

Multi-Vendor Solution for Reception and Review of ECGs to Shorten Treatment Delay in AMI Patients

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Abstract

To provide optimal pre-hospital acute myocardial infarct (AMI) care, a system has been developed to receive ECGs from (ambulance) defibrillators from different manufacturers, and from ECG equipment in other hospitals or community medical centers. ECGs are sent as FAX to a special network-FAX, which forwards the received FAX (ECG) as e-mail attachment to a dedicated mailbox on the LUMC Microsoft Exchange mail server. Cardiologists and CCU nurses can view these e-mail messages (and thus the ECGs) to determine patient's eligibility for primary PCI, based on predefined criteria. If necessary the cardiologist on-call can view the ECG either in or outside the LUMC by logging on to the LUMC mail system.

Between November 2004 and April 2005 ECGs from 209 patients (mean age: 62.3 yr, range 26-91 yr; 77.8% male) have been sent to the LUMC using this setup (136 ECGs from Medtronic defibrillators, 63 from Zoll defibrillators, 10 other).

1. Introduction

As advocated by the guidelines, the cornerstones of optimal pre-hospital acute myocardial infarct (AMI) care are: rapid diagnosis, early risk stratification, minimal treatment delay and aggressive reperfusion strategies.

Pre-hospital triage, thereby early AMI diagnosis, and rapid access to an intervention or community center can reduce the treatment delay significantly. Furthermore, primary percutaneous coronary intervention (PCI) or thrombolysis prevents unnecessary extension of the myocardial infarction.

All these aspects are incorporated in the pre-hospital MISSION! protocol as developed at the Leiden University Medical Center (LUMC) in the Netherlands. MISSION! has been designed to restructure and optimize regional AMI care, concentrating on early and aggressive reperfusion therapy, active life style improvement and implementation of guidelines.

MISSION! contains a pre-hospital, in-hospital, and

out-patient clinical framework for decision-making and treatment of patients with AMI. As MISSION! covers both the acute phase and chronic phase, all regional healthcare providers are actively involved in the MISSION! project. The Holland-Midden region has 750.000 inhabitants and covers an area of approximately 50 by 25 miles. Based on historical data, it is estimated that approximately 1000 patients within the area will suffer from AMI annually.

On the pre-hospital phase, in patients with acute chest pain, trained ambulance paramedics obtain a high quality 12-lead ECG in the field. If the ECG fulfils the positive identification criteria of the pre-hospital MISSION! protocol, the ECG is transmitted to the LUMC. Then, if the patient is eligible for PCI, the paramedics will immediately transfer the patient to the LUMC.

Before, ECGs were acquired by the ambulance personnel with the defibrillator and sent to the hospital (LUMC) by FAX. Problem was that the attending cardiologist (or the cardiologist on-call) could not easily review the received ECG while not near the receiving FAX system. Recently, a dedicated ECG receiving system has become available (Medtronic Lifenet System) but half of the ambulances in our region use other defibrillators than from Medtronic.

2. Methods

2.1. Technical aspects

We have developed a special system architecture which allows us to receive ECGs from (ambulance) defibrillators from different manufacturers, and from ECG equipment in other hospitals or community medical centers. ECGs from Medtronic defibrillators are sent to the Medtronic Lifenet RS Receiving Station installed at the LUMC. ECGs from other defibrillators (mostly Zoll) are sent as FAX to a special network-FAX. This network-FAX prints the ECG and then forwards the received FAX (ECG) as e-mail attachment to a dedicated mailbox on the LUMC Microsoft Exchange mail server (see figure 1). Cardiologists and CCU nurses are all authorized to view these e-mail messages (and thus the ECGs) (see figure 2).

The Medtronic Lifenet RS system also forwards incoming ECGs as FAX to the network-FAX, which then forwards the ECG again to the CCU-FAX mailbox. This way, all incoming ECGs from all modalities are available in the CCU-FAX mailbox. ECGs received via the Medtronic

Lifenet system are sent to the Draeger Megacare ECG management system, this way completing the patient's EPR with pre-hospital data. Of course this is only applicable if the patient is admitted to the LUMC.

