
PROFESSIONAL PAPER

**FILMLESS HOSPITAL: INTEGRATION AND DATA
WORKFLOW IN HOSPITAL**

¹Nihad MEŠANOVIĆ**²Haris HUSEINAGIĆ****³Harun AVDAGIĆ***University Clinical Center Tuzla**¹Information Technologies Sector**²Department of Radiology**³Department of Cardiovascular
Surgery**Tuzla, Bosnia and Herzegovina**Received: 07.09.2009**Accepted: 09.01.2010***Correspondence to:***Nihad Mešanović**University Clinical Center**Information Technologies Sector**Trnovac bb, 75000 Tuzla**Bosnia and Herzegovina**email: nihad.mesanovic@ukctuzla.ba***ABSTRACT**

The move to filmless is newer easy. It is important to have a vision, and of course to have the right people to implement a complete project. Implementing a picture archiving and communications system and radiology information system is not only about replacing film, but how the technology can improve an organization, its services, and its financial picture. Going filmless provides a prime opportunity to reassess and revitalize the way a center does business.

Keywords: *Picture Archiving and Communication System, Radiology Information System, Filmless hospital, financial benefit*

INTRODUCTION

Enterprise systems are one of the most important information technology (IT) categories to emerge in the last decade.¹ Even in branches like banks and insurance organizations, management must continuously invest in new IT infrastructure to keep up with growing demand and competition, otherwise it is recognized that competition is really hard to follow if your IT department doesn't meet the new demands.²

The Radiology is the service most sensible at the technologic evolutions, and one of the most innovative goal is the digitalization with the Picture Archiving and Communication System / Radiology Information System project (PACS/RIS).

The main advantage deriving from the use of a PACS system is a great improvement in the managing of the

work, vital importance in today health system and essential element in the diagnosis and the cure of the patient. This system is designed for the growing need of radiologists and technicians in conjunction with the IT personnel, to store, manipulate, retrieve, review, and send various medical data for planning and managing purposes.

Quality control can only be achieved with the integration of all patient medical and administration data in unique EPR (Electronic Patient Record).

As the primary plan of the University Clinical Center (UKC) Tuzla in 2008 was the mission and vision to improve service and lower cost for the hospital, and the introduction of the PACS/RIS system was crucial to fulfill this plan. UKC is a university hospital with 1200 beds and it covers area with population of approximately 520,000 people. Located on the hills above the

