COMPUTED RADIOGRAPHY (CR) INSTALLATION: LESSON LEARNED AT AGA KHAN UNIVERSITY HOSPITAL

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Introduction

Computed Radiography (CR) has gradually become a symbol of quality radiography services in Pakistan. Despite slower adoption at national level, yet every person from radiographer to radiologist and clinicians to surgeons are becoming more and more convinced to the imaging quality produced by CR. Five years back, when the word 'CR' was a jargon to radiology personnel, Aga Khan University Hospital (AKUH), being the leader in adoption of CR system, started installation and integration with picture archiving and communication system (PACS) and Radiology Information System (RIS).

Background

Aga Khan University Hospital (AKUH) is a JCIA[1] certified 500-bed tertiary healthcare hospital located in southern part of Pakistan and serves the most populated city, Karachi. Currently AKUH radiology department[2] is providing services to more than 200,000 patients annually and is equipped with modern diagnostic machines and IT infrastructure including telemedicine facility. Back in 2004, AKUH looked into possibility of installing Computed Radiography (CR) system with an objective of improving the quality of imaging and as a result increasing the productivity. During installation phase AKUH went through a different nature of experiences which are more specific to developing world; and that is why this paper shares those experiences and the lessons learned in the process of purchase and installation. We believe that these experiences and the lessons learned can prove beneficial for any radiology department which is planning CR system installation in Pakistan.

The remaining article first describes the scenario we faced and then the lesson learned from that particular scenario.

Scenarios and lesson learned

1. **Scenario:** Five years back, when no one was using CR in the country, providing the justification of CR image quality and convincing hospital administration for CR purchase were the aims which we wanted to achieve in first place. Therefore radiology department invited country's one of the leading vendor for demo installation. The whole process took more than six months and luckily all effort proved in favor when CR images were compared with the conventional radiography images. After a successful demo-run and convincing the hospital administration based on referring physician's feedback, RFP (request for proposal) was distributed for the purchase of CR.
   Lesson one:
   Be prepared for the financial **justification of CR purchase** in terms of quality and finance. Try convincing vendor for demo-unit installation. This way technologist, radiographer and radiographer will get hands-on experience on the CR. Changing the mindset of hospital administration can be influenced by physician's feedback and suggestions

2. **Scenario:** Once hospital decision makers are convinced for budget release, next step of **"planning the best deal"** came in. In a developing country like Pakistan, purchase and installation of CR was

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not that simple as anticipated. In 2004, when we started the purchase process, there were no local consultancy services available for helping in estimating the need and proposing the customized CR solution according to specific needs. Based on our eight examination-rooms requirements, we estimated the usage of individual items which make the CR system. Those components were number and size of imaging plates (IP), quality assurance and registration consoles, IP readers and printer specifications. We also considered the depreciation cost of CR system components. Based on budget constraints, we tried to implement the CR system which could expand to higher scale in future. After a complete estimation study, with assistance of biomedical and information technology departments, we prepared a wish list of items and asked for proposal from three vendors who were selling the product in Pakistan. We intentionally avoided third-party CR sellers due to after-sale support issues.

Lesson two:

Currently, three major vendors have CR installations within Pakistan. Try visiting installed setups and make sure that your visit is not escorted by vendors as they may influence you or the owner of the system who have purchased the system.

To get the best deal, we tried to create a competition among local vendors. Vendors were invited to submit the CR system details for purchase.

Involve IT and Biomedical experts from the beginning as CR system is not an independent entity like X-ray unit or CT scanner.

Consult experienced CR/PACS experts (if available) who are into this business of installation and expansion.

Make sure that whatever you purchase should have the capability to be integrated with other CR vendors' equipments in future. This would help protect you from monopolizing situation by vendor. For example option of connecting film-printer from other company.

Do not downsize the number of CR registration station. Consider one to one ratio for registration station to examination room. Every room must be equipped with CR registration console connected with CR QA and reader consoles. This helps in dealing with greater number of patient at same time and consequently decrease patient waiting time ad increases patient satisfaction. Do not forget to include DICOM file export that is "Image export functionality on compact-disc". Most of the time this area is not highlighted by vendors but from hospital perspective, this is the potential area which gives options to radiology department that either print films or give an option of giving Examination-CD to patient.

3. **Scenario:** Mostly, CR system is packaged with DICOM dry laser printer. We have that production cost of CR-film is approximately double the cost of conventional-film production. The calculations were made keeping consumables items in either case.

   Lesson three:

   CR should be run in film-less PACS environment; meaning printing the films only on patient's need basis. Running CR with film-printing must be discouraged and alternatively CR must also be equipped with exam-CD production module. At the end, it would be patient's choice that either to pay more for film-prints or to chose a CD containing high quality images and report.

4. **Scenario:** To be cost effective with film production, we tried to decrease the life size image on film thus producing more than one images on single printed film. Decrease in image size was processed through software of CR system. But soon our radiologist noticed that it decreases the diagnostic significance of image and also causes dissatisfaction in referring physicians. Therefore, we reverted back to life-size image printing with exception in fluoroscopy imaging.