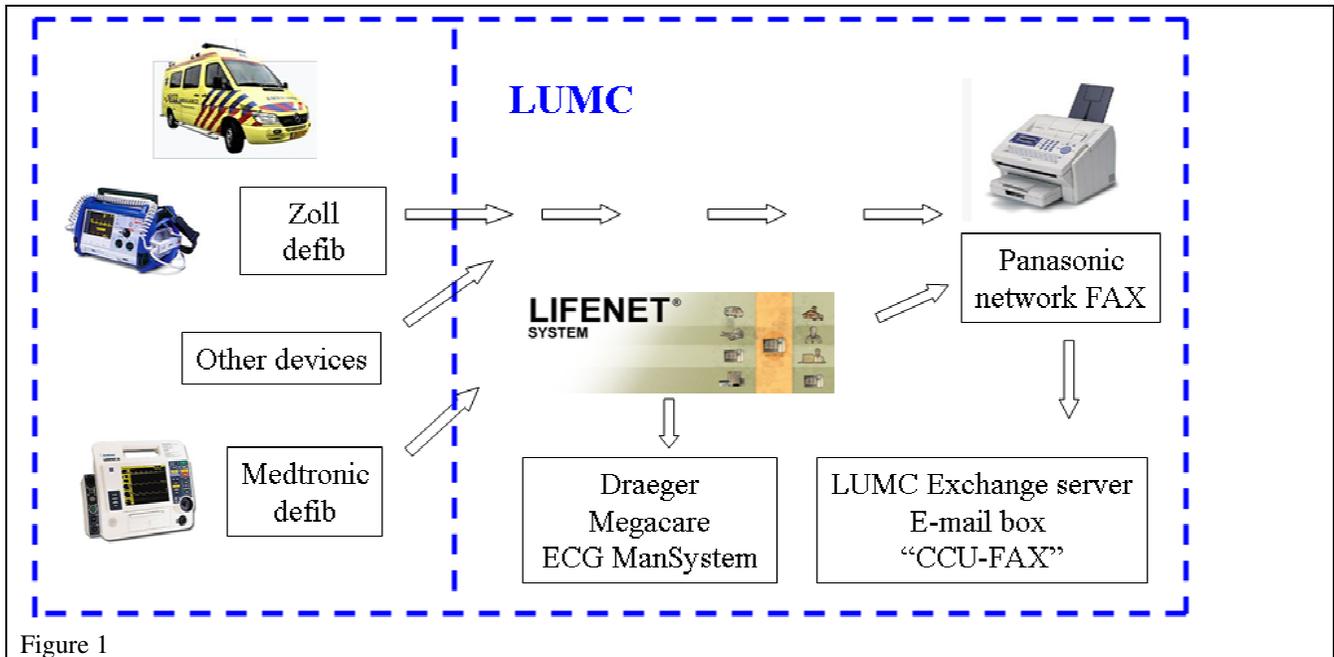


Figure 1

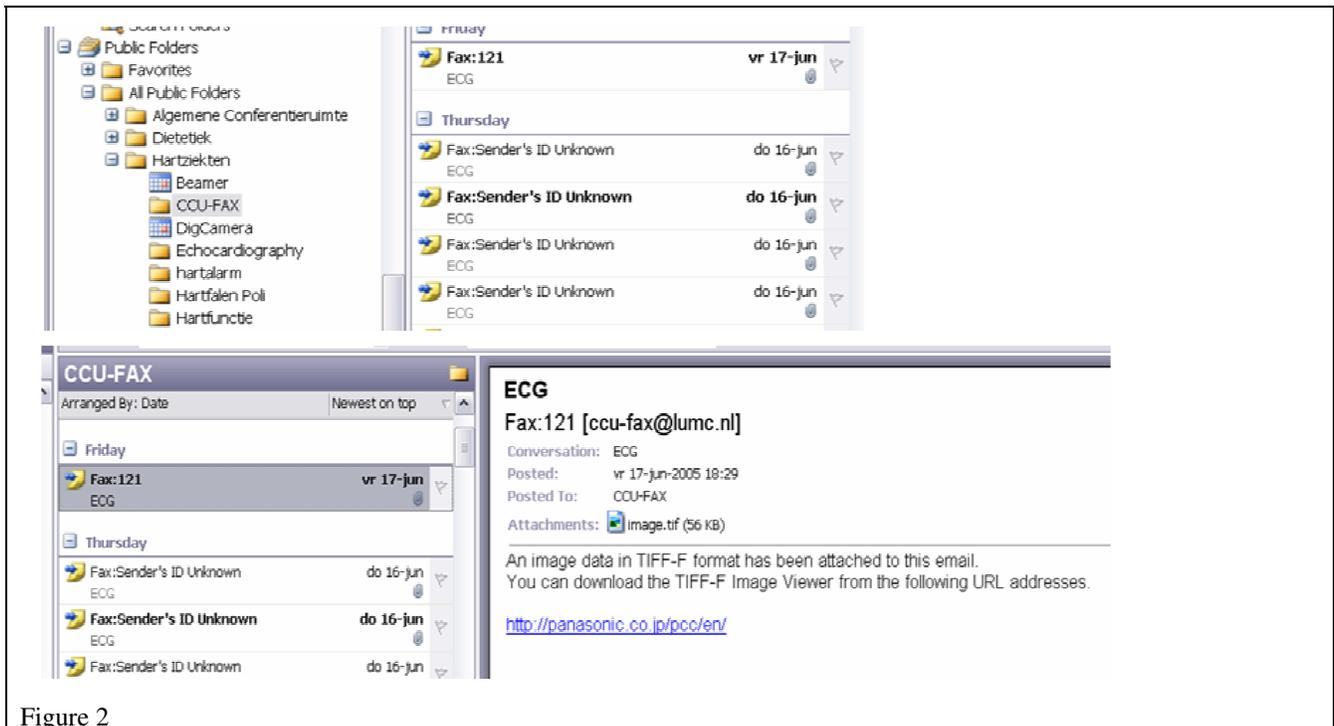


Figure 2

2.2. Clinical aspects

CCU nurses review the ECG to determine patient's eligibility for primary PTCA, based on predefined criteria. If necessary the cardiologist on-call can view the ECG either in or outside the LUMC by logging on to the LUMC mail system. If the patient is eligible for PCI, the ambulance paramedics administer antiplatelet agents (clopidogrel and aspirin) intravenously and transfer the patient directly to the LUMC. The CCU will be prepared and the catheterization staff will be informed.

If the ECG does not fulfill the criteria for primary PCI, but the patient is a candidate for thrombolysis, pre-hospital triage for in-hospital thrombolysis will be performed. These patients also receive antiplatelet agents intravenously. The patient is then directly transferred to the nearest hospital to receive thrombolysis therapy. Because the distance to the nearest hospital never exceeds 15 kilometers, in-hospital thrombolysis is preferred over pre-hospital thrombolysis.

3. Results

The clinical MISSION! project has started in February 2004, while the CCU-FAX solution was established in November 2004.

3.1. Technical results

Between November 2004 and April 2005 ECGs from 209 patients (mean age: 62.3 yr, range 26-91 yr; 77.8% male) have been sent to the LUMC using this setup (136 ECGs from Medtronic defibrillators, 63 from Zoll defibrillators, 10 other). Of these 209 patients, 51 were sent to the LUMC for primary intervention; 48 did receive primary PCI (one received thrombolysis, 2 patients had no culprit).

3.2. Clinical results

