## PACS: TAKING RADIOLOGY INTO THE 21st CENTURY.

There are certain inventions that are rightly termed "Game Changers". Personal computers, mobile phones, digital cameras can all be placed in this category. In the field of diagnostic radiology there have also been many such innovations. The multi slice CT scanner, the humble ultrasound and ofcourse the Magnetic Resonance Imaging immediately come to mind. There is another such game changer which has been around for over a decade but only just making its appearance on the Pakistani scene. This is Picture Archiving and Communication Systems or simply PACS.

PACS has revolutionised how radiological images are stored, reported and distributed. Not only has radiology work flow and patient care been changed forever it has also had a huge impact on education and evaluation of trainees not only in radiological sciences but in all clinical disciplines.[1] The global impact is evident however as PACS is in its early period of evolution in Pakistan, its impact here has been limited. This article sets out to describe the basic components of a PACS system and describe how it may be able to achieve cost savings along with improving service, education and research in Radiology.

### PACS: Basic Considerations

PACS is essentially a database program that stores images. Like all computer applications it requires some hardware (the computers that will store and process the data) and the software that will organise and manipulate this data. In its simplest form the entire PACS may be a single desktop PC which receives, stores and displays the images. In its most complex form it may be a country wide system with hundreds of healthcare facilities linked to each other by a high bandwidth network, having many servers and data centres with thousands of terabytes of data. One such example of a country wide system is the National Health Service Systems in the UK.[2]

The exact make up of the system depends on the scope of the work to be undertaken. This should take into account many different parameters. These include but are not limited to the clinical requirements, the amount of data to be stored, the minimal acceptable availability, the length of time the data needs to be stored, the number of users, the distribution requirements, the level of data security required and the resources available to implement this system.

The kind of hard ware required is largely standard. Broadly this consists of a storage computers to store the images, workstations to review and retrieve them and a network to connect all the components. The software however varies significantly. The data security and loss are major considerations. Back up and disaster recovery solutions are essential to ensure that the smooth long-term working of the systems. Reliable and robust networks form the backbone of the system. Image viewing may be done on standard VGA monitors for clinical review however for radiology diagnostic readouts high resolution mega pixel monitors are recommended.

Both the back end applications which maintain the database and the front end viewers vary between the providers. The format in which the images are stored also varies. Most PACS systems store the images in a format called Digital Imaging and Communications in Medicine (DICOM) while a shrinking number of solutions use propriety formats. DICOM archives are the way forward as it allows the mobility of the images and is much more robust. The standards for image storage and communication have their origin in a working group set up in USA by the American College of Radiology and National Electronic Manufacturers Association. This group known as ACR/NEMA developed the first standard in 1985. This standard known has ACR/NEMA300 has matured and evolved over time into the current standard called DICOM 3.0. This standard governs the all aspects of medical imaging including handling, storing, printing, and exchange of image data. As the standard

defines both the file format and a network communications protocol, DICOM files can be exchanged freely between two entities that are capable of receiving image and patient data in DICOM format. Needless to say that all this is only possible if the images are generated in digital format. This is usually not an issue with the modern CT, MR and Ultrasound scanners as they are all DICOM compatible (although it is worth verifying that they are fully DICOM 3.0 compliant before embarking on a PACS). Plain films need to be acquired using either a Computed Radiography (CR) or a Digital Radiography (DR) system to ensure compatibility.

The implementation of a Radiology Information System (RIS) is also a prerequisite of a good PACS environment. Having said this a RIS is not essential for PACS but the functionality of any PACS is significantly improved if it is working in conjunction with a compatible RIS. Several PACS vendors therefore also market their own RIS as well to take advantage of this expanded functionality.

**Impact of PACS:**

Patient care: Distribution of hard copy images is not only problematic but also prone to break down and image loss, The image needs to move physically where ever a clinical decision or a consult needed to be made. As the physical films are bulky their storage is both expensive and space intensive. Storage in itself is useless unless they are retrievable when needed. This requires indexing and other archiving facilities. Due to the many problems associated with them, most health care facilities in Pakistan have shied away from long term image storage. The patients a have the added burden of caring for their image records. They have to carry them whenever they come for a follow up. They images are therefore not always available when needed. In addition to improved availability there is a significant improvement in the efficiency of the radiology work flow and report turnaround times,[3] Our own experience has also borne out these efficiency saving. Images are simultaneously available for reporting and review on the clinical floors and the inordinate delays in reporting due to non-availability of images no longer occurs. As all images are available online the need to compare with any previously achieved scan takes seconds. Expert opinions from subspecialists is available round the clock as the images may be viewed from anywhere in the world using a web portal. The overall effect has been a huge improvement in patient care.[4]

Research And Education: Evolution of the digital image and PACS has revolutionised the development of educational resources. Copying of radiology images was associated not only with cost but also with loss of image quality. Digital archives are robust, easily shared and of a quality that is no different from the original image. The teaching of radiology trainees can take place directly from the PACS. Anonymised archives to protect patient confidentiality can be generated. There is no deterioration of image quality over time. Similarly research is facilitated as the archives are searchable and similar images and cases can be located without too much difficulty.[1]

**Barriers in PACS Implementation:**

Although most obvious barrier appears to be the cost involved, as the advantages of PACS are largely quality related and do not improve revenues or reduce direct costs (other than cost of films) actual experience is somewhat different. The most often experienced barrier is the attitude of the users and lack of knowledge and understanding. Lack of adequate training and change management is also a significant barrier to acceptance of PACS. The change in the work place associated with the implementation is threatening to some practioners particularly those who are uncomfortable with technology. All these barriers are manageable with good project management and strong leadership.[5]

**Conclusions:**

Implementation of PACS will change radiology forever. If done properly for the better, if not for the worse. It is important that organisations embarking on the PACS journey educate themselves as much as possible regarding the nuances of living in the digital world. It is also important to assign adequate resources not only to acquisition of the system but also to change management and training of users. Without training and support PACS is doomed and will fail at the first hurdle.

**References:**


1. Gutierrez A. , Mullins M., Novelline R., Impact of PACS and Voice-Recognition Reporting on the Education of Radiology Residents. Journal of Digital Imaging, June 2005;**18(2):** 100-8.

2. Collin S, Reeves BC, Hendy J, Fulop N, Hutchings A, et al. Implementation of computerised physician order entry (CPOE) and picture archiving and communication systems (PACS) in the NHS: quantitative before and after study.*BMJ*.2008;**337:** a939.

3. Lepanto, L., Paré, G., Aubry, D., Robillard, P. Lesage, J., Impact of PACS on Dictation Turnaround Time and Productivity. Journal of Digital Imaging, January 2006;**19(1):** 92-7.

4. Paskins Z. A. Rai, A. The impact of Picture Archiving and Communication Systems (PACS) implementation in rheumatology. Rheumatology 2006;**45:** 354-5.

5. Paré G. , Trudel MC, Knowledge barriers to PACS adoption and implementation in hospitals, International Journal of Medical Informatics, January 2007;**76(1):** 22-33.