Cardiac Surgery and Cardiological Data Integration between Remote Structures

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Abstract

Patient data exchange between remote cardiology and cardiac surgery may represent a real problem in everyday patient care. This study was aimed to assess database connectivity in a cardiology department with a remote cardiac surgery, to explore possibilities of technology standards and to establish a background for developments in teleconsulting. Digital Imaging and Communication protocol (DICOM) and HL7 standard were adopted. Data from cardiology were dispatched to surgeons by an internet connection. For patients undergoing surgery, information coming from the surgical department could be reviewed by cardiologists for subsequent follow up. This approach allows rapid consultation and exchange of structured data and images between cardiologists and surgeons even in remote sites; this model improves clinical care by reducing geographical barriers between physician practicing in distant structures.

1. Introduction

A modern cardiology department has almost everyday relation with the heart surgery referral center. However, the two departments may be remote, being sometimes in different geographical areas.

For this reason, management of patient data may be difficult and time consuming. In this respect, informative systems which manage clinical records allowing interchange of structured data and images as well as cineloops may provide a significant improvement in overall patient management. This is particularly true in those situations requiring rapid information exchange between cardiologists and surgeons when textual data, as well as images coming from different laboratories or cine loops from the echocardiographic or the cardiac catheterization laboratory must be rapidly dispatched.

High speed telemedicine links can offer a real time interactive assessment of clinical cases by specialists from both sides, supporting and mentoring one another on appropriate treatments and decision making. [1-4]

Aim of this study was to evaluate the connectivity of databases between a cardiology department and its remote (more than 50 Km) cardiac surgery referral center, as well as to analyze the possibilities offered by updated technology standards and to establish a background for future developments in teleconsulting.

2. Methods

The clinical process underlying patient evaluation and clinical care can be subdivided into several steps, each of them generically managed by a single informative system interconnected to form the HIS (Hospital Information System).

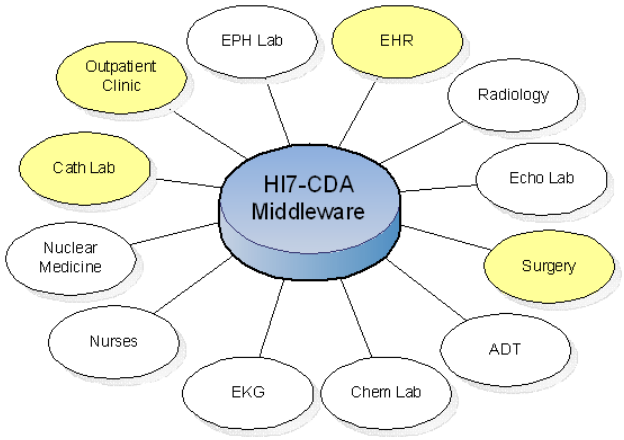

Figure 1. Extension of HIS with colored connected instrumental laboratories involved in this project.

Pre existing standards such as Digital imaging and communication protocol (DICOM) and Health-Level 7 (HL7) were adopted in order to use already established infrastructures and to reduce the technological efforts of proprietary communication protocols [5-8]

Following a functional model of patient data treatment, we built a sequence of interactions among informative subsystems.

In the outpatient setting, patient admission was managed by the ADT (Administrative) system which stored all demographic data, and followed by a clinical patient evaluation managed by EMR (Electronic Medical

Record) System allowing a first analysis of patient clinical status. All collected information were merged into an overall EMR in order to build a comprehensive view of patient data suitable for other specialistic evaluations.

In the ward setting, data gathered directly, or coming from a previous out- or in-patient EMR characterization were used to build or update the clinical charts suitable for further assessment.

For physicians interaction, the different types of informative systems must be connected in order to build a coherent clinical view of patient records, thus a standard protocol adoption is mandatory. HL7 and DICOM protocols provide standards for exchange, management and integration of data supporting patient care and management, delivery and evaluation of healthcare services.

The most important instrumental aspect of interface between cardiologists and cardiac surgeons is represented by the exchange of images and cineloops acquired during a standard procedure in the cardiac catheterization laboratory; this is due to the fact that surgeon consultation for coronary artery disease treatment represents the most frequent request from the cardiological department.

To support communication between specialists, a consultation system was developed, able to transfer coronary angiographic images and cineloops from the cardiac catheterization laboratory to the remote surgical unit [9].

The core of this system is represented by a computer acting as broker for data exchange. Every diagnostic modality using the DICOM standard is enabled to send toward a DICOM Server a selection of images or cine-loops. This modality also provides the opportunity to transfer material for consultation in a way that the single diagnostic modality can recognize a normal DICOM server on the net. The DICOM broker may send images and cineloops to multiple receiving workstations; therefore, once the images are received, the program can extract the necessary information to start transfer even to multiple teleconsulting nodes.

