

Managing the transition to digital mammography

PET/CT moves closer to diagnostic standard of care

MRI's role expands with new applications

3-tesla MRI goes mainstream with powerful new applications

CT powers up with dual-source scanning

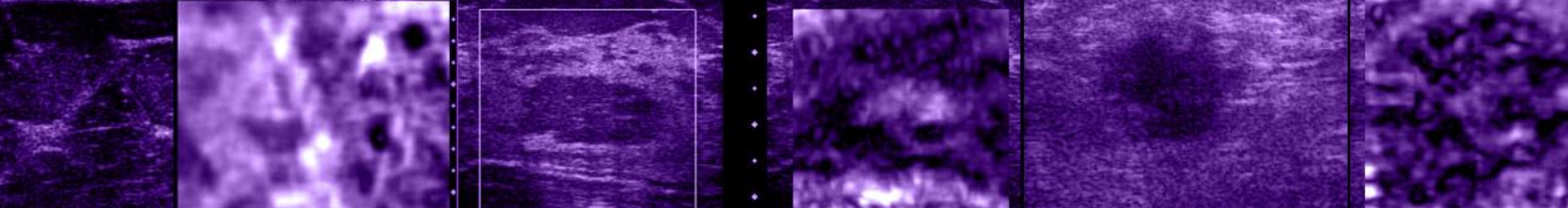
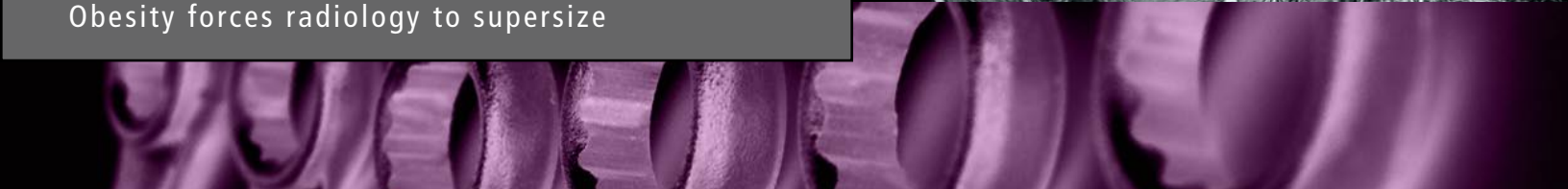
Equipment Service, Part I: Making the most of equipment service personnel and contracts

Equipment Service, Part II: Equipment uptime and workflow efficiency begins with service

New techniques in breast ultrasound may find more cancers

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“We considered replacing our analog unit with another analog, but instead chose to move ahead with digital and have actually increased the number of exams by 10% per day.”

— Paul Conklin,
St. Mary Medical Center, Walla Walla, WA.

Last year’s Digital Mammographic Imaging Screening Trial (DMIST) pretty much laid to rest doubts about the clinical performance of full-field digital mammography (FFDM). But a host of questions remain for breast imaging centers thinking of making the switch, ranging from FFDM’s impact on workflow to how to handle and store all those digital images.

The benefits of digital mammography are legion, according to Bonnie Rush, president of Breast Imaging Specialists, a San Diego-based consulting firm. Digital mammography offers a dynamic range that film-based mammography can’t, allowing radiologists to manipulate images and examine areas in the breast in ways that aren’t possible with analog images.

Digital mammography also eliminates chemical processing and its associated personnel expenses (no more trudging to the process room) and external noise factors such as dust; it can also reduce the amount of hard-copy storage a facility needs, and, with a good PACS network in place, ensure that images aren’t lost or misplaced. If staff expense is a concern, FFDM can reduce the need for darkroom assistants, radiology aides, chart room staff, and technologists.

Installing a digital mammography system can also reduce recall rates in the long run, according to Rush. “Initially, recall rates and interpretation time increases with digital, depending on how much training radiologists have in the technology prior to the transition,” Rush said. “There’s a learning curve, sure, but as radiologists get used to looking at digital images, and as they get used to the workstation’s tools at their

disposal, recall rates will settle down and interpretation time will decrease.”

