GE Healthcare

Clinical excellence in computerized ECG analysis

“The fact is,
the electrocardiogram
is needed to deliver
modern medical care
now more than ever.”[1]

J. W. Hurst

ECG and its role in modern medical care

"There is a misconception that newer diagnostic modalities have replaced the ECG. The fact is, the electrocardiogram (ECG) is needed now more than ever to deliver accurate and cost effective modern medical care."[2] Furthermore, it is noted in the current American College of Cardiology (ACC)/American Heart Association (AHA) guidelines that: "Recording the resting 12-lead ECG continues to be the most commonly used laboratory procedure for the diagnosis of heart disease." In addition, "The procedure is safe, simple, and reproducible; the ECG record lends itself to serial studies; and the relative cost is minimal."[3]

The ECG continues to play a key role in the proper selection of the latest therapies. In the setting of an acute coronary syndrome, the ECG is used for treatment selection and expedited care.[4] The ECG continues to be central in the management of arrhythmias.[5] New advancements in electronic cardiac implants have solidified the role of the ECG in selection of appropriate target populations for such therapies as biventricular pacemakers[6] and implantable cardioverter defibrillators.[7] Even in the presence of superior diagnostic imaging methods, the ECG often provides valuable prognostic data showing that the ECG still has a significant role in determining patient care.[8,9]

Quality digital waveforms driving clinical excellence

Many physicians can recall instances where a single ECG made all the difference in determining a critical diagnosis. To be the most effective and to maintain clinical excellence, it is critical the ECG enters the digital/paperless domain.

Advancements in computer technology brought digital writers and displays to the clinical environment. This allowed for the computerization (digitization) of the ECG. Digital acquisition of the ECG signal is important to reduce noise and artifact.[10] GE was the first to introduce a digital acquisition system and lead the way in developing sophisticated signal processing programs designed to improve ECG signal (waveform) quality. This processing is critical and helps to maximize the accuracy of computerized measurements, interpretation and waveform display.[11,12]

Bringing continued innovation to the ECG

GE was the first company to provide digital electrocardiographs, which simultaneously acquired and analyzed all 10 seconds of all 12 leads of ECG waveforms.[13] Introduced in 1982, this innovation had a profound impact on the industry.[14] GE continues its history of new innovations and raising the standards of clinical excellence. (See our Breakthrough Innovation timeline brochure, identifying advances in ECG devices, analysis programs, and system connectivity, along with the impact they had on the establishment of new clinical guidelines and ECG standards.)

ECG across the continuum of care

GE provides products and systems that incorporate digital ECG processing, in every patient care setting where the ECG is needed. Starting with out-of-hospital emergency care, GE's Marquette® 12SL™ program is implemented in ZOLL® and Medtronic LIFEPAK® pre-hospital defibrillators for recognition of acute coronary syndromes.[15] GE provides a complete set of diagnostic systems for resting ECG, stress testing, Holter, clinical patient monitoring, cardiac catheterization and electrophysiology (EP) testing, all of which include advanced analysis programs.[16,17,18]

Information management for effective, broad support

GE uses industry-standard networking to connect ECG acquisition systems. All ECG types, whether it be Holter, stress, resting, signal averaged ECG, vectorcardiogram, etc., can be sent to the MUSE® Cardiology Information System. In addition, ECGs acquired from bedside monitors and telemetry units can also be transmitted via the Unity Network®. This network can include a secure wireless capability to provide automatic routing of the ECG to the point-of-decision. Furthermore, the network has HL7 functions for accurate administration of patient demographics, orders, test results and billing-related information. GE's network connectivity has been reported to reduce errors, cost, and report turnaround time resulting in expedited patient care.[19,20]

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Although GE offers a solution for an Electronic Medical Record (EMR),[21] it also can provide the ECG to other third-party information systems, including the Veterans Administration (VA) Hospital Vista System.[22] GE has a long history of providing quality ECG data to enterprise-wide hospital information, or office-based systems.

GE also supports multiple standards for graphical reports, as in the portable document format (PDF), for the export of ECG data (via SCP-ECG, HL7, DICOM and XML) and the import of ECG data (via GE's Information Interchange program called I^2 or XML).

Streamlined workflow and real-time decision support

Throughout the continuum of care, GE provides real-time electrocardiograph-based applications that assist the user in obtaining high quality ECGs through tools, such as Marquette Hookup Advisor,™[23] and clinical decision support tools, such as ACI-TIPI, for chest pain patient management.[24] Additionally, with systems such as MUSE and Unity Network, real-time decision support has been implemented to automatically capture, identify, prioritize, compare, and route critical ECGs.[25]

Real-time decision support is most valuable when a sophisticated analysis program is combined with an information system. This combination facilitates a practical, streamlined workflow, and provides the decision maker with timely patient information to make appropriate medical decisions.

Arrhythmias and decision support

Major cardiac centers often store information about patient arrhythmias for the purpose of optimizing patient care decisions. These recordings of critical ECG events assist the electrophysiologist in making the most appropriate decisions regarding implant settings, ablation, or other forms of therapy.

Continuous ECG recordings from all bedside monitors or telemetry units are available via the Unity Network, and can be routed to an arrhythmia review workstation, known as MARS® (Multi-parameter Arrhythmia Review Station). At the MARS station, critical arrhythmias can be viewed, sorted and sent to the MUSE system for long-term storage.

