Information System for Assessing Health Care in Acute Myocardial Infarction

Alessandro Taddei, Umberto Paradossi, Emiliano Rocca, Tiziano Carducci, Maurizio Mangione, Stefano Dalmiani, Elaine Laws, Marina Marchi, Barbara Badiali, Sergio Berti

G.Pasquinucci Heart Hospital, G.Monasterio CNR/Tuscany Region Foundation, CNR Institute of Clinical Physiology, Massa, Italy

Abstract

A network system was organized in our region for quick diagnosis of ST-elevation myocardial infarction (STEMI) patients and their transfer to specialized center for primary percutaneous coronary intervention. A clinical data repository, integrated with the Hospital Information System, was set up, recording door-to-balloon times (since emergency call to angioplasty) and follow-up information in addition to any patient clinical or interventional data. Gold standard of DTB≤90 min was assessed in 45% of patients. The developed repository was useful for evaluating care pathways in STEMI patients, assessing the correlation between DTB times and outcome and driving the improvement of health-care delivery.

1. Introduction

The benefit of prompt expertly performed primary Percutaneous Coronary Intervention (PCI) for Acute ST elevation Myocardial Infarction (STEMI) is well established [1-2]. A network was organized since 2006, according to Hub & Spoke model, for care of STEMI patients in the northwest of Tuscany (1300 km^2), involving 5 Spoke and 1 Hub centers, 1 medical helicopter, 6 advanced life support ambulances with direct transmission of the ECG and the vital parameters to the cath lab of the Heart Hospital in Massa (the Hub), on call 24h a day for primary PCI (Figure 1) [3]. Delay in starting the reperfusion therapy (from symptoms to emergency call, by patient transfer and to admission and treatment in cath lab) affects the clinical outcome (Figure 2). Efforts are needed to limit this delay, first by patient education campaigns aimed at prompt identification of symptoms and secondly improving health-care efficiency at both extra- and intra-hospital pathways.

Figure 1. Orographic complexity of territory (400.000 inhabitants) 60% mountains and scattered small towns

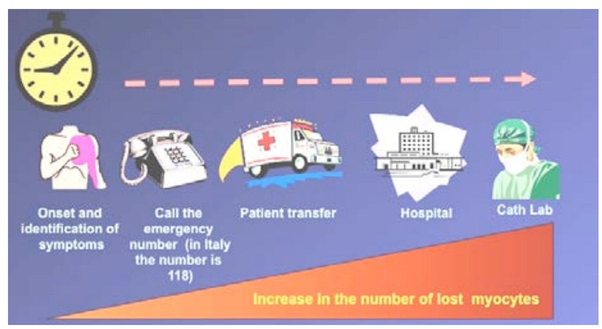

Figure 2. Typical steps in STEMI patient care (delay in starting reperfusion therapy).

The Acute Myocardial Infarction (AMI) repository was developed to document STEMI patients allowing evaluation of care delivery by analysis of door-to-balloon (DtB) time (i.e. since emergency call until angioplasty) versus mortality. That was integrated with the Hospital Information System (HIS), based on administrative and clinical levels of data archiving and on two modalities for data exchange (middleware data integration into the clinical database ARCA and Web distribution of health care information) [4-5] (Figure 3).

2. Methods

The AMI repository dataset, defined by cardiology staff, consists of 219 features (of which 141 structured and 78 free text format) related to patient anamnesis and clinical conditions before and during hospitalization, to coronary angiography and Percutaneous Transluminal Coronary Angioplasty (PTCA), post- PTCA, hospital discharge. Times related to onset of symptoms, EMS call, first ECG, hospital call, cath lab arrival and balloon inflation are recorded for each case for DtB analysis. Follow-up information is also recorded.

This repository, by integration with the HIS database (Oracle RDBMS), was able to import any patient information which was already recorded in the electronic medical record, currently applied for all health care activities at our hospital, from diagnostic, intervention and operation reports to in-patient and out-patient records.

