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Happy Birthday DIOGENE: a Hospital Information System Born 20 years ago

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Abstract

Since its birth in 1978, DIOGENE, the Hospital Information System of Geneva University Hospital has been constantly evolving, with a major change in 1995, when migrating from a centralized to an open distributed architecture.Since a few years, the hospital had to face health policy revolution with both economical constraints and opening of the healthcare network. The Hospital Information System DIOGENE plays a significant role by integrating four axes of knowledge

- medico-economical context for better understanding and influencing resources consumption
- the whole set of patient reports and documents (reports, encoded summaries, clinical findings, images, lab data, etc.) patient-dependent knowledge, in a vision integrating time and space
- external knowledge bases such as Medline (patient-independent knowledge)
- integration of these patient-dependent and -independent knowledges in a Case-Based Reasoning format, providing on the physician desktop all relevant information for helping him to take the most appropriate adequate decision.

Keywords
Hospital information system; Change management

Introduction

In Switzerland as in other European countries, new orientation of healthcare is clearly organized around stronger economic constraints. The control of expenses is particularly oriented towards hospitals, implying efforts for decreasing length of stay and subsequently developing ambulatory care. Quality of care is endangered, because there is a gap between the well-developed tools for measuring costs and the relative under-development of the tools for quality measurement.

In order to face these problems, a hospital has to develop tools for measuring costs, tools for measuring quality of care, tools for developing ambulatory care (as an alternate way of caring for patients) and tools for recording and communicating detailed patient documentation, including images and new technologies.

This paper describes the Geneva University Cantonal Hospital's approach for facing these problems with a particular focus on its decentralized Hospital Information System (HIS) DIOGENE, which registered its first patient on January 1st, 1978.

Tools for measuring hospital costs

The general philosophy of DIOGENE HIS for obtaining rough data of good quality is :

- **to get data** on a transactional basis, i.e. where the basic action naturally takes place;
- **to record** medical data close to the knowledge, i.e. medical encoding is performed by the physicians themselves on an interactive basis;
- **to validate** data throughout communication, e.g. a medical summary can be directly sent to the family practitioner as a rapid "discharge note";
- **to get close** feedback to the care providers, e.g. general availability of hospital statistics on a daily basis throughout the private Intranet network.

DIOGENE HIS applications cover almost all hospital activities. Each application is running on a transactional basis, i.e. they act as a natural way of communication between hospital actors :

- ADT (Admission-Discharge-Transfer) is directly performed by the nurse when announcing a patient movement from the ward;
- laboratory request is performed by physicians or nurses from the ward telestation. They receive as an immediate feedback a sticker to be pasted on the patient's specimen, explaining all relevant information (patient's identity, type of tube for specimen or blood sample, transportation care such as infectious disease, etc);
- UNILAB (UNIX-LABoratory) application handles the specimen from its arrival in the laboratory up to the edition of the result in the patient ward unit, even if the patient has been transferred;
- an operating room procedure can be planned in advance throughout a dedicated application;

- Pharmacy is directly ordered by the nurses, ward by ward. Individual drug prescription is under development;
- Personnel is managed on a central application by each of the nine administratively independent units of the hospital.

All these applications save their patient related data within a common application called ARCHIMED (« ARCHIves MEDicales »). This application gathers all the DIOGENE data related to the patients, beyond the actual archival process of each application (including pointers to texts and images).

In order to constantly improve the quality of the HIS data, an immediate feedback is provided to the hospital actors be giving them statistics on a private hospital Intranet network. Statistics are available on an annual, monthly and even daily basis, about ADT, outpatient clinics, laboratory consumption, etc.

ARCHIMED contains today all mandatory information for computing a cost per pathology. All these data are directly originated from the HIS and are thus validated on a transactional basis.

Quality of care and medical record

A unique centralized medical record is a masterpiece within a teaching hospital, where several disseminated actors simultaneously take care of the same patient (at the bedside, in the radiology department, in the laboratories, by a cardiologist or gastroenterologist consultant, or for planning a surgical operation). This need of an ubiquitous medical record is even increased by ambulatory care, where all action around a patient (from investigation planning to diagnostic, therapeutics and further treatment planning) is to be performed during the reduced time of the encounter.

It has been decided in Geneva that the unique patient record would be computerized; computerization being the only way for having multiple copies of the same record at the same time, each of them up-to-date.

UNIDOC

One of the central pieces of the DIOGENE patient record is UNIDOC (« UNIX-DOCuments »), an integrated patient report processor [1]. UNIDOC illustrates a feasible marriage between two worlds, the central UNIX world providing both archiving facilities and the HIS patient identification, and the peripheral world Windows on PC, with its local processing power and the richness of the Winword text processor.