To respect data privacy one of the following transmission methods should be adopted: DICOM TLS (Transfer Layer Security) Transmission or Secure transmission through an S-Tunnel connection; however, the crypt transmission introduces a well evident communication deceleration so that its application in emergency cases on slow network connection is not recommended.

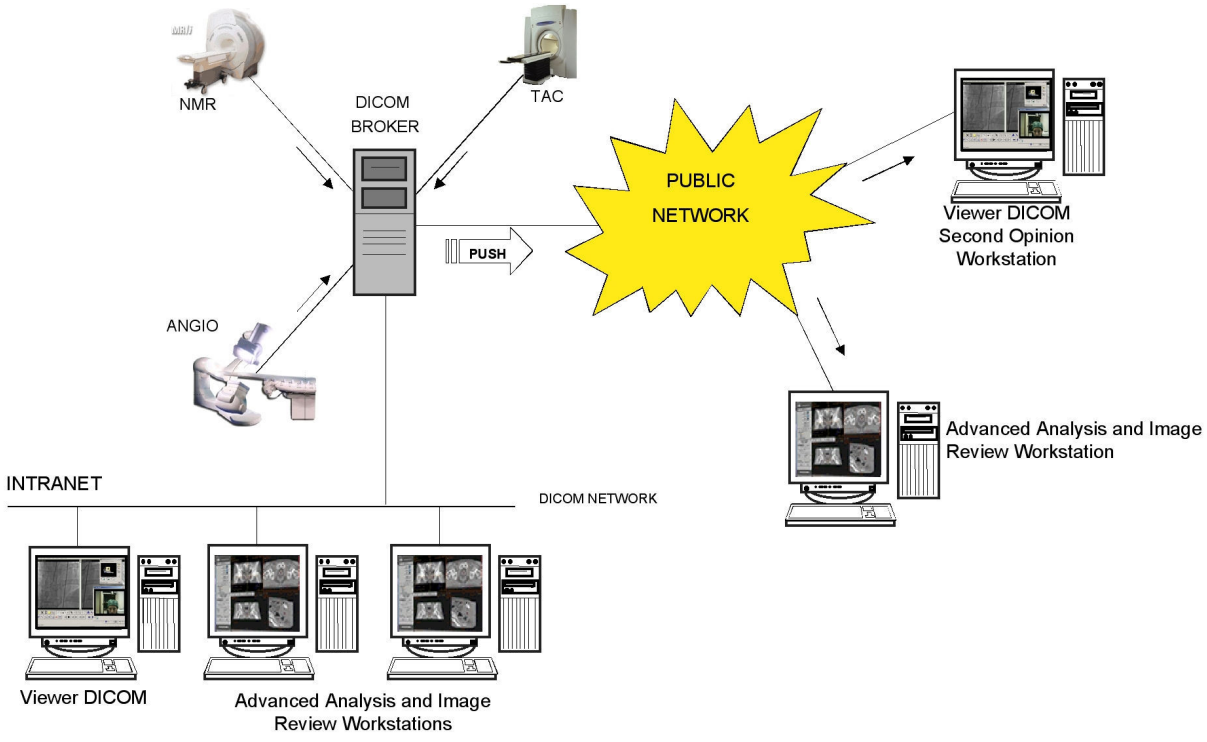

Figure 2. System architecture

3. Results

In the last 6 months more than 100 clinical cases have been treated with this system. Most of the cases were represented by inpatients performing coronary angiography during hospital stay for coronary artery disease.

