A Situation Analysis on PACS prospects for a Developing Nation

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Sri Lanka Journal of Bio-Medical Informatics 2010;**1**(2):112-117
DOI: 10.4038/sljbmi.v1i2.1730

Abstract

Picture Archiving and Communication Systems (PACS) provides a digital radiological workflow environment to improve efficacy and efficiency in patient care. The traditional film based system existing in Sri Lanka is fast becoming obsolete with an array of shortcomings and drawbacks such as high turnaround time, film loss and high cost of generation, storage and transport. PACS in combination with the Hospital Information System (HIS) and the Radiological Information System (RIS) provides seamless integration of patient and administrative data to digital images. It also provides remote and multiple accesses to all digital images and image manipulation, thus, providing solutions for current issues in Sri Lanka. Though, with an ocean of benefits around the corner the practical application of such a system is indeed not straight forward for a developing nation with limited resources. The practical implications of the lack of basic technology, network infrastructure, qualified personnel, strategy and legal backing need to be addressed. Although, the most important aspect would be dedication and positive attitude towards attaining excellence to through "digitisation", for the sheer betterment of the masses.

Keywords: PACS, DICOM, Medical Imaging, Situation Analysis, RIS, HIS, Drawbacks, Solutions, Medical Informatics, Developing Nation

Introduction

Medicine as we know today, is practised using modern equipment and technological advancements, to deliver the expected "quality health care" in the current volatile environment of changing disease and disease patterns. In this sense, medical imaging plays a

pivotal role in health care decision making, provision and review to guide clinicians and health care providers to become efficient in achieving the desired results.

In developed countries, medical imaging in combination with PACS has provided state of the art digital technology that has revolutionised the way health care providers capture records and use patient x-rays and scans [(1)]. PACS is a combination of hardware and software for short and long term storage, retrieval, distribution, presentation and management of images. It has given the ability to deliver timely and efficient access to medical images their interpretation and related data by breaking down physical and time barriers associated with traditional film based image retrieval, distribution and display, still present in most developing countries. This has enabled the present day medical imaging to be virtually free of hard copies with remote and multiple accesses from electronic image integration platforms. Radiology work flow management thus achieved has contributed to improved quality and efficient health care in developed nations worldwide [(1)].

Sri Lanka being a developing nation, with limited recourses in terms of manpower and finances is presently faced with the task of managing large amounts of health care needs of patients presenting to hospitals nationwide. It is thus timely to assess the feasibility of implementing PACS for the betterment of health care provision in Sri Lanka.

The present state of medical imaging and reporting in Sri Lanka

Medical image generation and reporting in Sri Lanka is presently based on film based manual systems involving plain radiographs. Digital scans including computed tomography (CT), magnetic resonance imaging (MRI), ultra sound (US), mammography (MG), isotope scanning and fluoroscopy are generated using respective devices and images are stored locally or more often hard copied. Routine plain radiographs produced are generally interpreted by relevant health care providers at wards and clinics. Reporting by consultant radiologists are carried out on request for special cases only. All other medical images are produced for reporting by radiologist. These images are generally handed over to patients with custody and responsibility and further retrieved from them on subsequent visits.

The present system in Sri Lanka generates a very high number of x-rays per month (this figure is approximately 3750 plain radiographs per month at District General Hospital (DGH) Nuwara Eliya – based on figures for February 2010). (DGH Nuwara Eliya caters to a population of about 0.75 million ; Sri Lanka has a population of 18.8 million according to census of 2001; therefore the figures for a Provincial General Hospital or Teaching Hospital would be more than tenfold). Radiologists' services are called upon by consultants attending to the patients on a selective basis where on average approximately 25-30 plain x-rays per day are reported by the radiologist. On average the time spent on reporting is around 5 minutes per x-ray. Patient details are retrieved by the radiologist through paper based referral letters, bed head tickets (BHT) and by contacting the relevant medical team. In this system the time taken for generating and reporting varies from 12 hours to more than 36 hours from the time of physician ordering the report. This situation is aggravated by lack of staff for transporting the hard copies to and from the wards and is most often done in batches unless urgent. Further, once the BHT is sent along with x-rays for reporting essential entries to the BHT cannot be made and therefore the ward staffs is often reluctant to send the BHTs for x-ray reporting. On the other hand when the patient details on the referral notes are inadequate and if the BHT is retained in the ward the radiologist is unable make accurate decisions. Further, on occasions where the radiologist is unable to be physically present for reporting the patient is unnecessarily kept warded or repeatedly recalled at clinics.