UNIDOC allows all patient reports to be centrally archived and available on the network (throughout appropriate access rights). Reports are dictated as usual by the physicians and typed by the secretaries. On her computer, the secretary first opens the folder of the patient (the right hospital stay or the right ambulatory visit of the right HIS patient) and then chooses the type of document. Documents are predefined for each medical specialty, according to their paragraph structure (e.g. a "discharge letter" will contain the following paragraphs: - header and title - diagnostic - history - physical examination - paraclinical examinations - discussion and evolution - discharge treatment - signatures and copies). The empty document is pre-filled within the UNIX world (with the patient identity, dates of stay, title, header and paragraph structure) and sent locally to the PC where the secretary completes it before sending it back to UNIX.

UNIDOC is used today by more than two third of the medical secretaries, including the radiology department. Around 500'000 documents are available on-line on the DIOGENE network. UNIDOC will soon cover all the hospital medical secretaries.

Medical Encoding

Medical encoding in Geneva is directly performed by physicians, according to IMIA's WG6 1984 recommendations: "There is a need to enhance the involvement of physicians and other healthcare professionals in the original entry of medical and other relevant data to increase its accuracy and quality" [2].

During the hospital stay, or at the end of it, the physicians enter on the terminal a set of diagnoses and of procedures [3]. A special tool called LUCID [4] has been designed for helping physicians to browse into dictionaries and classifications for finding the adequate expression. Once entered, such a summary can be edited for being sent to the family physician, after appropriate signatures by the intern and the resident. This communication process, which replaces a more extensive discharge letter for simple cases, is most efficient for reaching quality of encoding. For other more complex cases, the summary is signed by the resident together with the complete discharge letter.

The complete encoded history of the previous stays is available when a patient is readmitted, providing thus immediate and valuable information.

In order to be prepared for the Swiss federal regulations that will oblige an encoded summary to be established for each hospitalization from 1998, Geneva's hospital has set up this obligation for January 1997. Up until now, encoding was optional for the departments. The obligation will prepare hospitals to budget allocation based on Case-mix and not any longer according to the length of stay.

Coding severity of the patient's state

Going towards quality of care, in order to better catch the efficacy of care, one must measure the severity of the patient's state and disease. Measuring the severity is moreover useful for better understanding health resources consumption (such as length of stay) inside a common principal diagnosis, for achieving comparisons (between patients or between institutions) and also for understanding the variability that could remain inside a defined patient group such as any DRG .

Some severity scoring systems fit for intensive care (TISS [5], APACHE [6], SAPS) (SAPS has been determined as an obligatory tool for measuring the severity of intensive care patients in Switzerland by the Swiss Society of Intensive Care [7]). Other scores seem to fit a wider set of situations, such as the Comorbidity Charlson score [8]. Another advantage of the Charlson score is that it can be derived from routinely collected data in hospitals, i.e. a list of ICD-9CM diagnoses. The Charlson score

is presently being tested at the Geneva University Hospital.

A clinical database for assessing quality of care

Going further towards measuring quality of care requires more specific protocols for a given disease. An example is given by DIABCARE [9], which is recognized as a European standard for assessing the course of a diabetic patient during a long period of time, or OBSQID [10] which assesses pregnancy and delivery.

Such clinical databases are moreover able to answer questions like the following one: "Dukes University's Coronary Artery Disease Data Bank allows a physician to indicate certain parameters of a patient, to instruct the system to identify past patients that had the same characteristics, and to request a display of how those patients did under various therapeutic options. The practitioner can then evaluate what the benefits of medical management versus bypass surgery or angioplasty would be in this particular case" [11, 12].

DIOGENE is presently developing tools for recording these types of protocols.

The Geneva hospital's physician workstation

The standard workstation lying on the physician's desk is a PC connected to the network with the following applications:

- medical encoding (MODCOD «MODule-CODage» and LUCID) giving access to previous encoded patient history;
- UNIDOC, containing the patient reports (discharge letters, surgical reports, specialists and radiology reports, admission notes, etc);
- OSIRIS, an image viewer, with an access to the PACS images (presently in test on some stations), today 40% of the Geneva hospital's radiological images are produced on the PACS;
- MEDLINE with Knowledge Finder; being more and more used on a daily basis, not only for publications, but also for the routine patient care;
- Internet (with both Intranet and Extranet);
- Electronic mail (internal and external);
- Word processor, a database, a worksheet and a graphics editor.