All these technical advantages go hand-in-hand with patient-care benefits, not the least of which is reducing a woman’s anxiety during her mammogram. With digital mammography, the technologist never needs to leave the room, and can show the images to the patient right as they’re taken, explaining why further images may be needed, Rush said.

“In an analog environment, the technologist leaves to take the film to processing, and while he or she is gone the woman has the opportunity to worry about problems with her mammogram,” she said. “Anecdotally, the digital environment helps ease patient anxiety since the technologist stays in the room until the exam is completed and the patient is released.”

Finally, digital mammography brings a certain cachet that can boost a facility’s market share, both through patient word of mouth and the facility’s advertising efforts. This effect is becoming more common as many women are beginning to actively seek out centers with digital technology due to its proven advantages in imaging dense breast tissue.

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Installation considerations

So, the verdict is in on FFDM's value. But there are still some challenges to installing digital mammography, especially from scratch. FFDM systems are sold at a premium to analog systems, with an FFDM unit's list price at more than \$400,000, and its upkeep can be as much as \$135,000 per year. Thus, a facility's return on investment, depending on the number of patients it serves and its particular insurance mix, can take a number of years.

Facilities can expect decreased productivity for a time while imaging staff learns to use the technology; it may be necessary to rearrange personnel or create temporary positions to smooth workflow, according to the 2006 "Mammography Regulation and Reimbursement Report," published by consulting firm HC Pro of Marblehead, MA.

"Since the industry indicates that one DR mammo unit can replace up to two analog units and still maintain current productivity, for facilities with older units, sufficient capital, and a patient base that can support DR, going that direction makes sense," Rush said.

Evaluating patient load and types of insurance within that patient base is crucial to determining whether digital mammography will work. The general rule of thumb is that a facility needs to perform between 15,000 to 25,000 mammography exams per year for a timely return on investment, although these numbers are not gospel, Rush said.

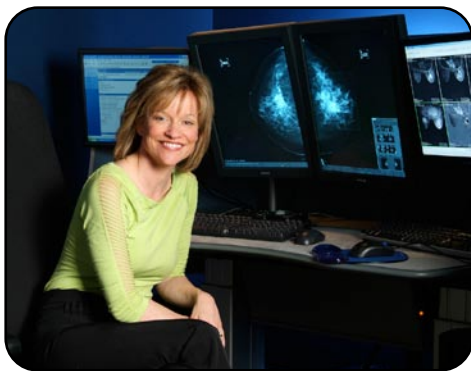
Something else to consider is that going digital paves the way to other services -- such as tele mammography or computer-aided detection (CAD) -- that might be impossible or more difficult to conduct without an FFDM system. In some cases, these additional services can mean the difference between

treading water and making a profit. For example, adding CAD to FFDM can increase a facility's bottom line without increasing staff cost, and more and more insurance companies are looking at CAD as standard of care for a screening mammogram.

"The question of how many patients it takes per year to make a return on investment is subjective," Rush said. "It's important that a facility review its current patient base, its growth potential, the patient-specific reimbursement rates, and any ancillary services it can offer that will bring additional monies into the department. This last point is particularly important for independent imaging centers not associated with a hospital."

Also crucial to the digital mammography decision is evaluating the facility's existing PACS, or investigating PACS options if no system is in place. Having a powerful PACS that can handle multiple modalities and workstations is key to the success of the transition to digital mammography, according to Gerald Kolb, chief development officer for Solis Women's Health, headquartered in Austin, TX.

Solis currently owns five breast imaging centers in the Dallas-Ft. Worth metropolitan area, is opening two more this month, and is actively acquiring another two. Solis facilities are in the process of converting to digital mammography via computed radiography (CR), installing 17 acquisition/image processing units, together with eight workstations, and all the associated infrastructure, including a fully integrated information management system; they perform more than 85,000 mammography exams per year.



"Going digital offers the possibility of earlier detection, and that's what we're trying to accomplish."

— Dr. Elizabeth Jekot,
Elizabeth Jekot, M.D. Breast Imaging Center,
Richardson, TX.

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Fairchild Medical Center mammography technologist Mary Ann Anderson positions a patient.



Fairchild radiologist Dr. Michael Maloney reviews digital images on the facility's workstation.