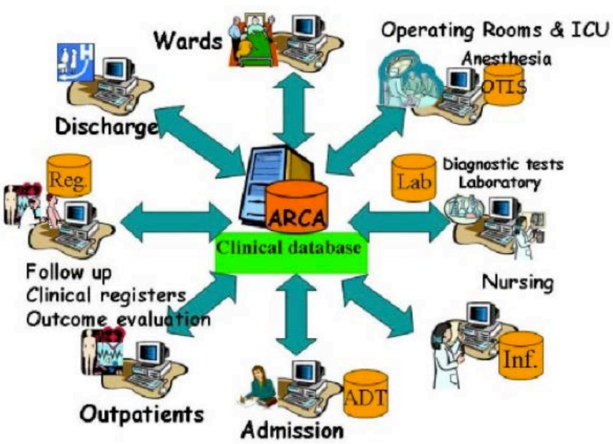

Figure 3. HIS: patient data flows.

For collecting data the information framework, called "Matrix" (previously reported by some of authors at CinC) [5], was applied. That is based on Dynamic Dataset Definition allowing rapid system deployment due to its capability of building a graphical interface directly related to a definition of collectable data. It is sufficient to initialize the system with a minimal data-set, even not yet

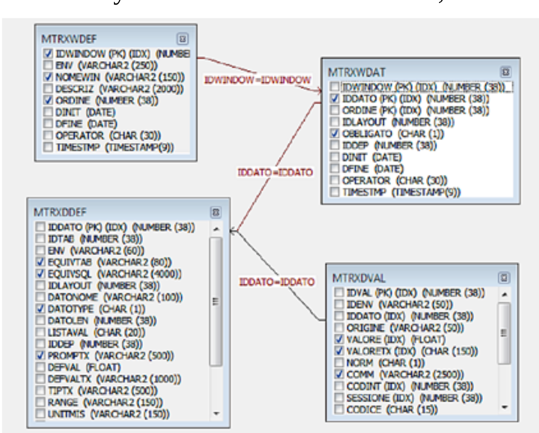

Figure 4. Meta-data tables: GUI windows, feature dataset and data records (MTRXW*DEF, DAT, DDEF, DVAL*).

completely established, and let to successive steps to refine detailed information during clinical use. This system, developed in Java language, was designed for allowing direct integration, through JDBC protocol, with HIS database to achieve automatic retrieval of source data, typically from medical record or clinical reports. Thus any patient information related to hospital care process is retrieved facilitating repository data entry.

Meta-data tables (Figure 4), overriding the limited number of columns in a normal relational approach, were used for definition of the dataset features, in terms of data type (from floating point to free text), data description, default value and graphical aspect, input policy (optional, mandatory) or update permission (read only, user locked, free). External data sources and related SQL queries were specified for retrieving from HIS database patient-related information, i.e. patient's medical history, clinical conditions, diagnostic reports, coronary angioplasty as well as DTB times (Figure 5).

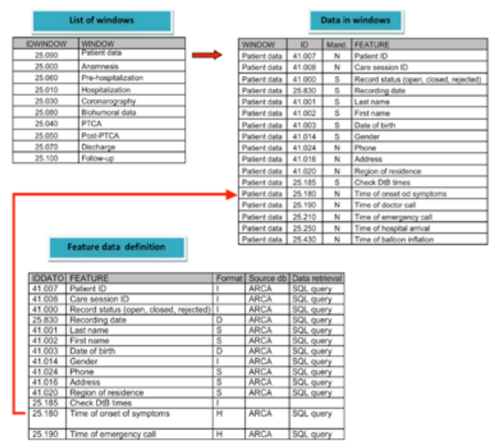

Figure 5. List of GUI windows and corresponding features (optionally retrieved by SQL queries).