One of the most significant issues is the loss of hard copies due to misplacement and spoilage. These are often repeated, increasing the burden on an already heavy system. There is also the issue of delay in these situations. Considering the time taken for processing and reporting, the resulting delayed management of patients could be critical and irreversible. The patients are also unnecessarily exposed to radiation.

The hard copy based system is indeed costly. X-ray films, developing chemicals and staffing (radiographers and logistic staff), physical storage and transport costs sums to a fairly high figure. Adding to this is the cost of often unavoidable and frequent repeats and less frequent copying.

PACS Technology

PACS is inevitably intertwined with the Health Information System (HIS) and the Radiology Information System (RIS), in delivering benefits of the digital age. All patient related data within an institution is linked via a unique identifier generated by the HIS. Image data are processed and stored in PACS with reports in RIS and administrative data in HIS with individual storage and backup [(1)].

The basic structure of PACS consists of institutionalised digital imaging modalities (CT, MRI, etc) and radiological workstations for review and interpretation, connected via a Local Area Network (LAN) or Wide Area Network (WAN). All institutions engaged in this system are interconnected via a general purpose network (often via a Virtual Private Network – VPN or Secure Sockets Layer – SSL, through internet) and also to a centralised server for storage and backup. The standard used in PACS for image distribution, handling and storage is Digital Imaging and Communications in Medicine (DICOM 3.0) [(3)]. Scanned documents and related non-image data are incorporated using consumer industry standard formats such as Portable Digital Format (PDF).

Images from various medical imaging instruments including digital radiography (DR), US, MRI positron emission tomography (PET), CT, endoscopy (ENDO), MG, computed radiography(CR) can be readily incorporated into PACS. These are stored both locally and remotely on off-line media such as tape or optical media, or partially or exclusively on hard disks. Although practically limited, depending on the band with and image volume some images may be transferred encrypted via the internet. Hard drives are configured to PACS server as Direct Attached Storage (DAS), Network Attached Storage (NAS) or via a Storage Area Network (SAN) with the capability of "hot swapping". Data stored on disk are backed up to tape or optical media or copied, in real time, to a slower, inexpensive disc. This is done often off-site. Two such backups may be taken in certain systems and remove them from the site on a rotating basis.

Images are retrieved from a PACS server through a C-MOVE request, as defined by the DICOM network protocol. Several proprietary DICOM viewers are available such as NovaPACS by Novarad, Medstrat, Myrain by Intrasense, eFilm and K-Pacs. Also open source products such as Asekulap, OsiriX and Kradview are in use.

Does PACS Offer a Solution?

The benefits of PACS are based on its main functionality; viz. hard copy replacement [(2)]. The digital images so generated, transferred, stored and retrieved are called "soft copies". Essentially, with the decreasing in the price of digital storage and hardware advancements, PACS will provide a considerable and growing cost and space advantage over film based

archives for a developing nation as Sri Lanka. The present burden of lost, spoilt films and painstaking retrieval methods would be a thing of the past. Digitally archived images can be easily available by improved use of online storage and nearline storage in the image archive. The PACS can obtain lists of appointments and admissions in advance, allowing images to be pre-fetched from off-line storage or near-line storage onto online disk storage. Radiologists will then be able compare displaying reference images from other or earlier examinations of the same patient [(2)] at a fraction of a time. Soft copies can be easily manipulated and copied for multiple viewing. PACS workstations offer an interactive display of digital images. PACS workstations offer means of image manipulation through functions such as crop, rotate, zoom, window, level and others [(2)]. This will allow the radiologists a better and improved view for faster and accurate diagnosis. The advantages of remote access will maximise the manpower utilisation of the limited number of consultants available in both radiology and other fields in Sri Lanka. Further, the inequitable distribution of specialists can be counter acted by teleradiology, telediagnosis and telemedicine [(2)] where frequent transportation is costly, time consuming and on occasions hazardous for both patients and doctors.