   Lesson Four:

   CR films (if unavoidable) must be printed in life-size image format. In Pakistan, it is now becoming a common practice of decreasing the life-size images on film print. Although this practice is profit-friendly but with compromise of patient's diagnostic imaging. We have learnt that there must be a national policy which every radiology diagnostic service should comply with.

5. **Scenario:** Once the system is in place and the vendor gives the green signal for daily use, acceptance by end-users must be the aim. It not only deceases the transition period but also increases the production in terms of quality and

finance. The primary users of CR are technologist and radiographers who interact with the system at first level. After installation, our radiology staff went through a very tedious process of transition.

Lesson five:

Administration must realize the fact that CR system is not just adjusting exposure values and developing resultant film. CR system completely changes the workflow of X-Ray image production. Therefore there should be change management team that should conduct **training sessions** for radiologist and radiographers. Training should be vendor's responsibility with the concept of 'train the trainer'. Vendor should also be asked for continuous presence in equipment area for first three month after installation. Our experience at AKUH proved the fact that beside radiography skills, computer literacy and aptitude towards technology is a key to successful running of system. We observed that junior radiographers between the ages of 20-30 years adapted CR system at faster pace as compared to senior level radiographers of 40-50 years of age. Similarly, radiographers' rotation in other sections should be closely monitored in a multi-modality department. We learnt that new radiographers at least take 10 -15 days to get familiarized with CR workflow. Therefore radiographers' turnover along with CR software upgrades should be closely supervised by section in-charge.

6. **Scenario:** Integration of CR with information systems in hospital is another area of importance. Technically, CR integration with Hospital information system - HIS (or Radiology information system - RIS) and with PACS (Picture Archiving and Communication System) adds productivity and improves quality reporting. Our technical team gave a special attention to inclusion of integration functionality during purchase of CR system and that is why we were able to connect our CR with RIS and PACS. The process of connecting other system requires the presence of integration specialists from local IT department and biomedical staff as well as from vendor's engineers.

   Lesson six:

   We have found that integrating **CR with RIS and PACS** is not just an exchange of data. This process threatens various traditional practices which senior age group radiographer may be reluctant to. Therefore training of the staff should be started from very first day of CR installation. Technically, we have observed, exchange of data between systems involves mapping of exam codes and other parameters to be understood between systems. Integration specialist must be hired or consulted during this phase of installation. IHE[3] must be considered for flawless complete connectivity. Lastly, do not ignore the inclusion of HL7[4] and DICOM[5] connectivity components in your purchase.

7. **Scenario:** CR when connected with hospital internal computer network can get infected by computer viruses; which then can lead to shutdown of whole CR system. Using anti-virus computer program which checks the information coming in and going out of CR system provides a safe barrier. Our CR system with vendors' computer anti-virus, suffered a serious breakdown due to unavailability of on-time updated version of antivirus program.

   Lesson seven:

   During the purchase of CR system, **antivirus program** must be considered as a necessary part and it must be agreed by consensus about the responsibility of on-time update of antivirus. The protocol for update of system must be agreed between vendor and buying-authority; and must be linked with vendors liability if in case system goes down due to non-updating of antivirus program resulting in infection. Remember, higher configuration demands higher commitments.

8. **Scenario:** CR communicates and share information with RIS and PACS through computer networks. Therefore computer network must be fast enough to not hamper the workflow of CR staff. Network is measured in bits per second (bps) and termed as bandwidth. AKUH network supports 100 Mbps to 1Gbps, based on the demand of particular radiology area. Bandwidth becomes crucial when PACS might be receiving images from more than one imaging modalities (for example CT and MRI).

   Lesson eight:

   If your department is considering PACS or RIS connectivity in future, then consider minimum 1Gps

network bandwidth; from end to end computer systems.

9. **Scenario:** CR equipment is sensitive to electric power failure. Beside this, patient may need to be re-exposed to radiation if power goes down during CR-based image acquisition and saving procedure. We did not realize the importance until first electric failure. It caused whole CR system out of order and we had to switch to conventional backup system.
   Lesson nine:
   Equip CR and network switches with **emergency power.** Emergency power must be both uninterrupted power supply (UPS) and electric generators.

10. **Scenario:** Unlike conventional system, CR system demands proper air-ventilation, temperature and dust-control measures. These measures help increasing the life of CR system components. For example, in our setup, improper cleaning or sticking on computed radiography IPs (Imaging Plates) and choked air ventilation ducts introduced mechanical fault in CR system which was later rectified by on-time support from vendor. We realized that CR requires extra measures for dust control and temperature control and it is not that simple as running darkrooms.
    Lesson ten:
    Consider a newly or modified designed **environment for CR equipment** which can provide good ventilation, dust protection and temperature controlled environment. Beside this, also consider regular equipment maintenance procedures without making complete system down. Maintenance should be performed in a way that routine CR procedure should not be stopped. Vendor with biomedical department must agree about procedure and responsibility for maintenance exercise.

