Information Systems for Health Care E-Government

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***Abstract*—This article discusses some aspects related to e-government with focus on health-care, describing Health-care Information System (HIS) involving- administrative services, medical staff and patients. Issues such as Quality of service provided and Privacy of data inaccordance with enforced laws/norms and international standards are also covered.**

Modern hospital in-houses different tightly integrated technologies, where HIS is a key member. HIS permits access to electronic medical record indicating the diagnostics and therapies, which helps the administration to determine the medical expenses and also the government for financial analysis.

Care has been taken to reproduce the normal work behavior while interacting with HIS.

1. INTRODUCTION

Last two decades witnessed an intensification of medical treatments accompanied by a reduction in the period of hospitalization as a method of care for patients.

These calls for upgrading the current healthcare structures incorporating either latest technological infrastructures or highly efficient ones, wherein the healthcare requirement should be conceived in a rational way since the inception of their project.

The practice of cutting down treatment time was with the sole aim to reducing medical expenses. But, at the same time, it augments the complexity of treatments prescribed. The consequence of that is a more technologically equipped healthcare structure, more and more integrated in all its functions. From structural point of view, Modern hospital in-houses different technologies, which are tightly integrated [SEL 90].

Information required for the formulation of a diagnosis or a therapy for the patient are assuming more and more relevance, and immediate exchange of the same within the healthcare structure is of fundamental importance. Within this framework, it is possible to formulate a first definition of Hospital Information System: a system for collecting, analyzing, storing, and retrieving all information connected to patient's management.

This has also allowed the medical personnel to file information in a more structured way, to resubmit them in a more useful format to the concerned persons, irrespective to time and location of information. Since all information filed is immediately available for consultation, all problems linked to the use of paper-based patients' folders are eliminated. The patient's folder represents a central element of HIS where all information related to the patient is integrated for his/her optimal diagnosis and treatment.

1.1. Hospital Information Systems

Hospital Information System is aimed at managing all the information needed for functioning of various aspects of a hospital. Information systems have a well coordinated for collection, management, presentation and exchange of information. At present there exist three healthcare information systems: *Hospital Information System* (*HIS*), *Radiological Information System* (*RIS*), and *Picture Archive and Communication System* (*PACS*).

Various connections have been designed among these three systems:

1) These three systems are fully independent even if they are able to exchange between each others series of data;
2) RIS is a HIS sub-system;
3) Due to its prevailing vocation in images management, PACS is an independent system (but these does exists a data inter-exchange);
4) PACS and RIS are integrated inside HIS.

Considering information contents managed by the system, it can be affirmed that there exist three main series of data: patients-related data, activities-related data, and resources-related data [ORO92]. This information is used for several purposes, such as: assistance to the medical and administrative personnel in carrying out their daily activities, planning activities of the organization, analysis of the work carried out, and acquisition of more aggregated information.

Currently available information and communication technologies enable the integration of information and services into a single structure irrespective of its physical location in the network for the completion of their tasks.

The modern Hospital Information System is designed on the basis of existing medical infrastructure which is, either facilitating equipment for diagnosis or organizing of activities or an integrated system enabling filing, consultation, sharing of information regarding patient's management. Thanks to the facilities offered by the urban and extra urban communication networks as this integration process can be extended beyond a

single hospital, thereby optimizing patients mobility, medical, and administrative data exchanges.
Hence, an information system for healthcare applications should comprise:

1) Archiving and analysis of patient's data;
2) Procedures for protection of recorded data.

The management of data must conform to the existing legal provisions enforced in the medical field and also to the recommendations spelled at the international level, thereby guaranteeing data protection and data confidentiality. Moreover, data should be protected from destruction and deterioration.

2. DESIGNING A HIS

The design of an information system consists of managing resources, methods, defining interaction between these entities. HIS project in its first phase involves collecting fundamental specification: data of interest, their quality, their rate of increment, methods to automate the procedures, and the performance requested. Then the structure of information system have to be built followed by an access point for its location.
From a general point of view, HIS have to be built on:

- a distributed hardware system and a communication system
- a distributed relational database.

Organizing the Hospital, the procedures actuated by several Operation Units and the integration of procedures constitutes the preliminary information needed for projecting HIS database.
The definition of information, their correlations, the definition of access points and the lists of people enabled for handling is the first phase of HIS project. That information represents the most critical point of the project: errors during this phase can lead to undesirable long-term effects. To assert a correct and well-ordered database in HIS are:

- Specification (Analysis of requisites): where requisite information is collected for the database;
- Conceptual project: from previous analysis a conceptual scheme of interaction between entities, information and actor has to be drawn;
- Logical project: from conceptual scheme, a logical scheme is built. In this phase several issues crop up like- data consistency and integrity, their reliability, safety and secrecy;
- Physical project: from logical project we design allocation scheme (we define the allocation of relationships between data and the several systems, fragmenting global information). Then we apply algorithms of choice created on relationship between database, and minimizing the global cost of local and distributed application.
- Developing phase: in this phase there are every activities focused on procedures which are about automatic information management, their elaboration and storage.

