IMRT: An Overview

by Carl R. Bogardus, Jr., M.D.

One reason radiation therapy fails to control malignancy is its inability to deliver a lethal dose of radiation to the tumor volume of interest and spare normal adjacent tissues at the same time. Intensity modulated radiation therapy, also known as IMRT, is a relatively new technique that brings the field a giant step closer to achieving this goal.

IMRT's precursor, three-dimensional conformal radiation therapy (3D-CRT), was developed in the 1980s and resulted in a significant improvement in the tumor-to-normal tissue protection ratio. 3D-CRT uses a multi-leaf collimator to shape the radiation beam to conform to the outlines of the tumor. Unfortunately, since the treatment beam remains static, the same dose of radiation is delivered to both the tumor and the small amount of normal tissue covered by the beam. This limited the amount of radiation that could be delivered to malignant tissue because the side effects of high radiation doses to normal tissue were too severe to be tolerated.

IMRT, developed in the 1990s, takes radiation therapy one step further by using computer programs to design the dose distribution, control the radiation therapy treatment delivery system, and allow collimator leaves to move during treatment. The motion of the leaves stops and starts the beam while the treatment is given, varying the beam's intensity so the radiation dose to the tumor is different than the radiation dose to surrounding normal tissue. This dramatically reduces side effects at higher radiation doses.

By exactly controlling the ratio between the tumor volume of treatment and the normal surrounding tissue volume of protection, intensive dose escalation becomes a real possibility, and with dose escalation comes a higher likelihood of long-term tumor control.

Because the leaves of the collimator move during treatment, IMRT planning involves the calculation of thousands of specific dose points across a treatment volume, a daunting task that can only be accomplished by sophisticated computer programs that design the treatment beams as well as control the equipment delivering the radiation. IMRT also requires a larger number of beams than conventional or conformal radiation therapy. The larger number of beams and dose points mean greater control of the dose distribution, but also mean that IMRT takes much longer to plan. The physicist, the dosimetrist, and the radiation oncologist must devote

continued on page 7

IMRT Budget Implications

Helen E. Berggren, R.T.(T), C.M.D.

Boca Raton Community Hospital in southeastern Florida is a 400-bed facility that treats about 1,300 patients a year. The radiation oncology department opened in 1977, and in 1993 a satellite clinic opened in Delray Beach. Over the last two years, Boca Raton Community Hospital has implemented IMRT at both locations.

Initially, the staff was apprehensive about implementing such a technically complex and potentially labor-intensive therapy. One concern was that increased treatment time slots could seriously affect our productivity. Today we have treated more than 150 patients with IMRT and, although treatment planning times have increased, actual treatment time, even with BAT ultrasound tumor localization for prostate cancer patients, has not been seriously affected.

IMPLEMENTING IMRT

We were fortunate that we could retrofit the linear accelerators and basic treatment planning systems at both our facilities to accommodate IMRT, which significantly lowered the implementation costs by eliminating the need for new treatment units and planning systems. The retrofit of our Varian 120 leaf collimators took about one week.

We added IMPAC sequencers to the existing systems to translate the treatment plan and drive the leaves of the linear accelerator, and we transitioned to CT-simulation. Because the Imaging Department at the hospital was upgrading its one year-old CT scanner, we saved money by moving that CT to the hospital simulation suite and adding a CT simulation package. We did need to purchase a new CT scanner with

continued on page 6

simulation package for the satellite clinic, which was a significant expenditure.

We chose the BAT ultrasound system to provide daily localization studies of the prostate gland, when necessary. The system took two days to install and one day of training. Although they were uneasy at first, our therapists quickly became experts with the BAT and have come to rely on it for accurate set-up. Everyone was amazed by the amount of variability in the position of the prostate on a day-to-day basis.

The initial cost for major upgrades and equipment was more than $810,000 at the hospital site. This cost included the Varian 120 multileaf collimator, the BAT ultrasound system, the IMPAC sequencer, the treatment planning system by Computerized Medical Systems, Inc., and CT simulation. Additional costs for upgrading the laser systems in the simulation and treatment rooms, marketing, IMRT-specific QA equipment, and PC/printer upgrades were also incurred.

Because Computerized Medical Systems, Inc., was still developing and modifying its software programs, our first IMRT patient took one month to plan. The subsequent start-up at the satellite clinic was a much quicker process.

While IMRT planning initially took about three days to complete, as our staff gained more experience they were able to decrease planning time to about four hours.

The two campuses were originally staffed with three physicists and four dosimetrists, but as implementation progressed, we realized that the greatest burden would be on our physics staff. During implementation, we contracted with locum physicists for the more routine physics duties to allow our permanent staff to focus on learning the new technology. In addition to IMRT, we were also implementing brachytherapy for restenosis and expanding our HDR program.

While our initial QA ran more than six hours per patient, we now complete it in an average of 1.5 hours per patient, which is comparable to the QA time reported for other experienced IMRT facilities. Our physicians spend between 1 and 1.5 hours calculating the dosimetry for each patient. We quickly realized that dosimetry time would be the limiting factor in our ability to provide timely IMRT treatment, so we hired another dosimetrist.

REIMBURSEMENT

Between April 2001 and April 2002, the Ambulatory Payment Classification (APC) rates for IMRT were $400 for planning; $400 for treatment; $100 for BAT ultrasound; $72 for simple simulation; $72 for special dosimetry; $137 for complex device; $72 for dose calculation; $197 for physics; and $64 for special physics.

