

Telemedicine: Latest Advances, Unresolved Problems

The use of digital scans and cameras in nuclear medicine has enabled practitioners to enter with ease the world of telemedicine and picture archiving and communication systems (PACS). Some nuclear physicians have been sending scans through computers from one hospital to another for 25 years—back when “Macintosh” was still a fruit and Bill Gates was still in high school. Other nuclear

week sleeping on a cot in the hospital.” He hired a consultant from Rosefield Community Hospital in Rosefield, CA who set up the system by installing software compatible with the gamma cameras and computers in the department. To review the scans at home, Beven receives the analog image scanned in by a technologist over his modem.

Although this is the least expensive way to set up

Videoconferencing with referring physicians, reading scans on their home PCs and converting to filmless departments, nuclear physicians are going high-tech. Tomorrow’s technology is here.

Who is using it, and what do they think?

physicians have not processed, handled or stored a film since the 1980s. To house patient records, their departments traded thousands of square feet of hospital storage space for a few shelves of gleaming optical disks.

With recent advances in telecommunications and computer equipment, more and more nuclear medicine departments are linked to sites beyond hospital doors. To gauge the effect of these advances, *Newsline* spoke with nuclear physicians throughout the country. We attempted to hit the broadest subset of computer users we could find from the two-man department in a small Louisiana town to the multimillion dollar system at a world-renowned Boston hospital. They have provided some insight into the realities of the high-tech world as well as the dreams that still are a few years away.

Taking Calls from Home

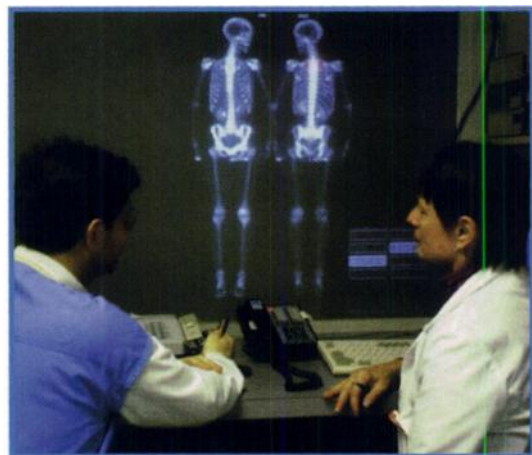
In terms of their personal lives, nuclear physicians find the greatest benefit of telemedicine lies in not having to drag themselves into the hospital at 2 a.m. to read an emergency heart perfusion scan. Terence Beven, MD, director of nuclear medicine at Our Lady of the Lake Medical Center in Baton Rouge, LA, can attest to this fact. Without the coverage of residents at his hospital, he and his associate in the two-man nuclear medicine department would be called in at least once or twice a night to read emergency scans. Seeing an opportunity after years of no sleep, they each paid \$6000 out of their own pockets to install computer equipment and software that enables them to take night and weekend calls from home.

“I’ve had a dramatic change in my lifestyle,” Beven said. “Before the computers were installed three years ago, I used to spend several nights a

telemedicine system (especially if all cameras and computers are not digital), it has some disadvantages. Sending several images at once over a standard fast modem (of 28,800 bps) could take several minutes. Moreover, Beven said he cannot add embellishments, such as color, on his home computer and cannot see motion which is required for gated imaging such as SPECT gated wall motion studies. “I still need to come in for procedures that require processing, but this happens relatively rarely,” he said. “Overall, I’d say my personal investment has paid off.”

Howard J. Dworkin, MD, head of the nuclear medicine department at William Beaumont Hospital in Royal Oak, MI, agrees that at-home calls have major benefits. The two-hospital system installed personal computers in the homes of its eight nuclear physicians. Although several nuclear medicine residents are in the hospital at night to interpret emergency scans, they have more access to the attending physician on call through the home computer system. “It offers a good back-up for residents who may not feel the need to call in an attending to the hospital but may want a second opinion,” Dworkin said.

Teleradiology at William Beaumont Hospital also plays a key role in heart perfusion scans for patients with acute chest pain who enter the emergency room at night. A nuclear medicine resident follows the patient, interprets the scan and makes



Instead of interpreting films, nuclear physicians at Beth Israel Hospital in Boston use a \$30,000 backprojection screen to interpret digital whole-body scans on computers.

send the scan digitally back to St. Louis where data processing is performed and the image is evaluated.

