Three Model IMRT Programs

St. Luke's Cancer Center in Bethlehem, Pa.

by James Goetz, R.T.(T)

The St. Luke's Cancer Center IMRT program was conceived at a seminar on IMRT at the Memorial Sloan-Kettering Cancer Center (MSKCC) in New York City in 1999. Those of us from the St. Luke's radiation oncology department who attended the seminar were intrigued by the reports of high doses of radiation reaching difficult targets, no increase in side effects, and great outcomes; so we decided to start an IMRT facility of our own.

Putting together an IMRT program turned out to be a scary proposition. Although the administrators of our oncology service line (spearheaded by Kathy Becker, associate vice-president) wanted the radiation oncology department to add IMRT to its repertoire, no one knew what level of resources would be required. When the project started in 1999, no IMRT codes had been issued and there was no way to find out what we would be paid for performing IMRT procedures. The hospital's billers thought the amount would be at least as much as we received for a complex radiation therapy procedure, but the department expected no more than a little bump in revenue because we thought IMRT was restricted to people who were not candidates for conventional radiation therapy. To their credit, our administrators' investment in IMRT wasn't motivated by profit but by patient welfare.

At first, the project seemed overwhelming. We moved forward carefully, duplicating the successful programs of larger institutions that already had IMRT experience. Physicians and therapists from the radiation oncology department attended training courses run by Varian Medical Systems at their training center in Palo Alto, Calif., or sponsored by institutions that already had programs, such as the Medical College of Virginia in Williamsburg. Even with these programs, we needed more time than we thought to feel confident enough to work on our own.

The initial learning curve was about six months. The process was tedious and included many quality assurance activities, such as point-dose calculations to check dose accuracy, fluence mapping to check dose intensity, and taking confirmation films from each gantry angle to make sure the equipment was correctly reproducing the radiation plan. Eventually we became skilled practitioners, and now IMRT treatments are ordinary procedures in our clinic.

STARTING UP

The first step was, of course, purchasing the hardware and the software. In general, retrofitting existing equipment to produce IMRT can cost up to $750,000, and a new machine runs around $2 million. Since St. Luke's had just purchased a 2100CD dual energy linear accelerator with an 80-multileaf collimator from Varian to replace an old machine used for 3D conformal radiation therapy (3D-CRT), the hospital administration decided to upgrade the purchase before delivery to a 120-leaf collimator and change from a CD to an EX machine that would accommodate IMRT.

Once the hospital had these two new components in place, the department purchased IMRT treatment planning software called Helios, which is overlaid on CADPlan, Varian's basic radiation oncology treatment planning system. Helios can cost between $100,000 and $125,000, and CADPlan can cost between $350,000 and $400,000.

We started treating patients with prostate cancer first, since more data had been collected for this disease site than any other. We followed the MSKCC prostate cancer protocols, which use very high doses of radiation to the prostate (81 to 86.4 cGy compared to 65 to 70 cGy for 3D-CRT) and tight margins to decrease patient morbidity and side effects.

Once everyone was confident using the new technology, we started treating other conditions. Although prostate cancer, head and neck malignancies, and brain metastases are still the high-volume procedures, St. Luke's has also treated neoplasms in the eye socket, the shoulder, and the spine as we slowly branch out.

FINANCIAL IMPLICATIONS

Although treatment time for IMRT is the same as for conventional radiation therapy, the planning takes more than three times as long and is not reimbursed adequately ($400 for conventional radiation therapy planning, which takes 40 minutes, compared to $800 for IMRT planning, which takes at least three hours).

The profit comes from the technical fee for the treatment itself. Payment for 37 conventional radiation oncology treatments at $100 each totals $3,700. Payment for 37 IMRT treatments, which are reimbursed at around $400 apiece, totals approximately $14,800. St. Luke's treats at least 600 radiation oncology patients annually—around 120 with IMRT at that 4:1 profit ratio—and they are adding approximately $1 million to the hospital's bottom line every year. A program with a similar patient flow that buys new IMRT equipment will pay off its equipment debts in two years and be able to put all that extra money onto the black side of the ledger from then on.

Up to 20 percent of all radiation oncology patients

are candidates for IMRT, and that number may rise to 40 or 50 percent in the future. An aggressive program that reaches for the full 20 percent will receive a phenomenal return on its investment.

We immediately saw that IMRT's potential for profit was also a potential for misuse. IMRT plays a wonderful role in cancer therapy and has been shown to affect cure rates in prostate cancer and cancer of the head and neck, but it is not necessary for every lesion. IMRT should only be used to irradiate malignancies near critical structures that need protection, and to re-treat patients whose critical structures cannot tolerate more radiation. Metastatic disease in the femur can be handled with conventional therapy. Metastatic disease that surrounds the spinal cord needs IMRT.

