr>
<tr>
<td>anteroscpal, 5-13</td>
</tr>
<tr>
<td>inferior, 5-11</td>
</tr>
<tr>
<td>lateral, 5-12</td>
</tr>
<tr>
<td>R</td>
</tr>
<tr>
<td>RAA, 5-7, 5-9</td>
</tr>
<tr>
<td>RAD, 6-7</td>
</tr>
<tr>
<td>RATE measurements, 7-3</td>
</tr>
<tr>
<td>RBBB, 5-10, 6-8</td>
</tr>
<tr>
<td>receiving ECGs, 8-1</td>
</tr>
<tr>
<td>recording, ten second ECG, 3-1</td>
</tr>
<tr>
<td>report</td>
</tr>
<tr>
<td>Auto 3x4, 7-7</td>
</tr>
<tr>
<td>Auto 3x4, 1R, 7-7</td>
</tr>
<tr>
<td>Auto 3x4, 3R, 7-8</td>
</tr>
<tr>
<td>Auto 6x2, 7-8</td>
</tr>
<tr>
<td>ECG, Glossary-2</td>
</tr>
<tr>
<td>research leads, 5-2</td>
</tr>
<tr>
<td>Rhythm ECG, Glossary-3</td>
</tr>
<tr>
<td>Rhythm ECGs settings statements</td>
</tr>
<tr>
<td>Chest, 7-10</td>
</tr>
<tr>
<td>Faulty Electrode, 7-10</td>
</tr>
<tr>
<td>filters, 7-10</td>
</tr>
<tr>
<td>Lamb, 7-10</td>
</tr>
<tr>
<td>Speed, 7-</td>
</tr>
<tr>
<td>Rhythm report, 7-1</td>
</tr>
<tr>
<td>Rhythm report formats, 7-11</td>
</tr>
<tr>
<td>rhythm strip, 7-6, Glossary-3</td>
</tr>
<tr>
<td>strips and interpretation, A-2</td>
</tr>
<tr>
<td>right atrial abnormality, 5-7, 6-6</td>
</tr>
<tr>
<td>right axis deviation, 6-7</td>
</tr>
<tr>
<td>right bundle branch block, 6-</td>
</tr>
<tr>
<td>right ventricular hypertrophy, 5-8, 6-7, 6-9</td>
</tr>
<tr>
<td>R-R intervals long, 5-4</td>
</tr>
<tr>
<td>RVH, 5-11, 6-6, 6-7</td>
</tr>
<tr>
<td>and PMI, 5-12</td>
</tr>
<tr>
<td>QRS voltage criteria, 6-6</td>
</tr>
<tr>
<td>T Wave voltage criteria, 6-7</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td>sample rate, 3-2</td>
</tr>
<tr>
<td>settings statements, ECG, 7-6</td>
</tr>
<tr>
<td>severity codes, 5-18, 6-14, B-4</td>
</tr>
<tr>
<td>severity statements, 4-6, 7-4</td>
</tr>
<tr>
<td>Abnormal ECG, 7-4</td>
</tr>
<tr>
<td>Borderline ECG, 7-4</td>
</tr>
<tr>
<td>Defective ECG, 7-4</td>
</tr>
<tr>
<td>Normal ECG, 7-4</td>
</tr>
</tbody>
</table>
Index

Otherwise Normal ECG, 7-4
simultaneous 12-Lead Acquisition, 3-1
sinus arrest
and long R-R, 5-4
sinus rhythm, 6-4
skeletal muscle artifact, 3-10
softkeys, Glossary-3
AAMI, 3-4
statement
concurrent, 5-16
tall T wave, 5-14
statement codes, ECL, 4-5
statements
anterior infarct, 5-13
anteroseptal infarct, 5-17
calibration, 7-5
ECG settings, 7-6
ECL criteria, 4-4
interpretable, 7-4
quality, 5-5, 6-3, 7-4
severity, 4-6, 7-4
status
AC filter, 3-6
filter, 3-4, 3-
ST Depression
anterior, 6-9
anterolateral, 6-
inferior, 6-9
Store-Log, Glossary-3
storing ECGs, 8-1
ST segment depression, 5-15
ST segment elevation, 5-17
suppressive conditions, 5-1, 6-1
T
tachycardia, 5-4, 6-4
tall T waves, 5-14
tall T wave statement, 5-14
ten second ECG recording, 3-1
toilet, battery, Glossary-1
T measurements, 7-3
transferring ECGs, 8-1
transmission site, Glossary-3
T wave
abnormalities, 5-15
interpreting regions, 4-3
tall, 5-14
T wave changes
anterior, 6-10
anterolateral, 6-
inferior, 6-10
typical value, 5-1, 6-2
V
VAT, 5-11
ventricular
activation time, 5-11
conduction delays, 5-7, 6-5
premature complex, 6-5
W
W and filter box, 3-6
waveform
amplitudes, 4-4
areas, 4-
areas vs. amplitudes, 4-4
interpretation, 4-2
jittery, Glossary-2
measurement, 4-1
offsets, 4-3
onsets, 4-3
recognition, 4-3
Welsh cups, Glossary-3
Wenckebach AV block, 5-5
Wolff-Parkinson-White, 5-7, 6-5