2.1. Elements of Clinical Folder System

The elements that constitute the system are:

1) The information held in clinical folder resides in the central database, and in the local database of several units (functional islands)
2) The central database modernization programs for synthesizing information is captured from local database of several units (link programs)
3) Various applications of functional islands

The units for consultation and control (application for managing the clinical folder and the information system via Intranet).

2.2. The database

The database is the most important part of the project.
The archive of heterogenous data is in fact the main source through which the aid for diagnosis reaches the consultation unit.
The database must be developed in such a way as to take maximum advantage of distributed architecture: a central database where data for synthesis is collected and local database of several units, centrally maintained history where particular data can be found.
Primarily there are tables containing general information of the patients and characteristic data of hospital till the patient is discharged (type of unit, accepting doctor, treatment doctor curing, medical of unit, address of pathologist, address of place of diagnosis, anamnesis, objective of examinations, clinical diary, visits of specialists when under medication, therapy, other events, certificate of discharge, etc).
Local database contains data of specific medical examinations and reports of specialists visited.
In the functional islands beyond local database there are background programs, which describe new examinations carried out and feeds this data in central database; ensuring no duplicate or incorrect information is inserted [TAD99].

2.3. Consultation Units

The consultation unit consists of a series of integrated applications having varied degree of complexity, all grouped into a system to aid medical decision.
The previewed applications are:
Management of the diagnostic protocol: it allows the representation of diagnostic approaches adopted by the cardiology unit and aims to standardize the diagnosis, to simplify data recovery, to one good classification of the patients.
Access to external data beyond the access to the central database for data on a specific patient, the consultation unit comprises of some procedures for accessing other databases or other reachable resources through Internet. Consulting archives of units for getting data of patients already discharged (follow-up), and access to information of bibliographical and druggist type are also of importance.
Post-processing: this function comprises of all the techniques available for elaborating the data archives after their acquisition.

In fact in many cases, the clinical data stored in the central database demands in-depth analysis. Therefore various programs come for elaboration of the data and their graphical visualization using visual programming techniques.
Similarly there exist procedures of statistical and epidemiological types, programs of clinical consultation: for helping in formulation of diagnosis and planning of therapy, and help systems for getting acquainted [OMB00].
Finally, it must be possible to access the information of Clinical Folder, also through the Internet by means of a web-browser to remote hospitals staff and the family doctor.
From technological point of view it is necessary to link HIS to a web server and provide programs to access all clinical archives using dynamic pages visualizing structured reports, biological signs, graphics, images or video recordings of clinical interest[CEC99].

2.4. Information network

Information network must be built with an objective to implement and to make easy the productivity of organization from the top to the single person. The architecture of the network must successfully support the information flow, which takes place inside the organization. The introduction of computer system for communication- increases the number of ways for accessing information and the quantity of available information, and aids in redistributing them where required.
Networking system must be open and to International Standard, conforming to national and Internet framework.
The communication networks of every single department of an Hospital or the entire Hospitals (LAN) should have the possibility to connect other departments which are far away from hospital, to other national hospital, on-line services, general medical practicers and to Internet too.
We need to think about the kind of data used by HIS, they are heterogeneous and their management is very complex. The data can be alphanumeric, textual, graphic, etc. There are several access points of information and the data elaboration must be nearest to the patient. The need for information integration pushes towards a solution based on distributed database between several functional units residing inside the hospital.
Therefore we have to take into account the need of a service for providing “historical” data.

2.5. Subsystems of HIS

It is possible to logically split an HIS in three following sub-systems:

- Government
- Administrative
- Clinical.

These subsystems are individual autonomous entities and are to be because they are related to the same patients. They base their activity on different information but inter-related. HIS collects all clinical information about patient to improve the procedure for diagnosis-care, and helps of come out with both a comprehensible clinical record and efficient consulting for research.
These characteristics are fundamental for the other two subsystems: the administration can derive medical expenses directly from data supplied from clinical information system and then send it to the manager of government subsystem for financial analysis.
The administration system supplies the procedures and the functionality for services, to manage the patrimony and personal. Management module supports automatic financial accountability. To integrate the government the system foresees the automatic production of attraction indicator, cash flow for every operative unit, and to permit the analysis for cost center, production factor and type of activity. From cost center, the activity of “functional island” and of medical record, the system allows to rebuild the patient medical expense and compares it with the DRG economic system or with the regional system of local health services.

