GE Healthcare

Quick Guide

GE Datex-Ohmeda Bedside Arrhythmia Monitoring

Multi-lead arrhythmia monitoring

Arrhythmia means any disturbance or irregularity of cardiac rhythm. Stability of the cardiac rhythm is essential for sufficient pumping function of the heart and adequate cardiac output. Maintaining adequate cardiac output is vital for organ perfusion and survival. Therefore, fast and accurate detection of arrhythmia is critical.

Each ECG lead views the heart at a unique angle. Multi-lead monitoring provides continuous viewing of the heart rhythm from multiple sites. The more leads that are used, in general, the more reliable the information is available for arrhythmia analysis.

A multi-lead arrhythmia algorithm uses more than one ECG lead for detection and analysis of cardiac arrhythmias. The performance of a multi-lead algorithm, in general, may exceed that of a single-lead algorithm. In noisy situations, there might be noise present on some leads, while the signal in other leads might be good enough for reliable detection of cardiac rhythm. Sometimes ventricular beats can be more obvious in some of the leads than in others where the changes in morphology are minor. It is also possible that QRS amplitude can be low in one lead and normal in others. Therefore, the sensitivity of the algorithm may increase when more than one lead is used.

The recognition of ventricular beats may be improved by multi-lead monitoring, and the same applies to QRS detection. The decision between normal and ventricular beats may be more reliable when information from more than one is available. The GE Datex-Ohmeda bedside arrhythmia algorithm uses two leads – I or II, and one precordial lead for arrhythmia detection. The user can choose which leads are used by the algorithm. See the section, “Practical aspects in bedside arrhythmia monitoring,” for details.

This quick guide applies to GE Healthcare’s Anesthesia Monitor, Compact Anesthesia Monitor, Critical Care Monitor, Compact Critical Care Monitor, and the CARESCAPE* B850 Monitor with the Patient Side Module (PSM) or E-PRESTN Module using the GE Datex-Ohmeda bedside arrhythmia monitoring algorithm.

How are arrhythmias monitored at the bedside?

The GE Datex-Ohmeda bedside arrhythmia algorithm is based on template matching. (A template is a group of beats matching the same morphology.) The algorithm detects QRS complexes, generates QRS templates and performs beat labeling. This algorithm is divided into three parts: detector, classifier and labeling. Parallel to this process there is an algorithm for detection of ventricular fibrillation. Detection of ventricular fibrillation is based on waveform analysis. The detector, classifier and labeling all use two leads: the first lead is I or II, and the second lead is one precordial lead (V1-V6).

The detector algorithm detects waves in the ECG signal that could be QRS complexes. Then the algorithm separates true QRS complexes from T-waves and artifacts.

The classifier algorithm forms a template for a normal QRS complex, which is created during the learning phase. This QRS complex is later updated upon recognition of a new normal QRS complex. If the QRS complex is not considered normal, it is further analyzed with the labeling algorithm.

The labeling algorithm further analyzes the QRS complex and labels the beat as either ventricular, paced or supraventicular. This analysis is based on morphological and rhythmical differences between the detected QRS and the normal template. However, if there are no significant differences the labeling algorithm labels the beat normal.

When using the a 3-lead cable, only one lead is measured at a time. With a 3-lead cable there is only one lead available for detector, classifier and labeling algorithms, as well as the algorithm for detection of ventricular fibrillation. The table on the next page describes the functionality with 5-lead and 10-lead cables.

Detection of ventricular fibrillation is based on waveform analysis. The main criteria for signaling ventricular fibrillation is irregular waveform with high enough amplitude and rate. The algorithm for detecting ventricular fibrillation uses two leads: the first lead is I or II, and the second lead is one precordial lead (V1-V6).

Detector

- Detects waves in the ECG signal
- Separates QRS complexes from T-waves and artifacts

5-lead cable:
- I or II
- V

10-lead cable:
- I or II
- One precordial lead (V1-V6)

Classifier

- Updates the normal template after each true QRS complex

5-lead cable:
- I or II
- V

10-lead cable:
- I or II
- One precordial lead (V1-V6)

Labeling

- Analyzes each template and labels it as: normal, ventricular, supraventricular or paced

5-lead cable:
- I or II
- V

10-lead cable:
- I or II
- One precordial lead (V1-V6)

Ventricular fibrillation detection

- Absence of QRS complexes
- Irregular waveform with high enough amplitude and rate

5-lead cable:
- I or II
- V

10-lead cable:
- I or II
- One precordial lead (V1-V6)

Practical aspects in bedside arrhythmia monitoring

Signal quality

Careful skin preparation is very important for good results in ECG and especially arrhythmia monitoring. Good skin preparation helps ensure a good signal. The use of high-quality electrodes also helps to improve the signal quality. A good signal helps ensure accurate arrhythmia detection and especially helps decrease the number of false alarms.