Availability of documents, security and access rights:

Summaries and reports follow the general DIOGENE availability rule, which is based on the physician's responsibility: all available information is provided to the physician in charge of the patient.

Access right to consultants raises a specific problem. Consultants (in cardiology, gastroenterology or surgery) can potentially see any patient of any department, even in an emergency. Giving an explicit authorization to a consultant before he can consult a computerized record may be the cause of loss of precious time in case of an emergency. The solution found is the "log", i.e. keeping track of who looks at what and when. Showing a message on the screen saying: "you are going to see confidential data for a patient who is not in your department. A track will be kept of this transaction and printed for the physician responsible. Do you still wish to proceed?" is most efficient for preventing inadequate browsing of information.

Security and availability is obtained through several technical tools. The application called "Directory" performs several matches between the user's identity, his password, the access-right profile and the physical location of the terminal before calling the application with appropriate parameters (or not calling if the conditions are not all fulfilled). Remote-loading is also used for providing the right executable program on the right Personal Computer (as MODCOD partly runs locally on Windows). Finally, the PC itself is protected by a specific Windows shell, which prevents the user to modify the set-up or the local programs.

Ambulatory care

Outpatients clinics have a major organizational constraint in the caring of patients: time and co-ordination. They have to co-ordinate in a single unit of time many events that may occur on a sequential way during hospital stays: encounter with one or several physicians or nurses or other care providers, examination procedure (such as laboratory or imaging technique), operation room procedure, communication of the various results and conclusions, billing and planning of subsequent care.

The people caring for the same patient seem more than ever disseminated throughout the hospital: communication becomes a crucial problem.

Each DIOGENE tool described in the previous sections (ADT, laboratory request, UNILAB feedback, UNIDOC reports, operation room planning, pharmacy and material ordering, as well as accounting and billing) are presently expanding to cover all ambulatory care units.

A decentralized HIS with growing capabilities

A HIS able to support these new orientations of healthcare strategies has to be expandable while continuously maintaining its functionalities and a coherent history with its archived data.

DIOGENE has constantly evolved since its beginning in 1978. A considerable mutation was recently achieved (in July 1995), with the so-called "migration" from a centralized to a decentralized system.

Since the initial design phase from 1971 to 1972, the DIOGENE hospital information system at the Geneva University Hospital has been treated as a whole and has retained its architectural unity, despite the need for modification and extension over the years. [13, 14]. In addition, to having a centralized patient database with the mechanisms for data protection and recovery of a transaction-oriented system, the DIOGENE system, like other large hospital information systems [15-19] supports many applications within the hospital [20]. The system was introduced for administrative applications, including personnel management, in 1974 Invoicing was added in 1977, patient admissions in 1978, and general accounting in 1979. The system was progressively extended to all the wards in 1979

and 1980. Extensions to the radiology department and laboratories occurred from 1979 to 1982. Interactive medical encoding by interns and residents was added in 1985. The system soon included new emergency laboratories (1986), monthly and yearly medical statistics on patients (1987), the pharmacy (1987), integrated outpatient clinics in surgery (1987) and medicine (1988), and the medical bacteriology laboratory (1988).

Now in 1998, DIOGENE 1 is 20 years old, counting from the first transaction made on the system. At this moment, DIOGENE 2, a federated HIS, [21] is reaching its mature stage and is ready to take over.

Distributed systems provide an environment where innovative off-the-shelf applications can be developed and distributed, provided appropriate measures are taken to reduce their cost of entry, and to broaden their potential market. Such applications should be seen as independent of the physical structure of the system. This need is fulfilled by the transparency of distributed systems.

Federation is seen to be a key structuring principle to combine components of a system. Finally, world-wide interconnection is likely to have a considerable impact on the development of various types of distributed systems, as anticipated by the CEC White Paper on Growth, competitiveness and employment (Bulletin of the European Communities, supplement 6/93 [22] and by the United States government policy [23].

Future directions

Future is going toward facing health policy revolution with both economical constraints and opening of the healthcare network. The Hospital Information System DIOGENE plays a significant role by integrating four axes of knowledge:

- medico-economical context for better understanding and influencing resources consumption ;
- the whole set of patient reports and documents (reports, encoded summaries, clinical findings, images, lab data, etc).patient-dependent knowledge, in a vision integrating time and space (i.e. regional hospital and General Practitioners) ;
- external knowledge bases such as Medline (patient-independent knowledge) ;
- integration of these patient-dependent and -independent knowledges in a Case-Based Reasoning format, providing on the physician desktop all relevant information for helping him to take the most appropriate adequate decision.

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