The Legnano Radiology Picture Archiving and Communication System/Radiology Information System Project Implementation

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The necessity to meet the ever-increasing diagnostic and interventional demands in the most cost-effective and efficient way led to the decision to turn the Department of Radiology at Legnano City Hospital nearly filmless. Crucial for the implementation of this challenging project was the development of a sophisticated and efficient digital architecture along with a nearly global renovation of the whole department, connecting it in the meantime to the hospital asynchronous transfer mode (ATM) backbone. The highlights and drawbacks faced in the implementation of the project are described and discussed.

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THE LEGNANO Hospital Department of Radiology is a large institution with a global yearly productivity, in 1999, of more than 220,000 examinations and interventional procedures, 175,000 within the main department. This great number of examinations, 55% of which are performed on inpatients and emergency room patients, required storage (by law) of all inpatient films for a 10-year period as well as of all written reports, the latter forever. The huge storage demands, which could no longer be met, as well as the necessity to renovate the main Department of Radiology, which was structurally and technologically obsolete, led to the decision to thoroughly renovate it. The project, started in early 1998, foresaw complete redesign and reconstruction of over 40% of the department, whereas the whole department underwent complete restructuring; at the same time, we launched a challenging project to turn it nearly wholly filmless, in order to avoid all previous management-related problems. Thus, a data transmission network was laid out, aimed at supporting the foreseen picture archiving and communication system (PACS) and radiology information system (RIS). This work was accomplished in four main consecutive stages, being impossible simply to close down the department for renovation. In the following paragraphs, the main characteristics of the project endorsed in Legnano will be pointed out, along with the difficulties we faced, and still are meeting, in implementing it.

Available Diagnostic Equipment

The Legnano City Hospital, a facility of more than 700 beds, is a major hospital within the Public Hospital Network of the Region Lombardy in North Italy, covering all major subspecialties.

To meet the very large and ever-increasing diagnostic and interventional demands, both for in- and outpatients, as well as the large emergency room-related activity, an assortment of state-of-the-art equipment has been recently installed. There are presently three computed tomography (CT) machines; two magnetic resonance imaging (MRI) machines; four ultrasound machines, of which one is digital; an angiographic suite; two digital radiography suites; six conventional radiology suites served by three computed radiography (CR) devices; one direct radiography suite (chest radiography) to be installed in the coming months; and one bone densitometry suite. Most of the equipment, with the exception of mammography, had to be put online, directly linked to the PACS and RIS installed within the department. This proved a very frustrating part of the project, since some of the older equipment did not comply with the required Digital Imaging and Communication in Medicine (DICOM)-3 standards.

THE PACS-RIS IMPLEMENTATION¹⁻¹³

Of paramount importance in solving most of our management-related problems was the development and implementation of an excellent digital architecture, to provide crucial efficiency and speed of the data lines in order to allow the most efficient workflow. This, in turn, is obviously expected to lead to a dramatic decrease of lost or unread films; to the possibility of definitely "real-time" film interpretations; and to a greater report and image accessibility, which will result in de-

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Fig 1. The Legnano project.

crease of redundant or useless examinations. All these goals require, besides a suitably fast data transmission network, an excellent, fully integrated PACS along with an equally important and integrated RIS (Fig 1). The systems, selected by a public tender, were SIENET PACS (Siemens, Erlangen, Germany) and RadioAssistant RIS (Siemens, Milan, Italy).

The PACS Architecture

The PACS installation within our department has to comply with a large daily work-flow of approximately 10 GB, for a global amount of an expected 3.6 TB/yr. Since Italian law requires storage of 10 years-activity images, the global storage capability had to be superior to 36 TB; in the Legnano configuration, it is of about 43 TB (lossless 2.5:1 compression).

The configuration of our system, aimed at achieving maximum efficiency, is characterized by a hierarchy of four data archival levels.

