

## So, You want to buy an ECG Management System?

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Welcome to another “So, You want to” article, in this piece, we will examine some of the key areas of concern to look out for when you want to purchase an ECG Management System. Electrocardiogram (or ECG / EKG) is a non-invasive, fuss free (no restriction on diet or medications prior to the test, no usage of lotion, gel, oil, or powder etc), risk free procedure that records the electrical activity of the heart by placing electrodes on one’s chest, arms and legs. The electrical activity are reflected in forms of ‘waves’ which can be displayed on a paper graph or a monitor, enabling a trained clinician to evaluate the patient’s cardiac condition (e.g. if there are any irregular heart beats or rhythm and if there is any insufficiency of blood supply).

The value ECG brings when employed for early detection of cardiac condition is undisputed and the virtues of ECG are plentiful. From being a simple, safe, non-invasive procedure that is easily reproducible and requires no special preparation, ECG tests are not only quick to perform (takes an average of 5 to 10 minutes) but also generally very affordable due to its low cost, yet, the importance of ECG has not been replaced by newer diagnostic modalities. In fact, the resting 12 -lead ECG continues to be the most commonly utilized procedure for diagnosis of heart disease, often determining the next course of treatment procedure needed.

The usage of ECG as a diagnostic test is not limited to the cardiology department; rather, ECG has found its use in various clinical departments within a healthcare enterprise, from Catheter Labs, Surgery, Step-down Care to Observation wards and the Emergency Department etc ECG plays an important role in the grand scheme of modern healthcare.

### **ECG Management Systems (EMS)**

With the rapid adoption of computers based medical devices, it is of no surprise that ECGs are being digitized for ease of storage and retrieval, while there are several commercially available ECG Management Systems (EMS), existing offerings by commercial vendors bears several limitations that spans from proprietary hardware and software that results in “vendor lock-in”, resulting in expensive service and maintenance contracts, little or no update on clinical features/tools.

However, an effective implementation of an EMS in a hospital (or among several hospitals) can bring forth numerous benefits including a central repository of ECG studies for clinical research, cost savings from the reduction of the ECG Graph paper and radical improvements of clinical and operational workflow by ensuring availability and ease of access to patient's ECGs as they are processed, store and distribution electronically, this enables clinicians to access ECG data for comparison or at 'points of decision'.

### **The Lack of Standards**

In order for effective assessment of an EMS to take place, it is important to first understand the limitations of digital ECGs. Unlike medical images, there is no standardized format to enable true interoperability of ECG readings, while there are initiatives trying to develop an open standards (e.g. DICOM Waveform Standard, SCP-ECG and MFER) the progress has been slow (if any progress is made at all). Hence, true interoperability and exchange of ECG files between different providers of ECG carts and EMS are not possible (at least at this point in time).

While some EMS solution providers tried to circumvent the issue of non-interoperability by adopting 3rd party "Format Translator" \* to enable exchange of ECG files from different solution providers, the "translation" is not made available for all ECG carts available in the market, hence It is important that one takes this important factor into consideration during the evaluation of an EMS to ensure that the offered solution is able to receive ECG readings from most (if not all) of your healthcare facility's ECG carts (not only 12 lead ECGs but also Stress ECG and Holters) to prevent the need to replace these ECG carts, which can be a costly exercise.

**\*Note:** Please read the article MFER – "The next big WAVE in Standards" for a full introduction on the current workaround solutions available for ECG Management Systems.

### **Integration to Clinical Information Systems**

ECGs does not work alone, it serves as a procedure to detect the presence of cardiac anomalies and would be best consulted in conjunction with the patient's medical records, this would requires integration or interface to other Clinical Information System (CIS) and the two most 'interlinked' CIS that be the facility's Cardiovascular Information System (CVIS) and the Electronic Medical Records (EMR) although interfaces to other CIS may be required. In other to facilitate effective Integration and / or Interface, do ensure that the proposed EMS supports the following;

- **Single Sign-On (SSO)**, the ability for a user to login once to an Information System and gains access to multiple independent but related Information System without the need to login separately for each of them (this is assuming that the user has the appropriate access rights to the relevant Information Systems). This is an important feature from both a clinical and operational workflow perspective as it saves a clinician's time by automating the relevant logins and searching for the relevant patient's medical records.
- **Health Level Seven (HL7)** is an internationally adopted framework of standards that will facilitates the EMS in effective exchange, integration, sharing, and retrieval of electronic health information between the relevant CIS.