Marquette EKPro™ is a program used for analyzing continuous ECG recordings from GE bedside monitors, telemetry units or Holter recorders. The Marquette EKPro program automatically labels the data and identifies significant arrhythmic episodes. In 2002, Marquette EKPro was enhanced to also analyze pulsatile data accompanying the ECG,[26] which "leads to a clinically significant reduction in the number of false positive heart rate alarms without reducing detection of serious arrhythmias."[27]

Atrial fibrillation is the most common arrhythmia that results in hospitalization in the United States. For this reason, the Marquette EKPro analysis program has been enhanced to include atrial fibrillation detection and trending in patient monitors. GE has developed advanced ECG processing techniques for the prediction,[28,29] detection[30,31,32] and quantification[33] of atrial fibrillation in many other care areas.

In addition to the detection, cataloging, and transmission of significant arrhythmias for decision support, GE is an industry-leading provider of automated measurements that have been correlated with Sudden Cardiac Death (SCD).

These measurements are generated from the following programs:

- Marquette 12SL ECG Analysis[34]
- Marquette Signal Averaged ECG (SAECG)[35]
- Marquette T-Wave Alternans (TWA) Analysis[36]
- Marquette Heart Rate Variability (HRV) spectral[37] and time domain[38,39]
- Marquette Heart Rate Turbulence (HRT) Analysis[40,41,42]

GE is also a provider of two analysis programs, TWA and HRT specifically used for the prediction of SCD.

GE is a leader in computerized ECG assessment of QT associated measurements, some of which have been correlated with the risk of SCD, such as QT dispersion[43,44] and principal component analysis (PCA).[45,46] To assist core ECG laboratories in the generation of more consistent, reproducible measurements, GE provided the first commercially available systems to offer high magnification, on-screen review and evaluation of QT/QTc measurements, using a digital editing tool which is supported by computer-assisted QT measurement analysis.[47,48]

Acute coronary syndromes and decision support

The correlation between superior clinical outcomes and time-to-treatment is well established for acute myocardial infarction (AMI), whether the treatment is via primary percutaneous transluminal coronary angioplasty (PTCA)[49] or a thrombolytic.[50] As compared to thrombolytic therapy, primary PTCA has been shown to lower cost[51] and shorten length-of-hospital-stay.[52] However, expediting patients through the emergency medical system (EMS) to a prepared cath lab takes more planning and is more complex.[53] As more community hospitals adopt this new treatment path,[54,55] a need exists for decision support to ensure that balloon dilation in the cath lab occurs within the ACC benchmark of 90 (±30) minutes once the patient enters the emergency medical system.[56]

The pre-cath ECG is the most common cited source of delay.[57,58] "There are numerous studies showing that the use of pre-hospital ECGs have been able to reduce door-to-balloon times."[59] By acquiring a pre-hospital ECG, admission and transport delays are reduced.[60,61] Studies also show that the ECG can be transmitted to the hospital before the patient arrives.[62,63,64,65]

Through the use of equipment with GE's Marquette 12SL program, it has been demonstrated that acquiring pre-hospital ECGs is easy to do,[66] significantly cuts total time-to-treatment,[67,68] and has "the potential to significantly increase the diagnostic accuracy in chest pain patients."[69] "Primary angioplasty programs employing pre-hospital 12-lead ECGs are reporting dramatic reductions in Emergency Department (ED) arrivals to reperfusion times. In particular, one hospital was able to cut its average time by more than 50%, from 87 minutes to only 40 minutes, with other case study programs either approaching or breaking through the 90-minute benchmark."[70]

Once the pre-hospital ECG is acquired by the MUSE system, GE's Marquette 12SL Serial Comparison program can identify significant changes in a patient's ECG history, including new left bundle branch block (LBBB),[71] an accepted indication for primary PTCA in the face of chest pain.[72]

The MUSE system can send a wireless electronic message, which includes the critical ECG, to the on-call cardiologist. Current and previous ECGs from the patient can be viewed on the physician's PDA.[73,74] This can be done automatically by the system, based on computerized recognition of an ST-elevated acute myocardial infarction (AMI),[75,76,77,78] or the emergency physician can manually request it to be sent to the cardiologist. Once confirmed by the cardiologist, the cath lab staff can be notified to prepare the cath lab for patient arrival.[79]

As the leading provider of cath lab monitoring equipment, GE offers the ability to continuously measure and trend the 12-lead ECG before, during, and after the cath lab intervention. These systems perform full 12-lead ST-segment analysis, and store all 12 leads for printing at a later time as specified in the latest AHA standard.[80] Continuous 12-lead trending can also be used to detect a failed thrombolysis and possibly prompt the decision as to whether or not rescue angioplasty is warranted.[81]

As GE Healthcare continues its leadership and expertise in providing assistance during difficult clinical care decisions, our understanding of disease at the molecular level is paving the path for breakthroughs that will transform healthcare. Working together, we'll help you to be better able to predict, diagnose, inform and treat.

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[19]PDAs, Bluetooth And Wi-Fi: Beaming Healthcare Into The Future Edited Transcript – Forum for Decisionmakers The U.S. Medicine Institute For Health Studies Washington, D.C. December 2, 2003 U.S. Medicine Institute for Health Studies 2021 L St. NW, Suite 400, Washington DC 20036: with following quote "Electrocardiograms are now wireless in our hospital. We were one of the first to adopt this. Once you roll the cart up to the patient, you actually download from the hospital system the name and a lot of the demographics, and immediately, once you've taken the electrocardiogram, it is up on what's known as the MUSE System, which can be directly visualized by our hospital system, and that can be visualized from home. We can call in and see those tracings and find out whether the patient is having an impending myocardial infarction or not. We can actually send by e-mail that ECG to this Pocket PC."

[20]Wake Forest University: Customer testimonial regarding HL7 and MUSE quote: Through an industry standard HIS interface from GE Medical Systems, Wake Forest University Baptist Medical Center has enhanced the flow of cardiology information between the Department of Cardiology and other points in the hospital. The results have been greatly improved efficiency, greater accuracy and easier billing."

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05-9599 3/05 Printed in U.S.A.