Picture Archiving and Communication System in Health Care

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INTRODUCTION

Radiology is the branch of medicine that deals with the diagnostic and therapeutic applications of radiation. It is often used in X-rays in the diagnosis and treatment of a disease. Filmless radiology is a method of digitizing traditional films into electronic files that can be viewed and saved on a computer. This technology generates clearer and easier-to-read images, allowing the patient the chance of a faster evaluation and diagnosis. The time saved may prove to be a crucial element in the patient's treatment process. With filmless radiology, images taken from various medical sources can be manipulated to enhance resolution, increasing the clarity of the image. Images can also be transferred internally within departments and externally to other locations such as the office of the patient's doctor. This is made possible through the picture-archiving and communication system (PACS; Dreyer, Mehta, & Thrall, 2001), which electrsonically captures, transmits, displays, and saves images into digital archives for use at any given time. The PACS functions as a state-of-the-art repository for long-term archiving of digital images, and includes the backup and bandwidth to safeguard uninterrupted network availability. The objective of the picture-archiving and scommunications system is to improve the speed and quality of clinical care by streamlining radiological service and consultation. With instant access to images from virtually anywhere, hospital doctors and clinicians can improve their work processes and speed up the delivery of patient care. Besides making film a thing of the past, the likely benefits would include reduced waiting times for images and reports, and the augmented ability of clinicians since they can get patient information and act upon it much more quickly. The creation of a permanent, nondegradable archive will eliminate the loss of film and so forth. Today, the growing importance of PACS on the fight against highly infectious disease is also identified.

BACKGROUND

PACS (Huang, 2004) started with a teleradiology project sponsored by the U.S. Army in 1983. A follow-up project was the Installation Site for Digital Imaging Network and Picture Archiving and Communication System (DIN/PACS) funded by the U.S. Army and administered by the MITRE Corporation in 1985. Two university sites were selected for the implementation—the University of Washington in Seattle and Georgetown University and George Washington University Consortium in Washington, DC—with the participation of Philips Medical Systems and AT&T. The U.S. National Cancer Institute funded one of UCLA's first PACS-related research projects in 1985 under the title Multiple Viewing Stations for Diagnostic Radiology.

The early installations of PACS in public healthcare institutions were in Baltimore Veterans Administration Medical Center (United States), Hammersmith Hospital (United Kingdom), and Samsung Medical Center (Korea). In Hong Kong, there was no PACS-related project until the establishment of Tseung Kwan O Hospital (TKOH) in 1998. The TKOH was a newly built 600-bed acute hospital with a hospital PACS installed for the provision of filmless radiological service. The design and management of the PACS for patient care will be discussed in this article. The TKOH was opened in 1999 with PACS installed. At the beginning, due to immature PACS technologies, the radiology service was operating with film printing. A major upgrade was done in 2003 for the implementation of server clustering, network resilience, liquid crystal display (LCD),

smart card, and storage-area-network (SAN) technologies. This upgrade has greatly improved the reliability of the system. Since November 2003, TKOH has started filmless radiology service for the whole hospital. It has become one of the first filmless hospitals in the Greater China area (Seto, Tsang, Yung, Ching, Ng, & Ho, 2003; Tsou, Goh, Kaw, & Chee, 2003).

MAIN FOCUS OF THE ARTICLE

It certainly goes without saying that most equipment is designed for reliability, but breakdowns can still occur, especially when equipment is used in a demanding environment. A typical situation is what could be called a "single-point failure." That is, the entire system fails if only one piece of equipment such as a network switch fails. If some of the processes that the system supports are critical or the cost of a system stop is too high, then building redundancy into the system is the way to overcome this problem. There are many different approaches, each of which uses a different kind of device, for providing a system with redundancy.

The continuous operation of a PACS in a filmless hospital for patient care is a critical task. The design of a PACS for such a system should be high speed, reliable, and user friendly (Siegel & Kolodner, 2001). The main frame of the design is avoiding the occurrence of any single point of failure in the system. This design includes many technical features. The technical features of the PACS installed in a local hospital include the archiving of various types of images, clustering of Web servers installed, redundancy provision for image distribution channels, and adoption of bar-code and smart-card systems. All these features are required to be integrated for effective system performance and they are described below.

ARCHIVING OF MULTIPLE IMAGE TYPES

In order to make connections with different imaging modalities, a common international standard is important. The Digital Imaging and Communications in Medicine (DICOM) standard developed by the American College of Radiology (ACR) and the National Electrical Manufacturers' Association (NEMA) is the most common standard used today. The DICOM standard is extremely comprehensive and adaptable. It covers the specification image format, a point-to-point connection, network requirements, and the handling of information on networks. The adoption of DICOM by other specialties that generate images (e.g., pathology, endoscopy, dentistry) is also planned.

The fact that many of the medical imaging-equipment manufacturers are global corporations has sparked considerable international interest in DICOM. The European standards organization, the Comitâ Europâen de Normalisation, uses DICOM as the basis for the fully compatible MEDICOM standard. In Japan, the Japanese Industry Association of Radiation Apparatus and the Medical Information Systems Development Center have adopted the portions of DICOM that pertain to the exchange of images on removable media and are considering DICOM for future versions of the Medical Image Processing Standard. The DICOM standard is now being maintained and extended by an international, multispecialty committee. Today, the DICOM standard has become a predominant standard for the communication of medical imaging devices.

WEB TECHNOLOGY

The World Wide Web (WWW) began in March 1989 at CERN (CERN was originally named after its founding body, the Conseil Europeen pour la Recherche Nucleaire, that is now called the European Laboratory for Particle Physics.). CERN is a meeting place for physicists from all over the world who collaborate on complex physics, engineering, and information-handling projects. Thus, the need for the WWW system arose from the geographical dispersion of large collaborations and the fast turnover of fellows, students, and visiting scientists who had to get up to speed on projects and leave a lasting contribution before leaving.

Set off in 1989, the WWW quickly gained great popularity among Internet users. For instance, at 11:22 a.m. of April 12, 1995, the WWW server at the SEAS (School of Engineering & Applied Science) of the University of Pennsylvania responded to 128