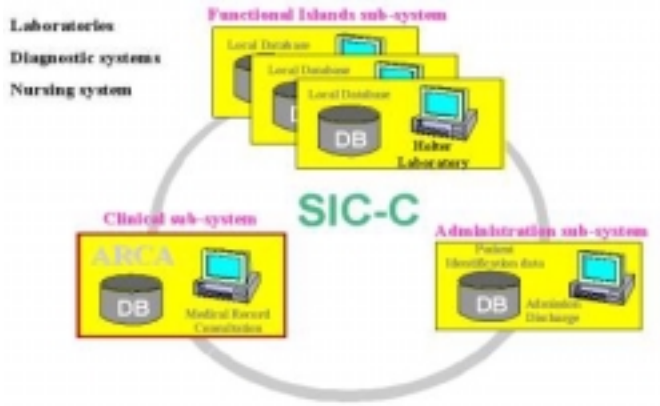
3. CINICAL INFORMATION SYSTEM

Clinical Information System (SIC) where the information collected by different components of the system is integrated for the optimization of patient’s process and care.
In spite of some decades of exploratory work and money investments in research and development of computer systems in health care, patient records today are often paper based. Implementation and deployment of electronic medical record (EMR) systems lag behind available technological solutions. Of the several clinical information systems, which have become operational in recent years, only a few are capable of supporting the complete patient record and developing them outside the development site is difficult. Even though most data of clinical use are now available in electronic form there still remains the need for health care personnel to report much of information in written form. This is the case of data gathered through patient consultation, referring to patient history and physical examinations, or physicians’ and nurses notes. Yet data captured from medical instrumentation is a crucial problem in clinical departments as there is lack of standard protocol for the communication. Thus, timely and accurate transfer of patient information into the computer is a difficult step in the maintenance of an EMR Interaction of clinicians with current computer systems is often labor-intensive.

3.1. The Information Infrastructure

SIC consists of three subsystems

1) Administration,
2) Clinical laboratories,
3) Clinical subsystem.



STRUCTURE OF INFORMATION SYSTEM

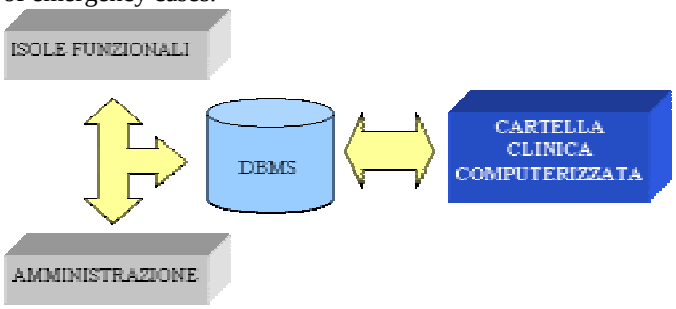
The first subsystem has to:

a) Identify the patient when it arrives,
b) Take account of his stay and the treatment given to him,
c) Admit the patient
d) Discharge the patient after treatment,
e) Manage medical tests and examinations.

The database used for the administration, connected to clinical network is read-only accessible to the other subsystems.
The single patient admitted in the department or to the ambulatory services undergoes a number of different tests, examinations and physician-visits, which are usually performed within specific laboratories or diagnostic units (egg. Clinical Chemistry, Resting, Holter, etc.). The integration in the SIC of these heterogeneous sources of data is difficult for three main reasons:

- lack of standard specifications among medical equipments produced by different manufacturers;
- lack of standard medical protocols for diagnosis,
- difficulties in the linkage of new installations to existing computer systems. Ad hoc solutions.

Each laboratory is considered a “functional island” which autonomously provides to conducting tests, local data archiving for clinical research, and listing materials. Each unit is in-charge for making available the test results in electronic form, according to a structured form established jointly by the doctors. Excerpts of signals or significant images are possibly provided to document test findings. Identification of patient data is always obtained from administration with the exception of emergency cases.



INFORMATION FLOWS OF CLINICAL SYSTEM

The integration of the databases is done using two different methodologies: middleware and Web. The first one is constituted by a set of interfaces, which let the communication from local application of different island and the central clinical database, and the data will flow in the EMR. The second one allows browsing EMR and administrative data using a web-browser.