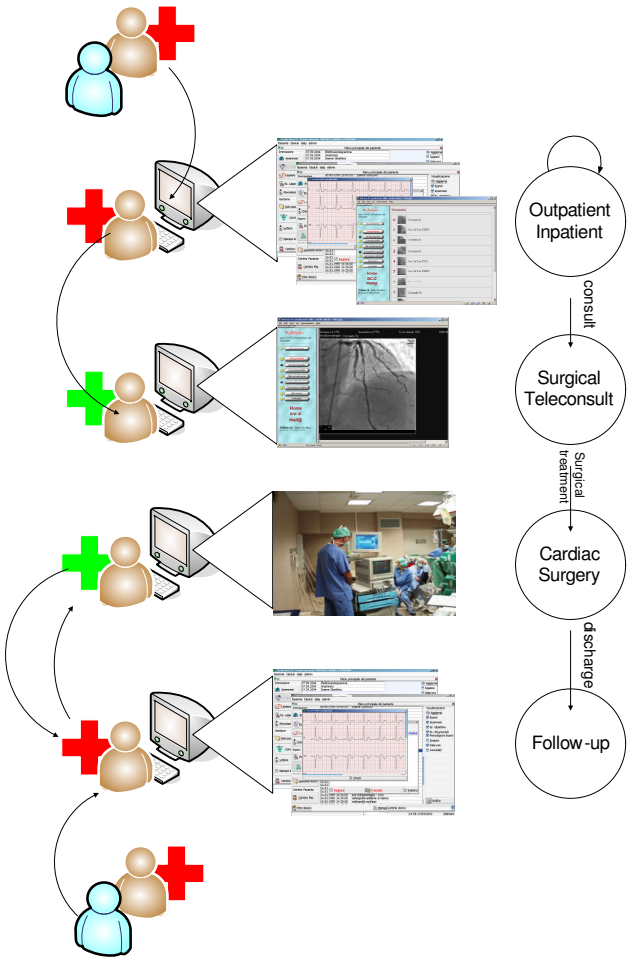

Figure 3. Example of physicians-surgeons interaction

When all the needed clinical data and instrumental examination results (coming from the radiology, the cardiac catheterization laboratory, the echocardiographic and – for a subset of patients - from the nuclear medicine and the magnetic resonance imaging laboratories) were available, the file could be opened through a password based access by the surgeon working in the remote structure.

The surgeons were therefore able to overview all clinical and instrumental data available in the EMR for remote patient assessment. An interaction between cardiologists and surgeons through the EMR was also possible which showed to provide easy, rapid and unequivocal consultations on both sides, when compared to the commonly used approach by telephone or telecopier.

In turn, after surgery was performed, all data relative to the surgical procedure, to the anesthesiological charts and to the post operative in-hospital course together with instrumental examination reports, could be sent from the cardiac surgery unit to the cardiology department for re-evaluation and case discussion.

All clinical data, signals and images collected in both departments, could be rapidly reviewed also on outpatient basis by surgeons and/or cardiologists deputed to patient follow up.

During follow up examinations, all records gathered from cardiology, cardiac surgery and other specialistic outpatient clinics inside our Institution, as well as from in-hospital course in the CNR Clinical Physiology wards, could be stored in the central repository. This data storage allowed the continuous update of a single longitudinal EMR in order to provide an overall continuity of care through years.

4. Discussion and conclusions

The rapid growth of information and communication technology has sped innovation of clinical information systems. Health-Level (HL) 7 message semantics allows effective functional implementation of Electronic Medical Record (EMR)-encompassing both clinical and administrative information-interchange systems.

The DICOM Standard provides support for the exchange of information on interchange media. Independence from the underlying network infrastructure allows DICOM to be deployed in many functional areas of application. Therefore, DICOM standard application in this specific environment resulted mandatory.

One of the features of DICOM standard is represented by its evolution while achieving new improvements. For example, it is already available, as a DICOM supplement, the new compression standard JPEG 2000 that permits high lossy compression ratios, while preserving clinical details. This approach can be very useful in order to achieve better results in teleconsulting without an increase in bandwidth requirements.

The approach we adopted allows interaction between cardiologists and cardiac surgeons working in remote sites, providing rapid consultation and exchange of structured clinical and demographic data as well as images and cineloops.

This interaction model seems able to improve the quality of care of cardiological patients contributing to reduce the possible geographical barriers of doctors and surgeons working in remote structures.

References

[1] Taddei A, Dalmiani S, Cecchetti G, Macerata A Carpeggiani C, Chelozzi C, Marchesi C: C3: Java-based Medical Record System for Cardiology. Medical Informatics Europe 99; P Kokol et al Eds, IOS press 1999

[2] Morales MA, Dalmiani S, Carpeggiani C, Macerata A , Ghione S. Electronic Medical Records in a Cardiological Outpatient Clinic IEEE Transactions 2002.

[3] Vahl CF, Tochtermann U, Gams E, Hagl S. Efficiency of a computer network in the administrative and medical field of cardiac surgery. Concept of and experience with a departmental system. Eur .J Cardiothorac Surg. 1990;4(12):632-8

[4] Bonvini RF, Caoduro L, Menafoglio A, Calanca L, von Segesser L, Gallino A. Telemedicine for cardiac surgery candidates. Eur J Cardiothorac Surg. 2002 Sep;22(3):377-80.

[5] HL7 Reference Information Model (RIM) and the HL7 Version 3 Meta-Model for the Message Development Framework.http://www.hl7.org/library/data-model/index.cfm

[6] Dolin Robert H, MD, Alschuler Liora, Beebe Calvin, et al.: The HL7 Clinical Document Architecture American Medical Informatics Association J Am Med Inform Assoc. 2001 November; 8 (6): 552–569

[7] Schadow G, Fohring U, Tolxdorff T- Implementring HL7: from the standard's specification to production application. Meth Inf Med 37(1) 1998: 119-23

[8] DICOM official website, Available at http://www.nema.org/. Accessed Sept 2003.

[9] Mazzarisi A, Marraccini P, Marcheschi P, et al.: Fully Integrated Hemodynamic Interventional Laboratory Informative System. Computers in Cardiology 2003;30:403-406

[10] Kocsis, O, Costaridou L, Mandellos G, Lymberopoulos D, Panayiotakis, G. Compression Assessment based on medical image quality concepts using computer-generated test images. Computer Methods and Programs in Biomedicine Volume: 71, Issue: 2, June, 2003;105-115.

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