FUTURE TRENDS

Using IMRT to treat malignancies in the upper abdomen and the chest is presently stymied by the problem of immobilization. The torso moves in and out of the radiation field when people breathe or in response to the normal motion of internal organs, and neither process can be stopped for treatment. Finding a way to treat the malignancy and not contaminate surrounding tissues while the body is moving is currently challenging radiation oncology personnel everywhere that IMRT is used. As soon as this problem is solved, IMRT will be employed to treat cancers of the lung, pancreas, bladder, esophagus, and breast.

St. Luke's is already working on an immobilization process called the *Exact Trac Immobilizer* that involves placing luminescent disks at strategic points on the body. Patients breathe normally, and when the body is in the ideal position for treatment, two infrared cameras take pictures of the disks. During the actual treatment process, the disks are laid at the same locations on the patient's body and the therapeutic beam is activated only when the disks are in the spots the cameras previously recorded. Patients are taught how to breathe evenly and rhythmically to expedite the process.

Another new system, called *Respiratory Gating*, uses a similar system of infrared cameras and luminescent disks as the Exact Trac Immobilizer. The radiation beam is activated and deactivated as the patient inhales and exhales so the same area of lung is treated every day and the tumor receives its full therapeutic dose of radiation. Breathing slowly and rhythmically also improves the outcome of Respiratory Gating, and patients are instructed accordingly.

St. Luke's is a community-based hospital. To be able to offer this kind of advanced treatment to our patients is tremendously rewarding. We are grateful to our administrators, who make sure that we have what we need to advance as the field of IMRT advances, and we are eagerly looking forward to incorporating the next generation of innovations that emerge for this rapidly developing therapeutic modality.

James Goetz, R.T.(T), is supervisor of radiation oncology at St. Luke's Cancer Center in Bethlehem, Pa.

Alta Bates Comprehensive Cancer Center in Berkeley, Calif.

by Patrick S. Swift, M.D.

Alta Bates Comprehensive Cancer Center, which is part of the Sutter Health Organization, was in a perfect position to implement an IMRT program in January 2001, when we asked Salick Health Care (which runs Sutter's cancer centers) to purchase the new equipment. Sutter runs 11 hospitals in northern California, and Salick provides the technical management for five radiation oncology departments and 11 medical oncology departments around the United States, including both programs at Alta Bates. Between the two organizations, Alta Bates had so much prior IMRT experience to draw on that the center treated its first IMRT patient on October 1, 2001, only three months after the equipment purchase order was signed.

In 2001 Alta Bates already had a good-sized radiation oncology department, with three full-time physicists and two full-time dosimetrists on staff. The facility is a major referral center for prostate cancer in the Bay Area, and it was this patient population that inspired our staff's interest in IMRT.

In 1997 Alta Bates was performing radioactive seed brachytherapy for patients with prostate cancer, but staff members were frustrated by the fact that urinary side effects after prostate brachytherapy were high and many patients were not good candidates for the procedure because their prostate glands were too large or they had high-risk disease. Since data from Memorial Sloan-Kettering Cancer Center showed that patients with prostate cancer who received treatment with IMRT achieved improved local control and had less rectal bleeding after the procedure, and the University of California at San Francisco verified that IMRT could also produce better local control and fewer side effects for patients with head and neck cancer (especially nasopharyngeal cancer). We had no trouble convincing the Sutter and Salick organizations to start an IMRT department at our institution.

In August 2001 Alta Bates had three linear accelerators, one of which had a static multileaf collimator for conformal radiation. We replaced two of the accelerators with Varian 21 EX machines with 120-leaf multileaf collimators and added a Helios/Eclipse IMRT planning software system. The center now has two machines capable of IMRT and will not have to interrupt services if one of the machines needs repairs. We are also currently purchasing a new CT simulator from General Electric.

Alta Bates sees around 70 radiation oncology patients a day, 20 of whom need IMRT, and our IMRT program is running in the black. In addition to patients with prostate and head and neck cancer, we also treat patients with breast cancer and pediatric medulloblastomas. Children with medulloblastomas usually receive platinum-based chemotherapy plus radiation to their inner ear that causes a high rate of deafness. IMRT lowers the risk of deafness in these children by making it possible to use a lower dose of inner ear radiation.

As a result of our experience, the Alta Bates radia-

tion oncology staff thinks the critical component of a successful IMRT service is good physics support.