4. ELECTRONIC MEDICAL RECORD

Main objective of clinical sub-system is the integration of every clinical data about the single patient to build the EMR, giving to the doctors and nurses instruments for browsing data and their interpretation.
The critical aspect of Electronic Medical Record is not the design of information exchange from archives, nor the realization of procedures to manage them, but the introduction of new technologies can produce on pre-existent organization of department and the hospital. If the impact is too much traumatic, is inevitable which reaction phenomena arises, These phenomenon’s are against correct work of the new system, In the information and the optimization of EMR is necessary to continue to follow the work process trying to use maximum possibility offered by hardware architecture where the information system is based reducing at minimum the changes to the organization.

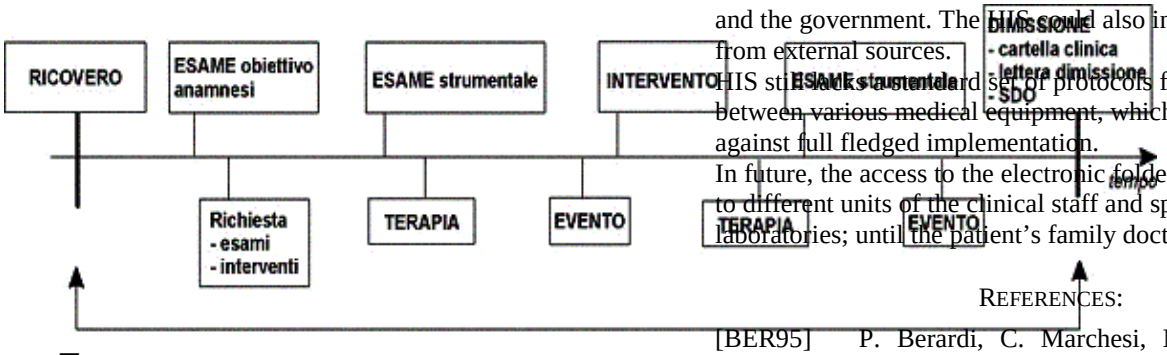
4.1. Logical organization of information in the clinical folder

The clinical folder looks like structured pages with collection of homogenous data. These pages can be characterized for homogeneity of data in the following:

1. Identifying administrative data: identification of patient and description of modes and types of treatments available.
2. Anamnesis data and objective of examination: data is compiled and the patient is admitted in the unit.
3. Clinical diary: directory of prescribed therapy, planning of therapy, request for performing treatment, recording sequence of biological parameters (blood pressure, temperature, etc).
4. Diagnostic path: directory of reports produced when the patient is under observatory. They are alphanumeric, numerical, graphical information, physiological tracings or images. Directory of the events of surgical treatment.
5. Discharge data: of EMR plus a letter of discharge with the conclusions.

4.2. Functional Aspects

The system deals with data related to the patient's admission and treatment, clinical tests, anamnesis and other data concerning the patient's medical history.
After treatment, the system allows to issue the certificate of discharge/transfer of patient (SDO)



TEMPORARY TREATMENT OF PATIENTS DATA

All the acquired data are structured according to medical complexity of the case to be memorized and they are identified and recorded in the central archive.
The central archive aslo serves as historical archive for scrutinising previous treatments and also forms a base for statistical, epidemiological or managerial surveys.
The program for management of clinical folder must comprise a series of serveral modules for:
selection of patients clinical folder
emergency admissions
registering and consulting data related to anamnesis and medical tests.
registering and consulting data related to reports concerning pathological tests, surgical operations, external experts consultations.
management and registration of the discharge letter and report(SDO)
print command for documents: a paper copy of the clinical folder, still essential for many implementations, can be obtained from the online version.

5. CONCLUSIONS

In-spite of the technology available at disposition, HIS is a very complex system for development.
Earlier, it was not possible to integrate and synchronize all healthcare related factors under a single seamless organization.
Technological advancement has enabled integration of various medical equipments to the informative systems. This made it possible to provide more rational information to its customers (patients) about available facilities and treatments.
The information produced by HIS is arranged according to its customers (patients) requirements.
Information is organized and managed as a utility for patients, but at the same time it is also based on requirements of the government and sanitary/hospital administration.
The HIS must assist in providing best possible method of treatment based on the available infrastructure.
The HIS apart from improving and making the system flexible and efficient, must also help in development of the user staff.
Finally, HIS must continuously adapt to introduction of new-means of treatment, rules of taxation, etc. which is necessary for efficient working of hospital.
Traditional paper based folder was successfully substituted by an electronic (clinical) folder, thereby meeting the requirements of hospital medical/administrative staff, lawyers, and the government. The HIS could also integrate information from external sources.
HIS still lacks a standard set of protocols for communicating between various medical equipment, which is holding it back against full fledged implementation.
In future, the access to the electronic folders will be extended to different units of the clinical staff and specific medical laboratories; until the patient's family doctor.

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