11. **Scenario:** In Pakistan, availability of trained experts from vendors is still an area of attention. We at AKUH suffered frequent shutdown of CR equipment at the time of deployment, because of non availability of experience staff. CR system was first of its kind for us and for our vendor; therefore experts also took time to understand the system thoroughly. We had a horrible time as we had to deal simultaneously with change in staff's workflow as well as training of experts. After three months of installation, our CR system gradually became stabilized in performance and now it seldom goes down.
    Lesson eleven:
    Minimize vendor dependency by training your in-house engineers and radiology staff from vendor's main support center before deployment of system. Try to have experienced opinion from people who are already running the system from the same vendor. Do not forget to include trouble shooting maintenance, response time and rectification time in your agreement papers. Also ask for compensation in terms of software or hardware upgrades and provision of consumable items.

12. **Scenario:** One of the biggest challenges during CR downtime is to fix the technical problem without loosing time and simultaneously keep business workflow least affected. Technical fixing is handled as per AKUH internal protocol, but the business workflows require shifting to conventional radiography seamlessly. We have noted that conventional system does not produce digital films and therefore all digital benefits of CR get compromised.
    Lesson twelve:
    Be prepared for **CR downtime and make preemptive measures** to deal with emergency situation. CR downtime demands standby conventional film equipment so that patient diagnostic services must not be compromised. Beside this, radiology setups should consider film digitizer/scanners as backup equipment for PACS integration. Film digitizer is usually sold by third-party vendors; with compatibility information with CRs and PACSs. Department may consider it as an essential part of film-less and PACS-based environment.

13. **Scenario:** Shortage of film-supply may lead to shutdown of CR system. AKUH had a experience of shortage once since the installation and then consequently we had to revert back to conventional system for one day.
    Lesson Thirteen:
    To date, mostly CR setups in Pakistan produces films as end product; and therefore the problem is more specific to Pakistan and has not been mentioned in literature. As an advice, make your

vendor liable in case of any **shortage of consumable items** such as films; or alternatively, to avoid one vendor dependency, department may accept offer of installation of film printer from other vendor as backup; thus also creating a competition among companies for good service and availability of consumables in stock. We have also learnt to make a stock of at least one month films available in-house all the time.

14. Radiology staff experienced errors in CR systems of mild to sever nature (see figure)

    Mild errors with no system shut down
    Reasons: difficulties in image workflow and abnormal delays due to slow system response etc;
    Moderate errors with partial system down
    Reasons: mechanical faults, IP quality, software upgrade etc;
    Sever errors with complete system down (sometimes)
    Reasons: Virus issues, electric failure, network failure etc)

    We at AKUH kept the log book for each and every minor to major errors. This proved vital as error arose and we could watch trends.

    Lesson fourteen:

    Do **quality audits.** This really helps putting you in better position for getting good support services on time.

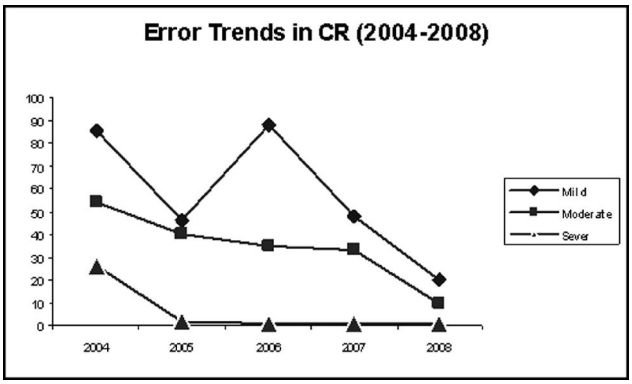

Figure: CR error significantly decreases over period of time.

Summary

Computed radiography is different from conventional radiography and it is designed to improve the pace of work and imaging quality. CR-based operations demand discipline and a specific order of implementation, beginning with technical support and backed by innovative leadership. As AKUH completes four years of CR-based operations, we asked our radiologist and clinicians if they feel disappointed with CR performance. We have not yet met any person saying 'No'.

Despite realization of quality improvements, radiology diagnostic-services in Pakistan may find difficult shifting to CR, primarily due to financial constraints; and here comes the role of government and vendors for devising the best financial deals. Radiology departments lived their lives playing with films and now this is the era of change, a change which will certainly reorder the world of radiology in Pakistan.

References

1. Joint commission of international accreditation, Website: http://www.jointcommission international.org/ (last accessed on 11 February 2009)

2. Department of Radiology, Aga Khan University Hospital, Website: http://www.aku.edu/AKUH/ Services/radiology/ (last accessed on 11 February 2009)

3. Integrating the healthcare enterprise (IHE), website: www.ihe.net (last accessed on 11 February 2009)

4. Health Level 7, Website: http://www.hl7.org (last accessed on 11 February 2009)

5. Digital imaging and communication in medicine, Website: http://medical.nema.org (last accessed on 11 February 2009)