The short-term memory sits in hard disks within the nine existing reporting MagicView (Siemens, Erlangen) workstations (5-day workload, plus the related pre-fetched previous images). The medium- (20 work days) and long-term (125 work days) memories are managed by a MagicStore (MS) (Siemens, Erlangen) master server, which manages two additional MS Advance servers; each MS

Advance manages a level 5 redundant array of inexpensive disks (RAID) storage unit of 360 GB (globally 720 GB RAID) and a jukebox with a 624-GB storage capability (lossless 2.5:1 compression). Thus, the global storage potential on the two jukeboxes amounts to 1.25 TB. The very-long-term and back-up memory (about 12 years) is managed by a StorageTek (Louisville, CO) Timberwolf 9740 tape library with a robot capable of handling 494 digital linear tape (DLT) 35-GB tapes, for a total memory of slightly over 43 TB, on lossless 2.5:1 fully reversible compression.

In order to allow the fastest data transmission and flexibility in devices connection within the Department of Radiology, we decided to install a cost-effective switch FastEthernet network connected to the asynchronous transfer mode (ATM) hospital backbone.

The RIS Architecture

The RIS is a new release of the recently developed Siemens RadioAssistant. It is characterized by two servers and 40 client stations, managing all of the activity of the department (examination scheduling, reporting, and filing). It sends the worklists directly to the modalities using DICOM standards. Further, it is connected to the SIENET PACS via the interface Siemens MagicLink I. This interface allows the extremely important function

of using only one patient identification modality, thus greatly limiting the risk of patient identification errors; moreover, it allows simultaneous visualization of both images and reports, pre-fetching of scheduled examinations transferring them from "slow" memories (optic disks or tapes) to "fast" memories on the MagicView reporting work-stations, and, finally, direct delivery to the eventual viewing stations in the wards. The RIS will be, hopefully in the near future, strongly integrated with the hospital information system (HIS), in order to share all the information necessary for administrative-related purposes (patient IDs, productivity, accounting, etc), as well as for outpatient examination scheduling, which is going to be centralized. In order to improve the quality of the daily activity, we decided moreover to extend the new RIS also to a second smaller Radiology Department (with an yearly productivity of about 45,000 examinations), located in a hospital about 20 km away.

Connection Outside of the Department

Three ways of connection are foreseen. A few departments of the hospital will be distributed images and reports via the MagicLink I, through the existing local area network (LAN) of the hospital based on an ATM backbone; they will be able to send their requests to Radiology online. All of the remaining departments will be distributed images and reports through a dedicated web server, named MagicWeb, thus enabling the use of the much less expensive PCs. A teleradiology link to the secondary smaller department is moreover foreseen, in order to rationalize the activity of the limited number of radiologists available.

Switch From Analog to Digital: Preliminary Experience

The choice to turn the whole department nearly filmless in no stepwise way has been, and still is, an extremely challenging project due to the size of

the department and to the not-too-large existing staff involved (10 radiologists and 29 technicians). Moreover, the switch from analog to digital, as well as from hard-copy to soft-copy reporting, has been all but trouble-free.

The switch to digital has been considered by most technicians, in a very early phase, as a time-waste, possibly leading to a decrease in the daily workload. This proved immediately wrong, first in chest radiology (where we were able to increase our workload about 10% in spite of the present use of a dedicated CR device), afterwards in skeletal radiology—provided soft-copy reading is performed.

Some problems, on the contrary, are still being faced in soft-copy/speech recognition reporting, done on the nine workstations, each with two reporting monitors (either 2K black and white or 1K color monitors) along with a third monitor harboring all RIS-related data, and comprised also of electronic dictation devices and IBM ViaVoice recognition systems (IBM Italia, Vimercate, Italy). There is in fact presently an average 20% increase in the time required to complete a diagnostic work-up (down to the signature) after 2 months of experience with the new system. I am strongly positive that this slowing down will be overcome in the next few months due to improved skills and acceptance of the new system; positive results can already be seen with the ultrasound examinations, 75% of which are presently reported according to the new trend.

CONCLUSIONS

The switch from the present mixed digital-analog system to a nearly wholly digital modality cannot be achieved all at once. It will probably take about 6 months of hard and constant work, making it day after day harder to resort to the "old" system.

During this intermediate step I hope to introduce in our nearly filmless department the electronic signature as well, which will further improve the work efficiency.

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