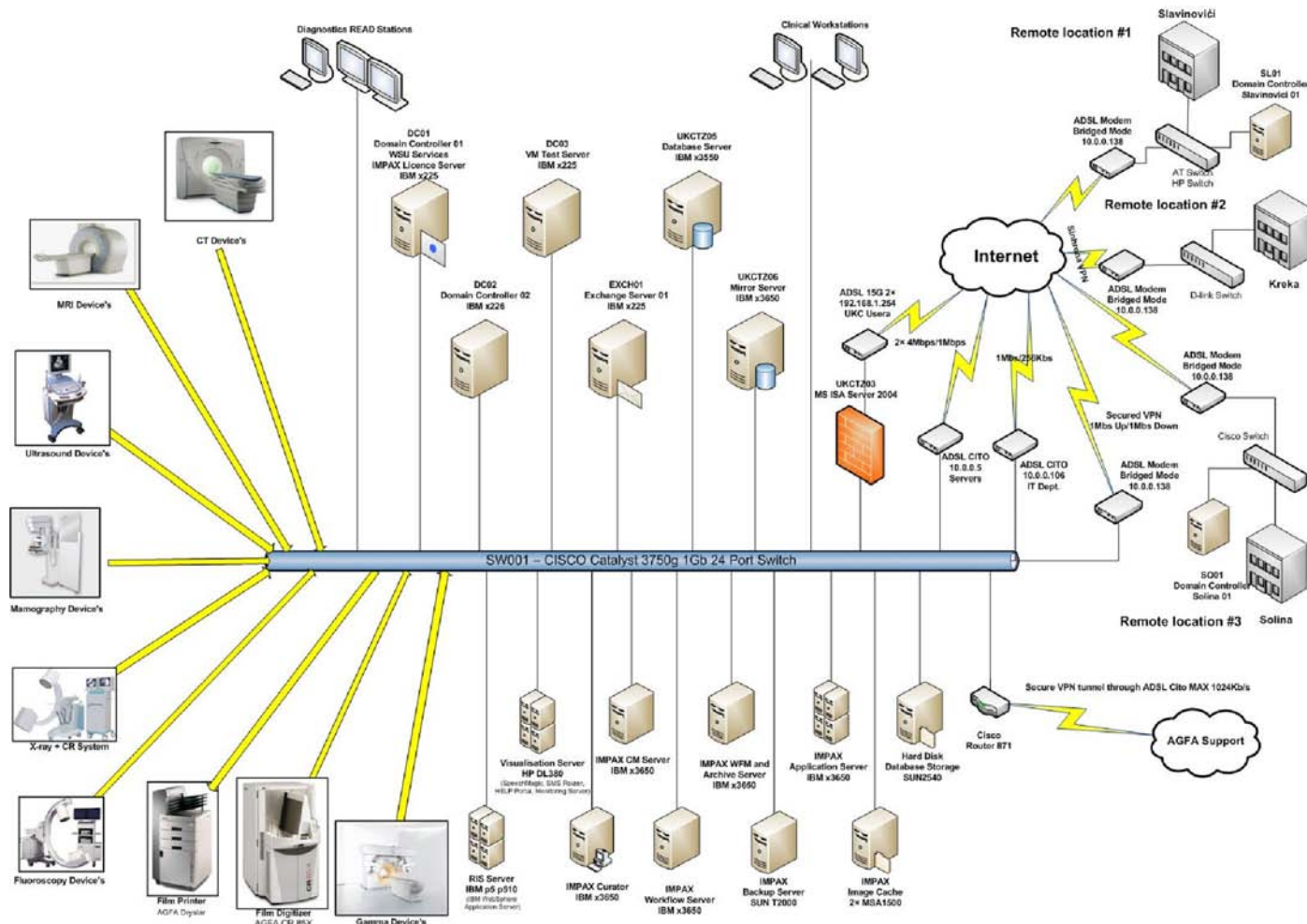


Figure 1. Networking diagram in University Clinical Center Tuzla

city, UKC Tuzla have also 3 satellite locations on different parts of the city, that also require radiology images. The plan was to start with the project that can easily meet with the demands of the growing radiology department.

TECHNICAL BACKGROUND OF FILMLESS HOSPITAL

PACS consists of acquisition devices, storage units (servers, tapes, etc), diagnostic workstations, PC's, software applications and database. Of course, this project cannot be implemented without integrated computer network solution with passive and active parts, such as UTP (Unshielded twisted pair) cabling, rack closets, patch panels switches, routers, UPS (Uninterruptible power supply), etc. Satellite locations are solved with VPN (Virtual Private Network) connections, so users can create, store and retrieve images from our central server farm on main location.

Having an integrated RIS/PACS solution provides large-scale multimedia storage of all types of medical images and diagnostic results and it enhance efficiency

and productivity. Image generated on modalities are transferred to the server and immediately to multiple users regardless to their location. Radiologists can quickly view a patient's complete clinical position for fast, accurate exam interpretations. Activating embedded native tool sets such as 3-D, MPR, MIP, and vessel analysis combined with automated prior image selection is just as quick and easy.⁴ The majority of work performed in radiology is presented as 2-D information, from conventional x-ray images to the most advanced CT, MRI or PET-CT studies. The availability of the volumetric data set led to the next step: new applications for post processing of the CT data. The first post-processing options included Maximum Intensity Projection (MIP), Multi-Planar Reconstruction (MPR) and Surface Shaded Display (3-D SSD).

Images can be automatically displayed on the workstation's diagnostic monitors, complemented by an RIS side monitor for viewing patient text information.

Simple mouse clicks access a comprehensive tool set, exam data, clinical data (such as laboratory reports), patient histories, and voice dictation. Ordering exams is fast, flexible, and accurate with RIS. Requesting physicians can enter orders directly into the RIS

through an HL-7 HIS (Hospital Information System) via secure SSL (Secure Socket Layer) Web communications reducing entry tasks and possibilities for error. Orders can also be entered manually, at the radiology reception desk. It all adds up to a more efficient workflow for the radiology unit and better service to referring physicians. RIS/PACS integration can sometimes encounter a language barrier, since RIS and PACS adhere to different data formats. RIS traditionally use HL7 (Health Level 7), a health communications protocol for exchange of information between applications. HL7 is an ANSI accredited international standard developed by the standard development organization HL73, while PACS use DICOM, (Digital Imaging and Communications in Medicine) the industry standard for transferal of radiological images and other medical information between computers.⁵ A DICOM-HL7 broker is a separate interface engine to translate data from one format to the other. See picture 1 for details.

Integrated PACS/RIS solution needs to be operational with minimum 98.5% of working time, which means that out of 365 days in year 5.5 days it can be out of service. This is for servicing purposes and also for non planned circumstances (lack of electric power, flood, etc..)

THE "DISAPPEARANCE" OF THE FILM

In the past, prints had to be made, which were then stored in file folders in large storerooms. For this task of having film made, you had to have the films, processors, darkroom, technicians to work inside, repairman, etc. It was also a big task to retrieve film images, because you had to cycle through all of the files to find the ones you needed.

