Vol. 7 •Issue 10 • Page 71

Web-based Telemedicine

The Mayo Clinic has launched an international telemedicine effort using store-and-forward technology and the Internet as the transmission medium. The technology overcomes serious limitations inherent in real-time broadcast video.

By Marvin P. Mitchell

For more than a century, people have traveled to Rochester, Minn., to receive care at the Mayo Clinic. The small clinic, founded by Drs. Charles and William Mayo at the turn of the century, has grown into a major integrated delivery network and earned a worldwide reputation as an innovator in care delivery. This reputation is a direct result of Mayo's long-standing mission "to provide the best care to every patient every day through integrated clinical practice, education and research."

Continuing the mission became a greater challenge with the openings of Mayo's Jacksonville, Fla., facility in 1986 and its Scottsdale, Ariz., facility in 1987. With the two new facilities, the goal of providing any Mayo patient complete access to all the resources of Mayo Clinic — regardless of which facility the patient visited — became more difficult to achieve. To meet the challenge, Mayo launched its initial effort in telemedicine.

The first telemedicine consultation took place three days after the doors opened at the Jacksonville clinic. Telemedicine capabilities enabled the 35 physicians at Jacksonville to leverage the resources and clinical knowledge of 1,100 physicians and caregivers at the Rochester campus. To accomplish this, Mayo built a satellite system to broadcast real-time consultations between Rochester and Jacksonville. One exam room at each site was equipped with cameras, microphones and video diagnostic tools to enable clinicians to perform remote consultations via real-time video. Initially, Jacksonville clinicians used the telemedicine system about five to eight times a week to consult with the physicians at Rochester.

This initial telemedicine solution provided an important proof of concept that was again used when the Scottsdale facility opened the following year. Although the system paid for itself by reducing administrative and travel costs, Mayo received no insurance reimbursements for the telemedicine consultations. The organization absorbed these costs as part of its mission to provide its patients with the full resources offered by Mayo. As the Jacksonville and Scottsdale staffs grew, the reliance on telemedicine declined.

Technology evolution

Today, Mayo's video system is used occasionally for domestic consultations between facilities and for intra-clinic videoconferencing, while the satellite system is used only for nationwide and international medical education broadcasts. Mayo has since launched an international telemedicine effort using store-and-forward technology and the Internet as the transmission medium.

The store-and-forward technology overcomes three serious limitations inherent in real-time broadcast video:

Broadcast video consultations must be conducted in real time, which requires advance planning to accommodate schedules at two or more facilities, virtually eliminating the use of the solution on an ad-hoc basis. Significant time differences between some countries present an even bigger obstacle.

Broadcast video consultations are time-intensive. At the Rochester campus, which covers approximately 100 acres, having a limited number of video-equipped exam rooms means clinicians may be required to travel to another building on the campus to do consultations. The resulting sessions can take three to four times as long as an in-person patient exam.

The low resolution of broadcast video does not allow clinicians to view clinical images (X-rays, MRIs, CTs, etc.) at a high enough resolution to be confident in the interpretation.

In comparison, store-and-forward technology creates a "virtual visit" by digitizing patients' medical records and diagnostic data, including still and motion images. Patient information is captured and stored at the location requesting the consultation (referring site), then is forwarded via virtual private network to the telemedicine

office at the Rochester campus (consulting site), where each case is triaged. A telemedicine coordinator reviews the case to ensure images have been captured correctly and forwards each attached record to the appropriate clinical specialist for review.

The store-and-forward solution overcomes the limitations of the broadcast video solution. Rather than conducting consultations in real time, clinicians now have the option of scheduling time — much like an in-person appointment — to review patient information and make recommendations. Consulting physicians can review the patient record from their desktop workstations, rather than from a centralized location.

Moving to store-and-forward

Mayo's use of store-and-forward technology began in 1996 for several reasons. Increased use of the Internet during the 1990s ushered in a new range of possibilities for transmitting images and clinical data over great distances. Mayo wanted to embrace these new Web-based technologies, which held the promise of being significantly less expensive to deploy than video broadcast solutions — and potentially far more adaptable to real clinical workflows. In addition, Mayo's long history of providing care for members of the royal family of the United Arab Emirates (UAE) offered an opportunity to enhance collaboration among clinicians at Mayo and in the UAE. Mayo also used the opportunity to explore the use of telemedicine on a fee-for-service business model, since the domestic use of telemedicine still faced reimbursement hurdles.