"The fact is you have to be able to work flexibly, with all vendors and modalities," Kolb said. "We want to be prepared in the future to move images around between centers, and to access offsite images -- radiologists want to pull down images that are on other PACS at hospitals and other facilities -- so we've put together a PACS infrastructure that can allow us to be extremely flexible."

The more pixels, the more storage and bandwidth are necessary, and facilities can expect each unit to produce 1 to 3 terabytes of information per year. Hiring a PACS administrator (and deciding whether that person is clinically or technologically based) can be helpful as well, according to HC Pro. Kolb brought all the vendors and staff involved in the transition into weekly meetings to decrease the chance of miscommunication.

The experience at Solis brings up a good point -- facilities going digital also now have a choice of technologies, a choice that didn't exist before 2006, when the U.S. Food and Drug Administration approved the first digital mammography system based on CR. The technology enables facilities to go digital with their existing mammography equipment (although they would need to install a CR reader if they didn't already have one).

Choosing between flat-panel DR or storage-phosphor CR depends on a number of factors, including the size of the facility, its patient load, whether it has more up-front capital or less, and the age of its existing equipment, according to Rush. For a facility already invested in CR, or with a smaller patient volume and fewer opportunities to boost referrals, CR makes sense, especially since the CR mammography readers can also do general x-ray exams.

Finally, before making any decisions, schedule a number of site visits, according to Rush.

"Once you choose a vendor, insist on going on site visits," she said. "For a smooth transition, it's important that all those involved in supporting, implementing, and using the new digital system fully understand the impact of the changeover."

The IT side of digital mammography

BreastScreen Waitemata Northland (BSWN) in New Zealand was established in February 2006 and serves a population of 93,000, performing about 24,500 exams annually. The two main sites in Takapuna, Auckland, and in Whangarei are both fully digital; a third digital site is planned to open in July of this year. Since the two sites were new, there was no transition from analog to digital. Instead, the focus was on analyzing the cost benefits between the two modalities, according to Andrew Cave, business project manager. BSWN was able to offset costs such as building in a film processor against the cost of setting up a digital site.

"Teleradiology was a key consideration," Cave said. "Our two digital sites are 250 kilometers apart, and the northern site has only two radiologists. One of our clinical requirements is that no two radiologists should consistently perform blind reads against each other. Digital mammography allowed us to meet this requirement without having the double handling involved with loading a viewer at one site for the first read, pulling the files down, transferring them, and then reloading another viewer for the second read."

BSWN is operated as part of the Waitemata District Health Board, and because of this,

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"The exam is quicker, and if the tech does have to repeat an exam, she can explain it to the patient right there."

— Mary Ann Fitzgerald,
Fairchild Medical Center, Yreka, CA.



Fairchild's file room, where analog films are stored.



Fairchild's digital mammography archive.

existing PACS and RIS networks were in place at the time the two digital mammography breast imaging sites were established. But these existing systems were inadequate to support the specific requirements of digital mammography.

In New Zealand, all mammograms performed under the national breast screening program (BreastScreen Aotearoa) are read independently by two radiologists, with discordant opinions resolved by a third read, consensus, or arbitration. To ensure that this requirement was adequately met, BSWN built in additional functionality into its breast screening information system and installed a dedicated PACS for breast imaging. To cope with the extra storage demands, BSWN uses a dedicated archive with setup costs split among the cardiology, radiology, and breast screening departments.

"One thing we learned early on was that we needed to have the image cache right next to the reporting workstation," Cave said. "Despite being connected to a 100-Mbps link, high network latency was adding up to 30 seconds reading time for each study."

BSWN changed its network architecture so that all sites where readings are done have access to the image cache. Radiologists' workstations and the image cache now sit on a 1-Gbps network, with no routers involved.

"This change gives good performance -- our radiologists are happy -- and it means we can operate our remote sites over a 10-Mbps link, thus reducing operating costs, which makes our business managers happy," Cave said.

Small centers make the shift

Fairchild Medical Center in Yreka, CA, is a 25-bed, critical-access hospital that does 15 to 17 mammography exams per day, with two alternating radiologists and five technologists on site. Its justification for digital mammography? The rest of the hospital is already online, according to Mary Ann Fitzgerald, PACS administrator and head technologist for mammography.