The ease and simplicity of the system has been working for all involved, according to Fletcher. It costs less for the remote hospitals than if they had a contract for nuclear medicine services with a private hospital in their local areas. The average cost to the patient for a nuclear scan diagnosed in St. Louis and performed at a remote location, said Fletcher, is \$450. The cost would be \$700 to \$800 if the scan was under contract with a local hospital. Billing is also not a problem since all nuclear physicians in the VA hospital system are salaried employees. What is more, the need for medical licensing in the states with remote sites is nonexistent since VA hospitals are owned and regulated by the Federal government. (Fletcher stressed, however, that the nuclear physicians at the St. Louis VA have attending privileges at the remote hospitals.)

Computerized care, however, is not without its kinks. Fletcher said the biggest problem is how to keep referring physicians at distant sites informed as to when nuclear medicine procedures are the most appropriate for their patients. Surprisingly, he is concerned about overutilization of the modality. "Some sites that don't have access to CT or MRI may try to compensate by doing a nuclear medicine study," he explained. Handling of radioactive materials is also a concern. Fletcher's group conducts on-site inspections four times a year at each site. "We also don't allow the remote sites to perform any therapies such as thyroid treatments," Fletcher said. "We don't feel comfortable with the level of safety [in handling more potent doses of radioactive materials] when there's no nuclear physician present."

In terms of the future, physicians in the VA network will be able to communicate with each other using a high-speed video linkup by the end of this year. Referring physicians and nuclear physicians will be able to correspond face to face, which could be a major advantage during clinical exams. Fletcher imagined a possible scenario could be for the evaluation of thyroid cancer: The oncologist could palpate a nodule on a patient's thyroid over video while the nuclear physician examines the scan findings 1000 miles away.

Looking further into the future, Fletcher said the VA network will have a World Wide Web home page installed within the next few years that will allow physicians to access both the images and the accompanying written reports on their patients over the internet. "This will be a marriage of PACS and telemedicine—an ideal world," he predicted. "We'll have images with electronically embedded arrows pointing to the areas of focus and explanations alongside." Written reports on the patient usually are stored separately from the images, which can make it time-consuming to look up previous scans.

One Group's Answer to Managed Care

John Freitas, MD, director of nuclear medicine services at St. Joseph Mercy Hospital in Ann Arbor, MI, thinks telemedicine is the answer to threatened cutbacks by managed care executives. The 25-member radiology group encompasses three local hospitals in the area with plans to add three more hospitals over the next year. The sites are linked by computer networks, which cost each hospital about \$200,000 to install. Radiology and nuclear medicine studies can be performed at any site but are interpreted by the appropriate expert in that modality.

At a time when nuclear physicians are being asked to take on less specialized services, Freitas' group is becoming more specialized. "As more physicians join our group, we're trying to subspecialize to improve the quality of care at all the hospitals," Freitas said. For example, a brain CT could be taken at any hospital, but the radiologist who subspecializes in neurology would be the one to read it. "Our goal is to allow referring physicians to send their patients to any of the local hospitals in our group knowing that the quality and interpretation of the study will be the same," he said. The system is not yet fully operational since certain radiology studies, especially nondigital x-rays, are difficult to computerize.

A few radiology positions may be eliminated once the network is fully established, according to Freitas. For nuclear physicians in the network, however, the payoffs are big: They preserve their specialization by interpreting nuclear scans in facilities that ordinarily could not afford to have a dedicated nuclear physician.

Operating Filmless Imaging Departments

An internet-accessible PACS system is no wishful dream for Beth Israel Hospital's nuclear medicine department. They have had a web page set up with patient images and records for the past few months. "Referring physicians can log onto our web site with a password and look at a full patient report with up to four images side by side. They can add motion and gray scale," said Gerald M. Kolodny, MD, director of nuclear medicine at Beth Israel. Moreover, this can all be done on a typical home personal computer—as long as it is registered on the department's security system.

The web site was a logical progression for the nuclear medicine department, which has been filmless for almost 10 years. The three nuclear physicians at Beth Israel have found that their department runs more efficiently as a result of PACS. There are no repeat images for the technologists because the film is too dark or too light. Time is not wasted trying to find misfiled, lost or missing studies. Cost savings are another added plus: Without the need for repeat films or expensive hospital storage space, Beth Israel's nuclear medicine department has calculated a \$15,000 per year savings on the 8000 studies it performs as a result of switching to PACS (*J Nucl Med* 1994;35(10):38N).

