Picture Archiving and Communication System Implementation: The Practical Considerations of Adapting the Technology to the Real World of Health Care Operations

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ALTHOUGH picture archiving and communication system (PACS) technology has been available for almost a decade, actual implementation has been limited. Start-up and implementation costs are significant, yet the cost of PACS typically is not the primary obstacle—as the system's capabilities actually should make it very cost effective after implementation. Based on equipment planning work on several construction projects for which PACS implementation was proposed, however, "real life" or practical considerations often present significant obstacles, making PACS implementation appear daunting or costly.

The Mayo Clinic Foundation currently is constructing a new facility to extend its network in Scottsdale, AZ. The new XXX-bed hospital will act as an extension of the existing Phoenix-area Mayo Clinic, which is located approximately 12 miles away. The Foundation's goal is to link the imaging departments of the two facilities, to allow primary reading to be completed both at the new hospital and at the clinic. From project inception, the Mayo Clinic Foundation's management team planned to incorporate PACS technology into the new facility and budgeted accordingly.

Because Mayo is constructing a new hospital, the issue of installing the required infrastructure to support a full-service PACS system was eliminated—although some modifications to the clinic's infrastructure will be required to support the PACS. The project team has faced a number of other issues, however. In this article, we review those issues; explain the reasoning behind the decisions made by the project team thus far; and discuss the impact on implementation, workflow, and other factors.

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COMMUNICATION SERVICES

Before designing an infrastructure for the new facility and planning for the purchase of the required equipment, we first worked with the Mayo project team to ensure that vendors capable of providing the level of service required to support a PACS system between the two Mayo facilities were available. Very simply, if the system's primary purpose was to link the clinic's imaging department to the hospital's, we needed to ensure that a vendor capable of supporting a continuous connection between the two facilities was available—and that the cost of the service meet the Mayo Clinic Foundation's budgetary constraints. Mayo needed a very robust connection between the two facilities—both in terms of the high band width required to carry the substantial traffic created by the digitized images and in terms of reliability. When we developed a request for proposal for network services, we quickly discovered the importance of developing a very detailed set of terms and conditions for the network services agreement. Any vendor agreement should include reassurances that back-up systems are in place to ensure the dependability of the service. We were pleasantly surprised to discover that a number of vendors could meet our requirements, which meant that Mayo could be selective about the type and level of service, and that they could negotiate competitive fees. With the market for these services becoming more competitive, the operating cost of a PACS and teleradiology system will continue to fall in the near future. If possible, we recommend that no fewer than two acceptable service providers be identified to ensure that an alternative is readily available should frequent service interruptions occur.

EQUIPMENT

Early in the planning phases for the project, the Mayo project team recognized the need to purchase digital equipment whenever possible. Although the purchase of digital equipment increases the budget for new equipment for the new facility in the short-run, use of PACS technology eliminates the need for most of the support spaces and equipment

required to support a film-based radiology department. Care must be taken to select digital equipment that is compatible with a DICOM network to ensure that it can be linked successfully into a PACS system. The need to convert to an all-digital format may present an obstacle to PACS implementation at an existing facility simply because of the high cost of replacing all existing systems that lack digital technology. At most existing facilities, the reality is that the PACS will serve only certain modalities at first, with the remaining modalities converted over time, as they are replaced with digital systems. We strongly recommend, however, that any *new* facility purchase only digital equipment—as the move to a PACS is much less costly if planned as part of a new construction project.

INFRASTRUCTURE

After ensuring an adequate connection between the two facilities, Mayo needed to make sure that the new facility's infrastructure was capable of supporting the system—both when the facility opened and in the future. A fiber-optic backbone is required to support a PACS, and any work station that will be used to gather and transmit images must be served by fiber-optic cable. The end result is typically a separate network segment dedicated to PACS activities, which include all digital imaging modalities, digital processors, file servers, and primary reading stations. For distribution to a wider audience, the system includes a gateway or switch that connects the PACS network to the larger hospital information system (HIS) network, through which selected images or studies can be made available for distribution to nondiagnostic workstations. This segment of the system also can be used to provide physician access from teleradiology workstations located in the physician's office or home. Even if workstations initially are not installed in remote departments, such as surgery or emergency, where demand for images is likely to be high, we recommend providing the fiber-optic cabling to support the installation of future workstations in these areas. Because of the cost, care should be taken to select the locations where the PACS workstations truly will be used. For example, within the next 5 years, it is unlikely that workstations—which currently cost approximately \$35,000 each—would be installed at each nursing station in a facility. The cost of workstations may fall in the future, however, and it is much less costly

to install the infrastructure to support future workstations in high-use areas, such as surgery, emergency and critical care, during construction than it is at a later date.

WORKFLOW

The issues of where to install workstations and how to best design the PACS' infrastructure is connected intimately with workflow, as the PACS will not just change, but, in large part, actually determine future workflow. Workflow issues that should be resolved during the design phase include the following:

- **Locations where diagnostic reading will be completed, including current and future workstations.** Although a PACS allows complete flexibility—diagnostic viewing literally can be done at any location the hospital and its medical staff chooses—Mayo concluded that it was important to have a primary reading area to maintain a collaborative atmosphere. A great deal of worthwhile socialization occurs in the reading areas, as colleagues consult with one another during the reading process and discuss their interpretations. The layout of the PACS should not preclude this essential socialization with peers during the reading process. A PACS can, however, make it possible for facilities to achieve economies, such as allowing a facility with 24-hour radiologist coverage to support a facility that has on-site coverage only 12 hours a day. It also can enable two facilities to run concurrently with radiology staffs that address different specialties, thus providing full coverage at both locations without staff duplication.
- **Locations where nondiagnostic viewing should be available, including current and future workstations.** Workstations can be installed in almost any location with the proper infrastructure. Because of the high cost of workstations, we recommend selecting key locations for workstations, but providing the infrastructure for additional workstations in the future to provide maximum flexibility.
- **Archiving and conversion of images.** Although scanning a large portion of the current archives—or even all current active films—into the new PACS is probably not practical, many facilities can be set up to capture and archive any new films introduced to the facil-

ity by scanning films that patients bring from other facilities as well as any films produced in-house on nondigital equipment.

- **Understanding the difference between a workstation and a viewing station.** A workstation is physically different from a viewing station. This becomes a critical issue in the surgery department, where space is at a premium and freedom of movement in the procedure room can be limited. We recommend that new facilities or hospitals undergoing a complete renovation of their surgery departments consider planning for a movable workstation, which can be set up for the specific procedure along with other equipment. Many of the highly specialized surgical procedures currently performed require that the surgical suite be set up for the planned procedure not unlike the way a stage is set for a play, and the PACS workstation easily can be positioned as part of

this “set” if the proper infrastructure is available. Although this will increase construction costs in the short run, it will greatly increase the department’s flexibility—and therefore possibly its potential throughout—during the facility’s lifetime.

SUMMARY

The issues discussed in this article are just *some* of the real-life considerations a facility’s management team should address during the planning process as they make decisions about PACS implementation. We currently are working with the management teams of many facilities on PACS implementation projects that have yet to be completed. In the future, we hope to report on our experiences, including both successes and failures, as construction is completed and the systems actually are implemented.