"Geographically, we're a long way from any other hospital, with mountain ranges in between," Fitzgerald said. "We wanted people in our area to have the best technology without having to go elsewhere, and, since the rest of the hospital was already digital, it was a natural move (to do so with mammography)."

Fairchild went digital in August of 2005, and added digital mammography to the mix in May 2006, increasing its PACS storage capability to add the new mammography exams, as well as priors that had been digitized. The biggest benefit Fitzgerald has seen since transitioning to digital mammography is the quality of the images and the patients' comfort level.

"Women aren't left alone in the room anymore," she said. "The exam is quicker, and if the tech does have to repeat an exam, she can explain it to the patient right there."

Paul Conklin is director of imaging services at St. Mary Medical Center in Walla Walla, WA, a 140-bed hospital that serves a population base of about 66,000. The nearest other town of any size is 60 miles away. St. Mary's converted to flat-panel digital mammography in January 2006; the facility installed its PACS four years ago. The decision was made

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based on the age of the hospital's existing equipment. Before the transition, St. Mary's had a dedicated analog mammography unit that performed about 20 mammograms per day.

"We considered replacing our analog unit with another analog, but instead chose to move ahead with digital and have actually increased the number of exams by 10% per day," Conklin said.

CAD was important to St. Mary's for its long-term benefit, Conklin said, and the addition of CAD has increased the general sense of confidence in a small mammography department.

"The addition of CAD has definitely reduced the number of overreads we're doing," he said.

Conklin and his staff conducted an analysis on what their return on investment would be going from an analog system that had been completely paid off and had depreciated, and estimated that it will take five years to start making a profit on the new digital machine with current volumes.

Managing the comfort factor

The biggest challenge for St. Mary's was making radiologists comfortable with the switch from rotor image viewing to a digital workstation, according to Conklin. The facility's radiologists underwent an eight-hour training course given by the device vendor.

Six things to do before you buy a new FFDM system

1. Conduct a self-analysis.

Can you support FFDM? What's your annual patient throughput? What kind of insurance do your patients carry? This will help you determine whether and how to implement digital mammography.

2. Pick the technology that's right for you. DR or CR?

Are you projecting or currently in need of increased productivity? One DR system can handle the load of up to 2.5 analog units. Are you looking to convert to digital, maintain viable analog mammography units, and support current and projected patient volume? CR could be your answer.

3. Get IT involved prior to implementation.

All those digital images have to be available in a timely manner for interpretation, and must ultimately be stored, both short- and long-term. Can your existing PACS handle the new imaging modality? If you don't have a PACS or your PACS is not up to the task, you won't be getting the full benefits of converting to digital.

4. Do your research and plan site visits.

Talk to peers who have already made a successful transition about their decision-making process, their roles in the digital transition, and why they chose their particular technology approach. Then do some site visits, as this will allow you to see the process in action.

5. Look at digital workflow patterns.

Digital mammography requires changes in facility workflow to maximize productivity. Make sure to address reconfiguring workflow and training staff to optimize the department.

6. Develop a marketing program.

Clinical studies are highlighting the benefits of FFDM in screening certain patient populations. Make sure you're ready to get the word out about your new service.

— Bonnie Rush, Breast Imaging Specialists, San Diego

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"Our radiologists were already aware of the benefits and challenges of digital," he said.

"In addition to the training, it took about two or three weeks for them to get back to their normal reading speeds," he said.

Dr. Elizabeth Jekot of the Elizabeth Jekot, M.D. Breast Imaging Center in Richardson, TX, believes that digital mammography technology adds to interpretation time, but is worth the extra effort. After serving as a breast imager in a hospital-based outpatient practice for many years, she established her center in January 2006 to offer women in her area the highest quality of care possible.

"Digital improves throughput by decreasing exam time for the patient and the technologist," Jekot said. "But it does increase read time for the physician, just because there's so much more information. Even with practice and improved hanging protocols, I doubt breast imagers will be as fast at reading digital exams as with film-screen any time soon. But going digital offers the possibility of earlier detection, and that's what we're trying to accomplish."