Relearning

When the morphology of the patient's ECG changes considerably (e.g. due to removal of a pacemaker), relearning should be started manually. This can be done in the ECG menu by selecting Relearn – Start.

Selecting leads for the arrhythmia analysis

The selection of user leads (ECG1, ECG2 and ECG3) on the monitor affects the leads used for bedside arrhythmia analysis. The first lead used for arrhythmia analysis is either lead I or lead II. The algorithm uses the lead appearing first in the user leads. The second lead used for arrhythmia analysis is one of the precordial leads (V1-V6). The algorithm uses the precordial lead appearing first in the user leads.

Bedside arrhythmia alarms

In GE Datex-Ohmeda monitors there are two arrhythmia analysis modes: Severe and Extended. The Severe mode is the default and Extended is an optional choice. The Severe mode detects asystole, bradycardia, tachycardia, ventricular fibrillation, rapid ventricular tachycardia and ventricular tachycardia. The details of arrhythmia alarms criteria and the two modes are described in the following table.

Bedside arrhythmia alarm definitions

Alarm	Criteria
A Fib	Irregular R-R intervals with absence of P waves
Asystole	Cardiac arrest, no QRS complexes for five seconds
Brady	HR below the HR alarm limit
Freq. PVCs	PVCs per minute above the alarm limit
Freq. SVCs	Number of SVCs during the last minute >10
Idiov. rhythm	More than four consecutive PVC's and rate of successive beats below 40 bpm
Long R-R interval	R-R interval is longer than 2.8 seconds
Missing Beat	Actual R-R interval more than 1.8 times the average R-R interval
Multif. PVCs	Over the last 15 beats two or more premature ventricular beats with different morphologies are detected
Rapid VT	Five or more consecutive PVCs and rate of successive beats over 150 bpm
R on T PVC	Early PVC, beat detected as a PVC, preceded and followed by a normal beat; current R-R interval is less than half of the previous R-R interval
SV Tachy	More than four consecutive SVCs and HR above 120 bpm and significantly higher than normal rate. Note: The length of the episode can be configured to more than 4 or more than 9
Tachy	HR over the HR alarm limit
V Bigeminy	The following pattern is detected: N, V, N, V, N, V where N = normal, V = PVC (every other beat is a PVC)
V Couplet	Two consecutive ventricular beats, preceded and followed by a normal beat, and rate of successive beats is over 100 bpm
V Fib	Fibrillatory waveform caused by ventricular fibrillation
V Run > 3	Three or more consecutive PVCs and rate of successive beats over 100 bpm
V Tachy	Five or more consecutive PVCs and rate of successive beats over 100 bpm
V Trigeminy	The following pattern is detected: N, N, V, N, N, V, N, N, V where N= normal, V= PVC (i.e., every third beat is a PVC)

Note: The Severe mode detects Asystole, Brady, Tachy, V Fib, Rapid VT and V Tachy. The Extended mode additionally detects the rest of the arrhythmias mentioned in the table above. Rapid VT is only available on software versions L-ICU07, L-ANE07, L-ICU07A, L-ANE07A and above, and Afib, Freq SVC, Idiov. rhythm, Long R-R and SV Tachy on software versions L-ICU07A, L-ANE07A and above. A Fib, Freq SVC, Idiov. rhytm, Long R-R, Rapid VT and SV Tachy are not available for the CARESCAPE Monitor B850.

Additional resources

For white papers, guides and other instructive materials about our clinical measurements, technologies and applications, please visit **http://clinicalview.gehealthcare.com/**

About GE Healthcare:

GE Healthcare provides transformational medical technologies and services that are shaping a new age of patient care. Our broad expertise in medical imaging and information technologies, medical diagnostics, patient monitoring systems, drug discovery, biopharmaceutical manufacturing technologies, performance improvement and performance solutions services help our customers to deliver better care to more people around the world at a lower cost. In addition, we partner with healthcare leaders, striving to leverage the global policy change necessary to implement a successful shift to sustainable healthcare systems.

Our "healthymagination" vision for the future invites the world to join us on our journey as we continuously develop innovations focused on reducing costs, increasing access and improving quality around the world. Headquartered in the United Kingdom, GE Healthcare is a unit of General Electric Company (NYSE: GE). Worldwide, GE Healthcare employees are committed to serving healthcare professionals and their patients in more than 100 countries. For more information about GE Healthcare, visit our website at www.gehealthcare.com.

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