Quality assurance is essential to IMRT, and one part-time physicist will not be able to handle the workload. When you go to your board, make sure that it will support the salaries of the physics staff as well as the outlay for new equipment. If you want to implement your program over a year's time, one full-time physicist plus a part-time physicist from a consulting firm may be adequate, depending on your case load. If you want to get everything up and running in three to four months, you'll need two full-time physicists for a 50- to 60-patient department. One of those physicists will need to work full-time on IMRT and the other can spend half-time on IMRT and half on brachytherapy or your other radiation procedures. If you see more than 60 patients, consider adding another physicist.

Physician training is important as well, and anyone without IMRT experience should receive hands-on instruction from a professional IMRT teaching program.

Our final suggestion to people starting a new IMRT service is not to get carried away with the new toy. The hospital has a financial incentive to accrue more IMRT patients and physicians want to treat as many people as possible, but it's a mistake to move before data are available on safety at different clinical sites. Wait until the information is published and you get appropriate training on the new procedures so you can offer your patients the best possible care.

Patrick S. Swift, M.D., is the medical director of the Department of Radiation Oncology at Alta Bates Comprehensive Cancer Center in Berkeley, Calif.

Dale and Frances Hughes Cancer Center in East Stroudsburg, Pa.

by Michael J. Greenberg, M.D., and Marc Miner, M.Sc., D.A.B.R.

When the Dale and Frances Hughes Cancer Center underwent a major expansion in 1997, Pocono Health System, of which the center is a part, put its emphasis on the future and decided to purchase only equipment that could grow with the rapidly evolving field of medical technology. We had just installed a new Varian high-energy accelerator with dynamic multileaf collimation capabilities and had constructed a new vault. In a bold move, hospital administration decided to purchase an IMRT software system and multileaf collimator from Varian in early 1998, even though the software was not on the market at that time.

We are the only cancer center in our county, and we wanted to be able to offer our patients state-of-the-art technology that could move into the future. The hospital board backed our willingness to wait, and waiting turned out to produce unexpected bonuses.

Our new IMRT system was installed in November 2000. We had occupied our time between January 1998 and November 2000 becoming acquainted with the new linear accelerator, and were so comfortable with the equipment that commissioning the IMRT program went very smoothly. We treated our first IMRT patient in January 2001. Hughes Cancer Center is now a reference site for Varian Medical Systems because our IMRT team worked closely with the Varian engineers to iron out software problems during the commissioning process.

Our radiation oncology staff attended many IMRT seminars and visited many hospitals that already performed IMRT therapy, including Memorial Sloan-Kettering Cancer Center (MSKCC) in New York.

Hughes' first IMRT patients had prostate cancer. We started treating brain and head and neck malignancies soon afterwards, and now also see patients with tumors of the spinal cord, gynecologic system, rectum, anus, and bladder. Patients with breast cancer will be added soon. People with difficult retreatment problems or who need stereotactic radiation boosts to the brain using a hypofractionated protocol also receive therapy at Hughes. While we treat lymphomas and sarcomas of the upper chest, we do not want to use IMRT for lung cancer therapy until respiratory gating is perfected. With all these additional applications, people receiving IMRT currently represent 50 to 55 percent of our center's radiation oncology patients.

The staff has set up an active database to go over the morbidity and outcomes associated with IMRT procedures, and our new goal is to take down our old accelerator and purchase a new one so two machines with IMRT capability will be available at Hughes.

We have several suggestions for people starting IMRT programs.

The first is that the team approach is crucial. You need to involve everyone. The physicians, the physicists, and the radiation therapists, and your computer department must all buy into the project, especially since they will need to share skills (radiation oncologists should learn axial anatomy to enhance the treatment planning process). If some people are pushing and others are pulling back, your program won't work.

It is also important to find other physicists that have already set up the system your center purchases so you can call them for advice during the commissioning process. These physicists, anyone else who is advising you, and your entire staff need to be comfortable with the change and constant evolution of margins, doses, fractions, and fields that takes place in the quickly growing world of IMRT.

Our final suggestion is to develop the capability to fuse CT scans, MRI scans, and PET scans in the IMRT planning process. CT scans are crisp, MRI scans offer better anatomical definition, and PET images provide information about biologic functioning in the affected area. Fusing all three provides the maximum amount of information for planning. The improvement in patient outcomes will justify the expense of using all three of these imaging modalities at once.

Michael J. Greenberg, M.D., is medical director, and Marc Miner, M.Sc., D.A.B.R., is head physicist at the Dale and Frances Hughes Cancer Center in East Stroudsburg, Pa.