Each time a new STEMI patient arrived to the hospital on emergency call and was treated by primary PCI, he was enrolled by cath lab nurses into the repository, recording DtB times and automatically advising by email

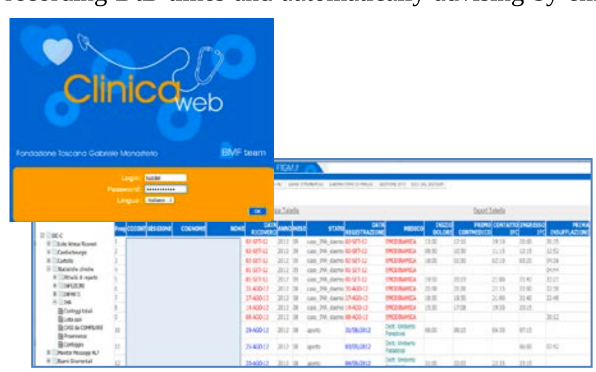

Figure 6. Web list of enrolled STEMI patients (those waiting for data entry are pointed out in red).

the cardiac team charged of data entry. List of enrolled patients (with dates of hospital admission) is made available by BioMedical Framework (BMF), allowing secure and reserved web access to all health-care information [6] (Figure 6).

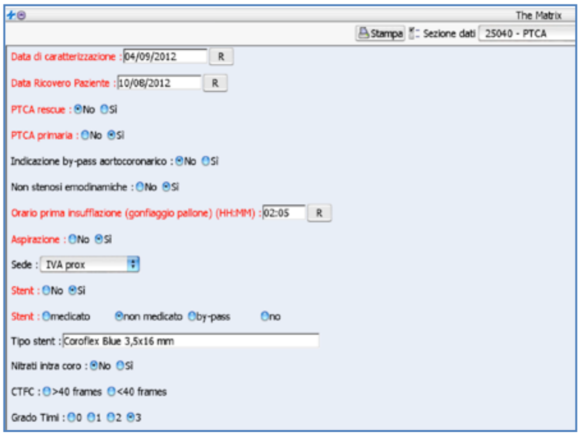

Figure 7. PCI information window, including the time of balloon inflation (SQL-retrieved from cath lab) (obligatory data are pointed out in red).

First step in AMI repository data entry is the access to the medical record corresponding to the enrolled STEMI patient. Next, Matrix graphical interface module is accessed where dataset features are grouped into a number of graphical windows, from patient identification data to anamnesis, PTCA and follow-up (Figure 5). A part of data, which are SQL-retrieved at login from HIS database, are represented in the window (e.g. the time of balloon inflation and patient admission date in Figure 7) while the others can be entered manually by cardiologist. A number of features were defined "mandatory" to achieve a comprehensive clinical repository for both outcome evaluation and statistical analysis.

Follow-up (at 30 days and 1 year after AMI episode) for mortality and morbidity assessment was first achieved checking if patient was again visited or cared (retrieving care sessions from HIS database) and eventually calling patients at home using the web list of STEMI records as a reference (Figure 6).

When full data entry or update was achieved the record was closed and declared ready for statistical analysis.

3. Results

Up to June 2012, 1422 STEMI patients, cared by primary PCI, were enrolled. Overall statistics are: 65 years age, male 73%, 32% from mountain, 20% with diabetes mellitus, 25% with Ejection Fraction < 40% pre-PCI, 26% with multivessel disease, 16% TIMI score <2 post-PCI, 6% with shock. In-hospital mortality was 4.1% while differences are observed between patients arriving from coast and from mountain region (3,5% versus 5,7%). According to follow-up, mortality was assessed 4.8% at 30 days and 8.2% at one year.

Average DtB was 95 min (91 for coast and 121 for mountain). Gold standard of DtB≤ 90 min was reached in 45% of patients (in 84% of patients from coast and in 21% from mountain). Mortality was associated with longer DtB as compared to alive patients (123 vs 95 min, $p<0.0001$) (Figure 8). Patients from coast had DtB lower than those from mountains and rate of mortality was significantly different. Risk of mortality was correlated with increase in DtB in all patients.

Improvement in DTB since 2008 was evident (Figure 9).