This is a thing of the past with digital radiology systems. With a couple of mouse clicks, you can look through hundreds of digital images to find the one you need in a matter of seconds. Relevant prior examinations are prefetched from the archive for comparison immediately. Storage of digital medical images will also save medical facility money. Digital images can be backed up onto CDs and DVDs as well as offsite archiving on hard drives and in databases by using radiology PACS systems.

Costs typically associated with storage, including storage space, paper, files, as well as chemicals used to print film images, are completely eliminated with digital radiology systems.

The decrease of the dose to the patient is one of the main advantages in the installation of the digital technologies brought by the PACS. This decrease should be

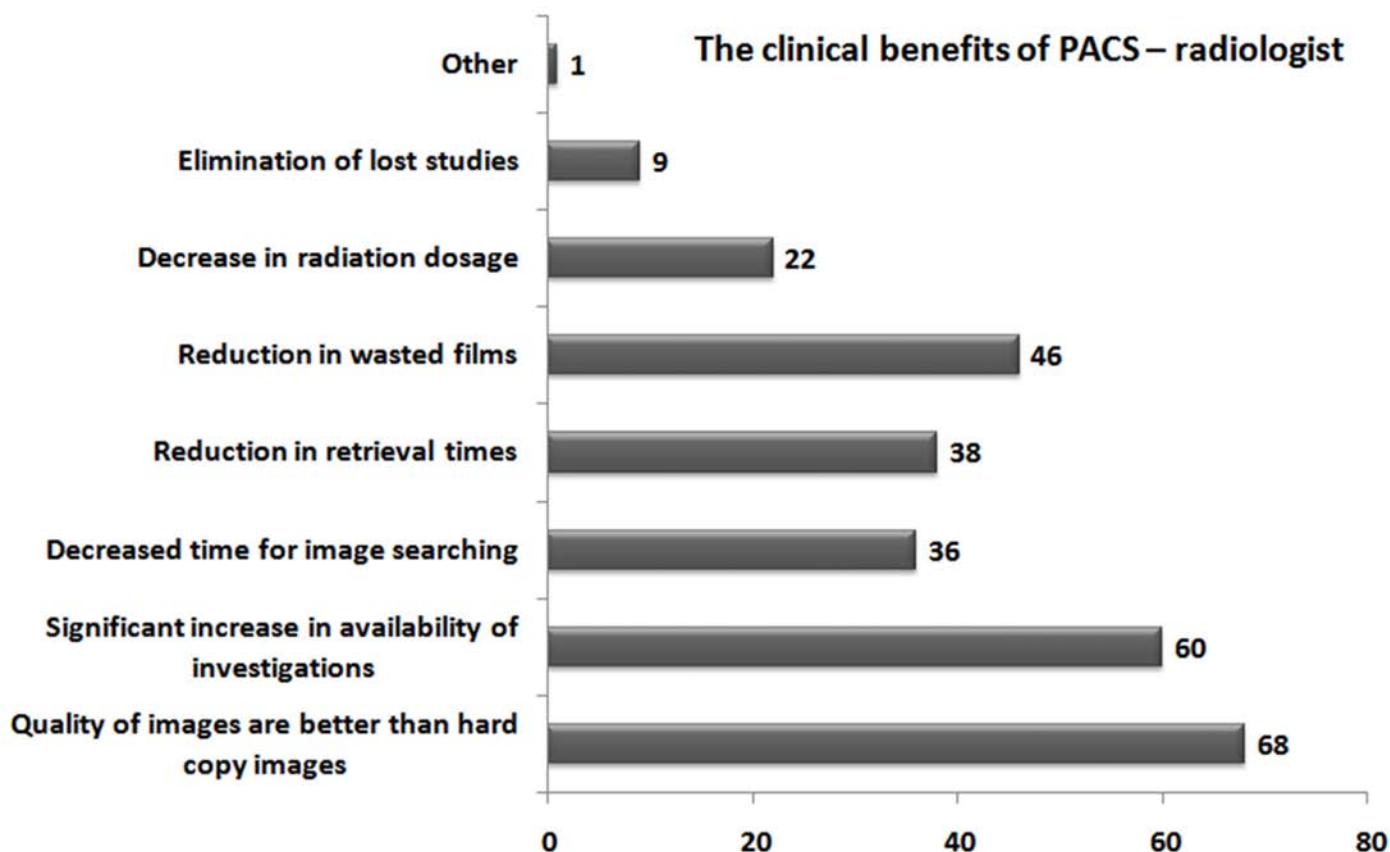


Figure 2. Clinical benefits of PACS according to radiologist survey

the result of the use of more efficient systems, as well as the less number of exams required, as well as the monitor recording.