From February 2004 to March 2005, 236 patients (77% male, 60 ± 12 year) have been included in the clinical and post-clinical MISSION! protocol. Four patients died during in-hospital stay. In 69% of the patients discharge was within 3 days (3.7 ± 2.5 days). PCI was performed in 97% of the patients.

Table 1 shows the outcome in 69 MISSION! patients, compared to 167 patients that were treated before the implementation of the MISSION! protocol. Both the time from onset symptoms to the first ECG, as well as the time

from arrival at the hospital to first balloon inflation has decreased significantly.

	Before implementation N=167	After implementation N=69	P-value
Start symptoms–first ECG	131±93 min	96 ± 93 min	<0.05
Arrival hospital-balloon	100 ± 35 min	56 ± 17 min	<0.01

Table 1. Clinical outcomes

4. Discussion and conclusions

The multi-vendor solution described above allows nurses and cardiologists to access ECGs sent to the LUMC in an unambiguous way, irrespective of the device that has sent the ECG. It allows access for authorized personnel to the ECGs from any location.

The initial results of the MISSION! project demonstrate that implementation of MISSION! stimulates adherence to evidence-based therapy for AMI patients. Pre-hospital triage reduces treatment delay significantly. Regular monitoring and adjustment of treatment during follow-up is of major importance to further optimize AMI care.

4.1. Present status

As of September 1, 2005 all ambulances in the Midden-Holland region are equipped with Medtronic Lifepak-12 defibrillators. This means that all incoming ECGs (from ambulances) can be received with the Medtronic Lifenet system. However, the the CCU-FAX e-mail solution will be continued, because it provides a reliable solution to make the ECGs available for cardiologists from any location in or outside the hospital.

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