Figure 8. In-hospital mortality and Door-to-Balloon (from mountain to coast).

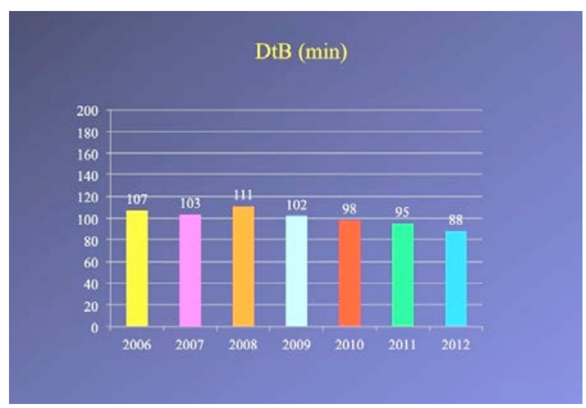

Figure 9. DtB delay is improving during the years.

4. Discussion and conclusions

The developed system for comprehensive AMI data collection, archiving and processing was useful for evaluating care pathways in STEMI patients. Integration with existing clinical database (medical records and reports) was crucial to achieve easy and reliable data

entry from cardiology staff into the AMI registry. On the other hand Matrix framework facilitated project development achieving a scalable system.
DtB was controlled to assess the quality of care, according to standards. Efforts to reduce the avoidable delay in STEMI patients for primary PTCA in our cath lab had good results (average 88 min DtB in the last year). Current goal is to achieve a DtB time <= 90 min for at least 75% of cases. Actually results from efforts for a rapid triage, transfer and treatment can be insufficient without patient education, aimed at reducing the time from onset of symptoms to the EMS call. That is the case of patient transferred and cared promptly (even down to 68 min DtB) but suffering by ischemic time of 178 min .
Future challenge in health-care of AMI will be symptom-to-balloon time less than 90 min through adequate patient educational campaigns, promoted by health-care and government associations.

Acknowledgements

We thank our colleagues of Information Technology and of Cath Lab and Cardiology teams for help, suggestions and advices.

Reference

[1] ACC/AHA Guidelines for the Management of Patients With ST-Elevation Myocardial Infarction J Am Coll Cardiol 2004; 44: 671-719

[2] Ting HH, Rihal CS et al. Regional systems of care to optimize timeliness of reperfusion therapy for ST-elevation myocardial infarction: the Mayo Clinic STEMI Protocol. Circulation 2007; 116(7):729-36.

[3] Paradossi U, Palmieri C, Trianni G et al. Tempo door-to-balloon e mortalità intraospedaliera nel paziente con IMA con sopraslivellamento del tratto ST: esperienza di una rete integrata in una provincia dell'area noed-ovest della Toscana. G Ital Cardiol 2010; 11: 386-392.

[4] Taddei A, Dalmiani S, Vellani A et al. Data integration in cardiac surgery health care institution: experience at G. Pasquinucci Heart Hospital". Computers in Cardiology 2008; 35: 287-290. IEEE.

[5] Taddei A, Mangione M, Marcheschi P, Dalmiani S. Data Integration and Management in Cardiac Surgery, Perioperative Considerations in Cardiac Surgery, Cuneyt Narin (Ed.) 2012, ISBN: 978-953-51-0147-5, InTech. (http://www.intechopen.com/books/).

[6] Dalmiani S, Taddei A, Glauber M, Emdin M. An informative system for structured data management to build a cardiological multidimensional database. Computers in Cardiology 2002; 29: 369-372.

[7] Mangione M, Alberini G "BMF Bio Medical Framework un sw opensource per applicazioni e-health", 2004 CNR-FTGM (http://www.edisef.it/informatica-medica-parte-ii).

Address for correspondence

Alessandro Taddei
National Research Council
G.Monasterio CNR-Tuscany Region Foundation
G.Pasquinucci Heart Hospital
Via Aurelia Sud
54100 Massa, Italy
taddei@ftgm.it