### Workflow Features enhancements

The implementation of a EMS should not be just a electronic repository replacing paper based ECGs but rather, the EMS should provide workflow and clinical features that can add value to a clinician's diagnosis, some of the common features that should be available in modern day EMS are;

- **Standardized Algorithm.**

Not only are there no standardized format for ECG files, there is also no standardized interpretive ECG analysis algorithm. ECG readings are effectively electrical activities of the heart and the signal acquired needs to be process by a mathematical algorithm before being presented as a 'Wave' format.

At this point in time, almost every single ECG cart manufacturer uses a different algorithm and this results in a situation where the 'look and layout' of ECGs produced by different ECG carts are somewhat different and this can cause some minor confusion for the clinicians if they perform ECG comparison (previous and current ECG readings) produced from different manufacturer's ECG carts. To resolve this issue, ensure that the EMS has the ability to reprocess all ECGs with a standard algorithm to achieve a uniform look and feel.

- **ECG Reporting Function**

The ECG readings send from the ECG carts usually includes a report generated by the ECG cart. Check that the EMS being offered allows clinicians to perform re-measurements (e.g. R-to-R interval) and the ability to edit / add comments into the reports if necessary. This serves as an avenue for a clinician to reassess the patient's condition should the need arise.

- **Serial Comparison.**

While this may seem to be a 'no-brainer', do remember to check that the proposed EMS has the ability to retrieve previous ECGs for comparison (what's the point of having access to historical ECG studies if you can't use them for comparison).

- **Web Based Access**

As mentioned previously in the article, ECGs are not confined to just the Cardiology department, hence it would be beneficial if the EMS can be launched from anywhere within the hospital's network from web-enabled PCs and not be confined to selected workstations. To achieve this, the best implementation would be the ability to access the EMS via the Web. Web-based application also brings forth several advantages from an IT management point of view (ease of deployment, maintenance and update).

- **DICOM Modality Worklist**

In a bid to improve workflow, some EMS solution providers adopted DICOM Modality Worklist or DMWL, a feature found in Picture Archival and Communication Systems (PACS) from the medical imaging informatics discipline. DMWL is invented to prevent manual data entry errors pertaining to patient demographics (e.g. MRN name, date of birth or gender etc). Proper identification of patient's demographics is important as any mistake may result in the relevant ECGs being rendered inaccessible due to 'mis-identification'.

What DMWL does is it retrieves the patient demographics from the Hospital Information System (HIS) or any chosen Information System that contains ECG order (registered before the ECG is performed) with the appropriate patient demographics and displays them or makes it searchable from the ECG cart before the ECG reading is acquired. This ensures that the ECG readings are 'tagged' with the correct patient demographics and prevents any chances of patient identification error.

### **Implementation of ECG in Telemedicine - Tele-ECG**

The cost effective, fuss free yet effective characteristics of ECG for early detection of cardiac condition has made it an extremely viable option to be implemented as part of a Telemedicine initiative (Tele-ECG) to serve remote-area populations where patients are unable to access qualified professionals to interpret the ECGs taken due to geographical locations or simply lack of qualified professionals to perform the diagnostic, even routine screening, condition assessment and monitoring can be achieved with ease .

The small file size of ECGs also eliminate the need for costing bandwidth, coupled with the availability of cost effective GPRS modems (or even utilizing the mobile phone as a GPRS modem), the implementation of Tele-ECG is made even easier. Other areas of possible Tele-ECG implementation includes ECG assessment from ambulances or homes as Holters can be fitted with a GPRS unit to enable real-time monitoring. These implementations will not only improve patient health through early and effective diagnosis but also lower cost of healthcare by simply bridging the gap of accessibility.

In order for Tele-ECG deployments to be successful, the main constituent would be the EMS, which serves to automates the processing, storage, and distribution of ECG data acquired from multiple sources across the enterprise while providing software tools to analyze, view, edit, and compare ECG records, as well as generate, manage, and distribute reports in various formats to meet specific needs.

## **Other Consideration**

For an effective implementation of an EMS solution, other aspects of the solution must also be considered. The first concerns that comes to mind is the technical aspects, the EMS must be available 24 hours a day, 7 days a week, this includes both the hardware (network equipment, Server) and availability of the network.

Another point to consider is 'cost savings', given that EMS are relatively 'simplistic' in nature and does not requires comprehensive customization (unlike other Clinical Information Systems), the return of investment for implementing an EMS as a state wide (or even on a national scale) maybe prove to be higher (after all, you only need to maintain and ensure 1 solution is in tip top condition).

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