Mayo developed the store-and-forward telemedicine solution in collaboration with Wellogic, based in Cambridge, Mass. The Wellogic Platform for Healthcare provided a modular solution to integrate with Mayo's clinical applications, such as its picture archiving and communications system (PACS) and internally developed patient scheduling system. Consult, an electronic medical record application with second opinion consultation capabilities, provided the functionality needed to enable the store-and-forward solution and orchestrate the care delivery process.

Consult is a Web-based solution that allows the movement of patient information through a health care system. At a referring site, the application collects and organizes patient information — from transcriptions and lab results to static and full-motion images — and organizes it for transmission to Mayo. At the consulting site, the system routes information to physician desktops and to departmental systems such as radiology. In the departmental system, it creates orders and makes various aspects of the patient case seamlessly available for clinician review. This allows a neurologist in Rochester, for example, to examine virtual patient information in much the same way he/she would for a patient sitting in a Mayo exam room. Physicians view and study static and motion images that have been digitized and sent directly from the UAE via the Internet.

As cases are reviewed, Consult's workflow engine transmits the consulting physician's reports and impressions — in the form of a formatted, human-readable report — back to the referring physician. The report can then be printed out at the referring location and delivered to a physician for action and inclusion in the medical record.

In the near future, the system will enable physicians to view and study digital images from within any Web browser, without the installation of a "fat client" application. Clinician tools within this version of the radiology viewer support zooming, panning, resizing, cropping, dragging, measurement and annotation. High-resolution, diagnostic-quality images will be viewed using progressive download technology that performs even over low-speed dialup connections. In addition to enabling consultations without requiring patients to travel, this future version of the telemedicine solution could greatly reduce the cost of such examinations by eliminating the need to output images to film — and eliminating the need to ship patient records via courier service.

The medical director for the Mayo Telehealthcare Center is George M. Gura, MD, FACC, who noted that for a telemedicine solution to be successful, "it must mirror clinician workflow patterns, rather than force clinicians to change the way they practice medicine." He added, "Mayo's store-and-forward telemedicine solution has resolved our internal procedural challenges with an efficient conduit to get clinical information in the right hands, and it provides the tools to manage the entire virtual patient encounter."

Tapping Mayo's expertise

The Mayo telemedicine solution provides numerous benefits to patients at Ministry of Health hospitals in the UAE. Besides having access to world-class health care services, the ability to triage cases and reduce the number referred to tertiary care centers saves money. In addition to the medical costs, the solution saves travel expenses such as hotel and per diem costs for patients and their families. On average, it costs $50,000 for a UAE patient to seek care in the United States. By comparison, the typical store-and-forward telemedicine consultation costs $1,000. In addition, use of telemedicine solutions avoids the administrative red tape of obtaining visas and other documents necessary for international travel, often difficult even in the best circumstances. This is especially beneficial when an acute health condition requires immediate treatment. Of the consultations facilitated via the telemedicine system to date, only 10 percent of the patients have required referral to a tertiary care center for additional care.

According to Gura, "nearly half of the telemedicine consultations are for neurology/neurosurgery orthopedic and oncology cases. These cases require complex subspecialty consultations not usually available outside major tertiary care centers."

During the recent war in Iraq, Mayo's telemedicine center was put on alert for cases requiring consultations with specialists. Mayo arranged for staff to be on call 24/7 to support the telemedicine center; fortunately, the services were not required for military casualties. However, the solution is now being used for consultations on trauma injuries suffered by Iraqi civilians during the war.

Although Mayo's turnaround on consultations is typically 48 hours, a significant number of cases require urgent processing for acutely ill patients in ICUs. The opportunity for rapid access to second opinions is of enormous importance to referring physicians, patients and their families. Frequently, multiple recommendations for supportive care are returned to the UAE hospitals the same day.

Future plans

Building upon the success of the deployments in the UAE, the future rollout of Mayo's telemedicine solution may take several forms. The domestic rollout of the solution still faces reimbursement and legal challenges, but connecting the Jacksonville and Scottsdale facilities and the Rochester campus may eventually prove effective.

Also under consideration is use of the Consult system to link rural areas within the Mayo Health System to the Rochester campus. This may reduce travel requirements and enable patients to be treated closer to their homes.

Future implementations of the telemedicine solution will help make Mayo's physicians and educational resources easily, inexpensively and immediately accessible to clinicians throughout the world. Overall, the telemedicine solution promises to add new avenues to cost-effectively extend Mayo's mission worldwide.

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