BENEFITS OF RIS/PACS

The benefits brought by PACS can be divided into the following areas:

1. *Clinical benefits*
2. *Patient and staff benefits*
3. *Financial and/or management benefits*

CLINICAL BENEFITS

The amount of information is increased rapidly, but one of the greatest comment from neurosurgeons is that before PACS, a lot of CT scans that they receive were too small and with less information than they needed. Now, they can have thousands of images, which they can manipulate, zoom, and look inside the operating room, if needed. Also, doctors can send a patient to the radiology department for scan, and look at the result before even a patient comes back.⁶ Because all the images and clinical details are available instantly, the turnaround time for reporting is much quicker, and with PACS, there are no lost images.

PATIENT AND STAFF BENEFITS

Access to relevant prior exams will help health care providers to monitor a condition and assess if treatment is working. It will also reduce the amount of exams that are duplicated.

Another obvious benefit from PACS/RIS are that radiologist doesn't have to be on the spot during late night trauma cases, or during the weekends. Connections from home are created, so a lot of time and money are saved with this.

By interfacing the PACS with RIS/HIS, data entry time is reduced, errors are eliminated, and a single source for access to patient and examination data is provided. The exciting concept of a 'film-less' hospital has many benefits for patient care including decreased exposure to radiation, no loss of images and lower rates of rejection.

To assess the benefits of PACS by the end-users, questionnaires were issued to the end-users, actually to the radiologists, the results are shown below.

When we count the result of the questions, all of them made the comment that the most important thing is the quality of images, and the rest is prioritized on the following way:

1. *Quality of images are better than hard copy images*
2. *Significant increase in availability of investigations*

3. *Decreased time for image searching*
4. *Reduction in retrieval times*
5. *Reduction in wasted films*
6. *Decrease in radiation dosage*
7. *Elimination of lost studies*

Compared with conventional film-screen operation, filmless operation using computed radiography was associated with a significant decrease in technologist examination times in the performance of general radiographic examinations. They inferred that the decrease in technologist examination times in a filmless environment offers the potential for increased productivity with resulting personnel savings and improved operational efficiency. There is no need to have that many employees (technicians) for filming purposes.

FINANCIAL AND/OR MANAGEMENT BENEFITS

PACS implementations did achieve a total of 99% reduction in film usage within the first year. One percent of film usage is on some critical cases and medical legal reasons, for example, court cases and similar. In addition, there are reports of reduced costs for film handling, storage, and couriers. In UKC Tuzla Department of Radiology, films were not used after 30 days of PACS implementation. This situation changed only after the head of the department realized that his radiologists hardly used them. PACS brings an end to the health and safety issues associated with chemical processing, allowing hospital staff to work in a cleaner environment.

Of course, everybody needs to realize that all the cost reduction doesn't come instantly after implementation of PACS/RIS. For this purpose, we did a research for the financial side of the PACS/RIS solution – implementation in our hospital. Looking back in years, situation is like this:

In 2007 and 2008, we spent 500000 convertible marks (250000 Euro) on film expenses only for radiology department; in 2009 nothing out of film material is purchased for radiology. These costs are only film associated cost, this is excluding a variety of chemicals are used in medical imaging as developer and fixer ingredients, germicides, and cleaning agents, or costs needed for installing a darkroom or daylight processing system.^{7,8}

However, all the radiology equipment is doubled, meaning we did install another 1.5T MRI device, and also we will start working with two Cardiac Angiography machine, two RTG machine and one more 64 slice CT. If we look at direct cost for radiology material, we would have at least double the amount of money spent for issuing the films to the patients, and if we also add the costs for chemicals, the financial benefit is obvious.

FUTURE WORK IN PACS/RIS FIELD

Some of the future work can be capturing and storing images from other fields of health departments, such as dermatology, pathology, endoscopy, ophthalmology, etc. With storing those images into database cluster servers, all medical images should be stored on one place, and in that case, computer aided technology can be taken into consideration.

CONCLUSION

It is evident that PACS/RIS installation brings a lot of benefits, and it is also important to consider the service efficiencies, cost-savings and service quality improvements that project can generate (noted above). When considering a PACS/RIS purchase or implementation, decrease in radiologist's time to process an examination is noticeable. Patients benefit because of improved quality and efficiency of care, and better education and understanding of diseases and treatments. Clinicians benefit via better tools for providing patient care, higher patient throughput, increased patient satisfaction, increased personal prestige, and greater collaboration with other clinicians both internally and externally. And the overall healthcare enterprise benefits because of improved delivery of service

from all aspects, an increased reputation as an innovative and effective care provider, and by attracting and retaining quality clinical staff.

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