Quality Assurance for Digital Imaging

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THE CONTINUING proliferation of digital imaging networks both within and between hospitals indicates the need to consider the requirements for a comprehensive network-wide quality assurance (QA) program. The term, quality assurance is usually applied to the broad spectrum of management practices that are implemented to ensure that radiology examinations are appropriate, that the necessary image information is obtained, that the correct interpretation is made available in a timely fashion, and that radiation exposure, cost, and inconvenience to the patient are minimized. The subset of QA which specifically deals with tests of equipment function is called quality control (QC).¹ The general principles of radiology QA which apply to a conventional, film-based department must be extended to incorporate the new components and processes which make up a digital image management and communication system (IMACS). Although there is a considerable volume of information available which provides guidance for QC of individual digital imaging modalities such as CT, MRI, and DSA,²⁻⁴ there is little information on QC requirements for the network which connects these modalities, the archive where the images are stored, the database which links these images with relevant patient and examination information, or the cathode ray tube (CRT) display workstations on which the images are displayed. Film digitizers (FD) and computed radiography (CR) are two additional imaging modalities which are prevalent in digital radiology departments, and some recommendations for QC of these devices have been published in recent years.^{5,6} Recommendations for QC of the components of the IMACS, and the QA of the processes which are used in the implementation of the complete digital system into the operation of the radiology department are crucial requirements for the successful transition to filmless medical imaging.

QUALITY ASSURANCE IN AN IMACS

An IMACS can be categorized into four subsystems, based on a functional classification. These subsystems are network/communications, database/storage, image output/display, and image acquisi-

tion.⁷ Within each of these subsystems we can list a set of relevant components which may or may not be present, depending on the configuration of the IMACS. For example, the image output and display subsystem could include several categories of CRT display workstations, laser film imagers, low end paper print imagers, and 35mm slide printers. Conventional QC is directed at tests which are sensitive enough and frequent enough to detect slowly changing parameters which affect image quality before the problem becomes clinically significant. One might suppose that in a digital system, there are no slowly changing parameters, and that any corruption of a digital system would be immediately evident. However, at both the input end and the output end of the imaging chain there are analog-to-digital (ADC) and digital-to-analog conversions (DAC) whose performance can slowly degrade with time. In the case of a CR reader acquiring an image to be displayed on laser printed film, there is an analog chain which includes a laser, a photomultiplier tube and an ADC in the CR reader and a DAC and a laser in the film printer. The drift of CRT monitors and degradation of the phosphors with time are also important parameters to monitor. The purely digital portions of the system, such as the archive and database also have indicators, such as error logs, which can be used to monitor system problems and correct them before they become more serious. In addition, software programs can be used to monitor network performance and utilization and provide trend analysis. The implementation of a comprehensive QA plan for a digital radiology department requires us to explore new areas of analysis and develop new skills which were not required in a conventional film-based system.

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