In April 2002, the Centers for Medicare and Medicaid Services (CMS) announced that charges 77280-77295, 77300, 77305-77321, 77336, and 77370 were now bundled into the IMRT planning payment, which increased to $875. The IMRT treatment rate remained $400. The complex simulation payment was $197, and BAT ultrasound localization was no longer funded.

In July 2002, CMS clarified that services performed on days other than 77301 could be billed if medically necessary and properly documented. However, local intermediaries may have different interpretations and need to be monitored consistently.

APC reimbursement for IMRT in 2003 looks good. BAT ultrasound has been reinstated at $77 per treatment, and APCs in 2003 maintain reimbursement levels for treatment planning and daily treatment.

When we began IMRT in 2001, Medicare was reimbursing us at about $25,000 per case. That amount fell to about $18,800 in 2002, but 2003 rates are back up to $25,000. Although this figure may seem high, under Medicare each stated APC reimbursement is subject to the Program Payment Calculation and, therefore, some portion of that stated reimbursement must be collected from the patient or a secondary plan. Although the calculation varies, the patient portion may be a significant amount of the total APC payment. This calculation is subject to the year and wage indexes, among others, and shows the need for increased communication with Patient Billing Services.

Helen E. Berggren, R.T.(T), C.M.D., is the director of the Lynn Regional Cancer Center of Boca Raton Community Hospital.

almost three times the amount of planning time to an IMRT case than is required for either conventional external beam or 3D-CRT therapy.

EQUIPMENT AND PERSONNEL

Here are the basic requirements for a successful IMRT program:

- *Linear Accelerator*. Most radiation therapy centers have invested in a modern linear accelerator, to which a multileaf collimator can usually be added. Although multileaf collimators are not common accessories on most older equipment, most (not all) of the older machines can be retrofitted to use IMRT at an average cost of $500,000 to $750,000.
- *Conventional or CT Simulation Capabilities*. The team must do a treatment simulation at the CT scanner to designate the treatment areas before the remainder of the IMRT plan can be developed. In 3D-CRT, simulation is done primarily to check the accuracy of the blocking and is performed *after* the three-dimensional plan shaping the beam to the tumor has been finalized by the physicists and dosimetrists.
- *Three-Dimensional Treatment Planning and Simulation Capabilities*. IMRT requires special, extremely sophisticated computer programs to design dose distributions. The software and additional hardware upgrades can cost from $250,000 to $500,000 per center.
- *Physics and Dosimetry Staff*. A highly skilled physics and dosimetry staff is required for either IMRT or 3D-CRT, but centers that want to run successful IMRT programs must hire practitioners with special IMRT training and experience. Each IMRT case may require 8 to 12 hours of additional physics and dosimetry time beyond the usual workload.
- *Physician Capabilities*. The radiation oncologist must know the clinical indications for IMRT and have training and experience in the delivery of this highly complex mode of therapy. Physicians will spend between two and three extra hours per IMRT case to design and set up the therapy and approve the final IMRT treatment plan.
- *Patient Load*. An adequate number of patients requiring IMRT therapy must be available, otherwise cost amortization of this highly complex and expensive treatment will not be achieved.

IMRT DELIVERY TECHNIQUES

In the United States, IMRT is commonly delivered using one of two techniques.

The first is called segmental or binary delivery. Multiple treatment ports are established, each of which requires the linear accelerator to stop and adjust the multileaf collimator for that port. The machine adjusts the collimator leaves, delivers the radiation dose, advances a few degrees, stops, and adjusts the collimator leaves again until the entire radiation dose has been delivered.

The second technique is called sliding window, continuous delivery, or dynamic IMRT. The collimator performs a rotational sweep over the patient, and during the rotation continuously changes the shape and configuration of the radiation beam and varies the rate of treatment delivery without stopping.

In addition, three other techniques are available but are not widely used in the United States: conformal arc (used primarily in Japan), intensity-modulated arc, and electronic forward planned compensator delivery.

TREATMENT PLANNING TECHNIQUES

Two basic kinds of IMRT treatment planning are used: forward and inverse planning.

In *forward or conventional treatment planning*, treatment blocks are designed and treatment beams are added until a reasonably satisfactory dose distribution is achieved. A target tumor volume is determined, critical structures are identified, and multiple treatment beams (with appropriate blocking) are directed by trial and error to completely cover the tumor.

Forward planning is mentioned in CPT-2002 as one of the methods of producing an IMRT plan under code 77301. Unfortunately, the design constraints in the rest of the CPT description are so restrictive that forward planning is not considered a practical option.

Inverse treatment planning starts with the final desired dose distribution in the tumor volume and the specified doses that cannot be exceeded in critical nearby structures. The computer then designs as many treatment beams and as many different levels of intensity as necessary to achieve both desired end results.

The true advantage of the IMRT technique is not just delivering a high dose of radiation to the tumor volume, which can be accomplished by methods of lesser sophistication, but the ability of IMRT to protect normal critical structures nearby while still sending a tumoricidal level of radiation to the targeted malignancy. This new technique has advantages and disadvantages for individual health care centers, but its value for patients is undisputed. IMRT is a true advance in cancer therapy. As IMRT technology is refined and improved in the next few years, more and more malignancies will be effectively treated and more and more lives will be saved.

Carl R. Bogardus, M.D., is president of Cancer Care Network, Inc., in Midwest City, Okla.