"The most important thing we found is to have a user-friendly system that doesn't require a computer programmer to operate," said Kolodny. "Any resident should be able to walk up to the computer and access the images they want." At Beth

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Designer of Receptor-Binding Radiopharmaceuticals

Dr. Krohn's insistence on rigorous and reliable methods led his Seattle team to implement a traditional labeling method for radioimmunodiagnosis and therapy. His work at the University of California, Davis with Robert Stadalnik, MD, Paul Scheibe, PhD, and myself led to a distinctly non-traditional approach to the design of receptor-binding radiopharmaceuticals.

After the introduction of receptor-based radionuclides by William C. Eckelman, PhD, and colleagues at George Washington University in Washington, D.C. in 1979, radiochemists thought that an optimally designed receptor-binding radiopharmaceutical would have the highest possible specific activity and receptor affinity. Their rationale for the first criterion was inherited from the classical concept of a radiotracer as a physiologic probe that does not perturb the system under study. Consequently, the reasoning continued, the amount of radioligand injected must be significantly lower than the number of receptors—hence the requirement for high specific activity. The second criterion of receptor affinity was based on traditional *in vitro* binding experiments where successful evaluation of receptor concentrations within a glass test tube required the highest possible receptor affinity.

Dr. Krohn, however, suspected that these tradi-

tional approaches were not consistent with the goal of maximizing the amount of physiologic information from this new class of radiopharmaceuticals. By combining kinetic theory with engineering principles, he presented the essential properties required to simultaneously evaluate target plasma flow, receptor-ligand affinity and receptor concentration at a radiotracer workshop held in 1980. He argued that imaging studies using receptor-binding radiopharmaceuticals of high specific activity and high receptor affinity would measure only target organ plasma flow. Moreover, by kinetic simulation he predicted that accurate measurement of receptor concentration would require the injection of enough radiopharmaceutical to perturb the number of free receptors at the target tissue.

Dr. Krohn's research with ^{99m}Tc-DTPA-galactosyl-neoglycoalbumin enabled it to become the first commercially available receptor-binding radiopharmaceutical when it was introduced in September, 1992 by Nihon Medi-Physics Co., Ltd., in Japan. In the final analysis, the unique contribution that Dr. Krohn brings to the nuclear medicine field is his ability to synthesize divergent facts and concepts.

—Based on the Aebersold Award nomination letter of David R. Vera, PhD, associate professor of radiology at the University of California, Davis.

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Israel, this is vital because primary care physicians, cardiologists and other specialists outside of nuclear medicine have been reading the results of their patients' nuclear scans on their own departmental computers for years—first on a PACS system and now on the Web.

The biggest concern about web pages is the issue of security. Although patient files are protected by passwords, the possibility of hackers breaking into the system has been raised by several nuclear physicians who spoke with *Newsline*. "We have seen some major security issues with Web access. There are an estimated 200 break-ins a day to federal Web sites," said Robert Henkin, MD, professor of radiology and director of nuclear medicine at Loyola University Medical Center in Maywood, IL. "I don't feel safe putting in my credit card number, so I can't say that we would feel safe putting patient data on the Web at this point." Fletcher said the VA network has also been cautious about going on the Web for this reason. "Security is one principle issue that needs to be nailed down. We're dealing with confidential information, which is a real concern," he said.

Larry Barbaras, a senior computer programmer and creator of the Web site at Beth Israel, has taken pains to ensure that patients' records are secure. Since the Web site is not public, he said he has been

able to implement unique security measures. These include user name/password combinations that will only work when originating from the unique Internet address of the physician's computer (so stolen passwords pose a small risk). He has also added such things as coded subdirectories and patient identification by number not by name. "Are we continually upgrading our security? Yes. Can we guarantee that an accomplished hacker can't break in? Probably not," said Barbaras.

Most likely, nuclear medicine departments will venture with tepidation onto the Web, with most waiting until another institution tries it out first. "Ironically, it is much easier to access confidential information in a typical hospital by impersonating a physician on the phone or dialing into digital dictation voice lines," said Barbaras. As was the case with the minute computational flaw in the Pentium chip, humans expect computers to meet a much higher standard.

—Deborah Kotz

FYI Questions about setting up a telemedicine system in your hospital? Contact Tony Parker, MD, PhD, past president of the SNM Computer and Instrumentation Council, at Beth Israel Hospital in Boston by e-mail: tony_parker@bih.harvard.edu. You can also contact Trevor D. Craddock, PhD, general manager of a nuclear medicine usenet group, LARG*net, at the University of Western Ontario by e-mail: craddock@largnet.uwo.ca.