PACS provides the electronic platform for radiology images interfacing with other medical automation systems such as HIS, Electronic Medical Records Systems (EMR), Practice Management Systems, and RIS. Therefore, patient related non-image data can also amalgamated into the PACS DICOM interface thereby eliminating the disadvantages of paper based referrals and BHT as discussed earlier.

Further, PACS-HIS-RIS combination will significantly cut down the running costs on all data processing by total elimination of the use of paper, reduction in stationery requirements, filing space, films, processing chemicals, film transport costs and staffing [(2)]. Medical images will never be spoilt or lost, hence never be repeated, saving massive amounts. Further, the congestion and over utilisation of the system will be reduced. The overall system will be very efficient and fast enabling to productively cater to the ever demanding patient base. PACS therefore can be deemed to produce quality and equitable health care as much needed for Sri Lanka.

Discussion

This promising technology seems almost fictitious. For the people of Sri Lanka to reap the benefits of such an advanced system much planning, consideration and effort needs to be exercised to establish the identified prerequisites. It is deemed mandatory to establish a seamlessly functional HIS and RIS environment beforehand [(1)]. The purely digital “filmless” hospitals can only be approached this way. Only then can the maximal return on the PACS investment be achieved. Sri Lankan hospitals currently lack an organised digital system, though sporadic developments of digital systems are observed country wide. Hence, an initial step would be to formulate a national policy on health IT and standards. Careful consideration should be given to the development of “home-grown” systems and open source materials as opposed to proprietary software. Basic technologies of networks and storage media also need to be developed [(1)]. It is the responsibility of the healthcare authorities to strike a balance between initial investment costs and long term reliability bearing in mind not to burden the already high health budget. The legislature also needs to be adjusted to accommodate and accept digital documentation.

Once in place, RIS-PACS complex must also efficiently map the operational work and data flow inside radiology departments and communication relations to radiology environments in

hospitals. Only then will it improve the patient care and workflow in the department of radiology itself [(1)]. Analyses show that comprehensive communication of patient demographic and clinical data between RIS, PACS and HIS are necessary prerequisites to achieve cost effectiveness. In order to achieve this, a successful change management strategy has to be launched aimed at making Sri Lankan hospitals more PACS receptive. This strategy should include among others, a planned and delicate approach for organisational workflow change. Emphasis should be given to achieve more flexibility on the present rigid structure of interdepartmental relationships and inter-institutional relationships by change of attitudes among stakeholders.

The required changes of attitude towards the acceptance of PACS partly depend on what it premises to deliver. If a system has a "first order effect" on the quality of diagnosis or therapy, it is a sufficient success factor and other factors like cost, ease of use etc. become secondary. If a system only has a "secondary effect" (only indirectly benefiting the quality of care) then acceptance is much slower and depends on a kind of trade-off of different factors [(1)]. PACS has proven to deliver both of these as discussed and therefore can be deemed to be accepted by the Sri Lankan health care providers, officials and patients alike. Studies also have shown that both radiologists and physicians give evidence of an excellent level of user acceptance [(4)] in countries where PACS has been operational.

It is also worthwhile to note studies done on quantitative analysis of report turnaround time (RTAT). The immediate post-PACS RTAT has shown a drastic improvement whilst the late post-PACS RTAT mellows down to a more realistic improvement. This is probably due to the direct initial involvement of enthusiastic key technological personnel in most PACS rollouts rather than due to pure technological advantage [(5)]. Therefore, it is important to develop key actors who can bridge the technological and medical divide and focus on wider organisational concerns for a sustainable system in Sri Lanka.

Conclusion

PACS have the potential for immense rationalization of operations in radiology and hence for the improvement of health care, as well as the return of investments. These systems must, however, be carefully designed such that they support routine work rather than being an additional burden. Further, apt consideration should be given to local factors, improvement of basic technology, organisational factors, staffing, human aspects and attitude, policy and legislation, for the system to be viable and sustainable. It should be noted that film based systems inevitably will become obsolete and unless otherwise Sri Lanka gears up to the challenge of health care digitization, we as a nation would be confined to the "dark rooms" in search of the "last remaining film".

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