Image Distribution in Electronic Patient Record at an Enterprise Level - Benefits to Clinical Practice with Special Focus on Radiology

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Authors: T. Chan; Hong Kong/HK
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**Learning objectives**

Explain what is ePR with image distribution at enterprise level

Demonstrate its benefit to clinical practice, with special focus on radiology

Discuss future developments of ePR with image distribution
Background

What is ePR with Image Distribution

Text based electronic patient record (ePR) has many advantages over traditional paper based medical record, including improved legibility over handwritten notes, easy retrieval and transfer of information, as well as assessibility by multiple parties. However, the full potential of ePR in streamlining patient care cannot be achieved when important information available from images is only available from paper or films outside of the electronic information system. Therefore ePR with image distribution is a natural extension of text based system.

Alongside with technological advancements that allow economical transfer and storage of the massive amount of data, image distribution in ePR becomes reality. This significantly enhances usability of ePR by providing information available in images that is be difficult to be effectively represented by textual description. The images concerned can be those obtained from radiological examinations, ultrasound, CT, or MRI, as well as other possible sources like pathology, endoscopy, ophthalmology, dermatology, electrocardiogram or electroencephalogram, diagrams outlining procedures. The technological requirements required for handling these very heterogeneous data of variable formats and sizes can be challenging.

Furthermore, in health care enterprise that manages multiple hospitals and health care facilities, between which patients or clinicians may move around and still expect to have the same information available to them, ePR with image distribution becomes even more complicated.
Imaging findings OR Procedure details

Case study of HK Hospital Authority

Hong Kong Hospital Authority (HA) is a statutory governing organization of all public sector hospital service in Hong Kong, serving a population of more than 7 million. It manages in total 41 hospitals and 122 outpatient clinics, with a workforce of more than 50000 staff. It has implemented its enterprise wide ePR with image distribution since 2004.

Currently the ePR is accessible to authorized clinicians throughout the whole enterprise. Images available include those from radiology, endoscopy, and operative records.

For Radiology, images from PACS in an imaging facility will be routed to data center residing within the nearest hospital via local DICOM gateway, and stored in a local image server there, which is available for distribution within the same hospital. These images will then be sent to the corporate data center of the whole enterprise using dedicated WAN, with images stored in dedicated image servers, and corresponding record updated in the enterprise wide ePR server. Such images then become available to the whole enterprise via query and retrieve made from ePR workstations anywhere in the enterprise.

The huge amount of data involved in modern imaging examinations, e.g. multidetector CT or multiple sequences in MRI examinations, is obviously become burdensome on both storage capacity and network bandwidth. As medical images distributed with ePR are essentially used for review after primary diagnosis has been made, and original data are available on the indigenous PACS or other information systems, it is rational to employ some form of image selection or compression, e.g. reformat of thick section 2D data from 3D raw data, or selection of representative image data, e.g. photos taken during endoscopic examination.

Benefits to Clinical Practice

Image distribution in ePR brings together information residing in images produced by different sources and other text based data to clinicians in a single platform. Benefits include improvement in diagnosis by allowing: 1. correlation with relevant clinical history; 2. correlation between different investigations; 3. correlation between different imaging examinations, even if they have been obtained in different imaging facilities.
In addition, other uses of ePR with image distribution include: 1. guidance of procedures with reference to prior imaging findings; 2. monitoring disease progression; and 3. providing basis for clinical decision making.

Last but not least, incorporation of images available to different clinicians enhances communications when visual cues available from images can be readily appreciated by different involved parties. Good communication is essential when collaborative efforts need to be taken.

**Future Developments**

Incorporation of image distribution with ePR is advantageous as discussed before. In addition to incorporating ever more different kinds of images (or multimedia, for that matter), some future developments in ePR with respect to image distribution that are anticipated to improve patient care include technologies in 1. extracting more useful information from images, 2. decision support, 3. knowledge discovery.

Information available from images can be obtained by direct visual inspection, simple measurements off the images, or calculations from imaging parameters. To extract more information, some simple functions like measurements or reformat are becoming available to ePR workstations to allow better evaluation of abnormality. Also, capability to display useful annotations made on the images by prior readers, e.g. radiologist making the primary diagnosis, will also help to highlight some important findings and further enhance communications between clinicians.

To make ePR a more efficient decision support tool, some new tools in imaging informatics, e.g. content based retrieval of similar images from database and computer aided diagnosis, can be incorporated into ePR. It is also envisaged that automatic assimilation or highlighting of other investigation results, e.g. tumor marker level from blood tests, can become part of such decision support tools. Another possible development for decision support can be some links to retrievable clinical management guidelines, selected based on the type of image and region of examination and made available to the viewing clinicians, e.g. BIRADS classification and suggested actions or alert of follow-up linked to mammogram examination.

With the incorporation of multifaceted information including images of numerous patients, the ePR database can be an ideal place for knowledge discovery. There will be multiple attributes available for data mining that examine relations between multiple variables and discover knowledge previously unknown of.
Fig. 0: This is a screen shot taken from the ePR. The left hand side window shows a summary of the patient containing tabs of alert, diagnosis, procedure, clinical note, laboratory results, radiology record, and medication. Clicking any of these tabs will open the top panel on the right, which shows a list of chronologically sorted examinations, from which results of a particular examination can be selected and displayed in the lower panel. For radiology, the images as well as their reports can be opened from the icons associated with each examination.
**Fig. 0:** This is the image display of CT images archived in the ePR system of the same patient as in Figure 1. When images of an examination is requested by clicking on the image icon, images are retrieved from ePR central image archive and displayed on the client image display software. Some simple display functions, include display format, zooming, windowing, and some simple measurements like length and ROI measurements, are available. Here it shows a recurrent tumor after cholecystectomy for gallbladder cancer.

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Fig. 0: This screenshot belongs to another patient, who underwent surgical work up after an incidental finding of tumor in stomach on gastroscopy. Subsequent reviewer can readily appreciate the mucosal extent of the disease and plan for treatment options.

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Conclusion

Enterprise-wide ePR with image distribution brings clinical data and images from heterogeneous systems to a unified platform that improves efficiency of health care delivery. Architecture considerations and implementation of such a system in Hong Kong is introduced.

This benefits clinical and radiology practice by allowing improved diagnosis, facilitate use of images for image guided procedures and disease monitoring, and improved communication amongst clinicians. Continuous developments include technologies like decision support and knowledge discovery will further enhance its applications and help to streamline patient care.
Personal Information

Dr. Tao Chan
MB ChB, PhD, FRCR, FHKCR, FHKAM (Radiology)
Clinical Assistant Professor
Department of Diagnostic Radiology
The University of Hong Kong

correspondence address:
Room 406, Block K, Queen Mary Hospital
Pok Fu Lam
Hong Kong

e-mail:
taochan@hku.hk