By Kate Madden Yee

AuntMinnie.com contributing writer

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PET/CT moves closer to diagnostic standard of care

With its roots now firmly planted in oncology, PET/CT has become a well-established diagnostic tool for cancer assessment, staging, and restaging. The combination of functional PET data with anatomical CT information has been shown time and again to provide more accurate and specific diagnoses than individual modalities alone, with the added bonus of sometimes detecting previously unknown tumors or conditions.



“Cancer patients -- in staging, restaging, and in response to therapy -- already get CT scans as well as PET, so why not do them on the same machine, at the same time?”

— Dr. Joe Busch, Diagnostic Radiology Consultants, Chattanooga, TN

In fact, the advantages of PET/CT compared to PET alone are so great that PET/CT has taken over the PET market, especially in the U.S. Some 57% of currently installed systems are PET/CT units, versus 43% for PET cameras alone, according to a 2005/2006 census of installed equipment by market research firm IMV Medical Information Division of Des Plaines, IL.

“You can’t buy a standalone PET anymore,” said Dr. Peter Faulhaber, assistant professor of radiology at Case Western Reserve University in Cleveland. “For us -- an institution with a major cancer center that has used PET heavily -- we need to be on the cutting edge, and the image quality of PET/CT is better than standalone PET.”

PET/CT’s benefits are so great that it is beginning to expand from its beachhead in oncology and into cardiac imaging, neurology, and radiation therapy planning. Both academic institutions and private practices are employing the hybrid devices.

Oncology still accounts for the bulk of most caseloads -- on the order of 75% to 90% -- but PET/CT is also developing a following in cardiac and neuro imaging as the list of indications eligible for Medicare and

Medicaid reimbursement grows. At the same time, though, the issue of reimbursement could cause PET/CT adoption to hit a snag, particularly in cardiac imaging (see sidebar).

“PET/CT is now a major integral part of the oncology workup at our hospital,” said Dr. Harry Agress of Hackensack Medical Center in New Jersey. “I think we are past the stage in many parts of the country where people have no idea what PET is. It is becoming so much the standard of care with a lot of cancers.”

Analyzing the economics

While the initial capital investment required to start a PET/CT service can be a challenge -- typically around \$2 million to purchase and install a single system -- with the right economic and market evaluations it can make sense from a financial perspective.

A facility’s return on investment is primarily dependent on the amount of competition in its catchment area, which clearly impacts the number of PET/CT studies that can be done in a day (typically around five to break even, although this is changing with the recent reimbursement cuts; the general consensus is that it now takes seven to eight studies a day to stay afloat). Other key factors include active participation with hospital tumor

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PET/CT moves closer to diagnostic standard of care

boards and educating referring doctors about the advantages of PET/CT and the indications for which it is most appropriate -- and reimbursable.

"Having a PET/CT scanner, whether in hospital or outside, is really like setting up a small business," Agress said. "It requires a new level of physician education of your referring docs for PET/CT versus just PET. Sometimes they want to order a CT scan with or without contrast, and you have to explain the differences to them; sometimes they don't want CT, so you have to explain that you need it for the attenuation."

There are alternatives for those sites still testing the PET/CT waters, such as adding PET to an existing CT scanner (which is how Agress' group first started) or setting up a mobile clinic to test a market's potential. Integral PET, a company based in New York City, owns and operates about 20 PET/CT facilities across the U.S., according to Ron Lissak, president of Integral PET. Because the cost of setting up a PET/CT center can range from \$1.5 million to \$3 million (depending on the equipment), they often move into a new region with a mobile service first.

"This business is very much about educating the referring doctors to see how PET/CT fits in their area," Lissak said. "After a couple of years, we then will build up to a fixed site, which is less risky and gives the radiologists time to build the referral pattern."

Hybrid diagnostics

Even if you're still weighing the pros and cons of investing in PET/CT, it's clear that the benefits in terms of patient care and throughput in many ways outweigh the potential economic concerns. In fact, because of its ability to combine functional and anatomic information and thus more clearly delineate what is going on when a potential tumor is detected and what the morphology is, it has become the standard of care in oncology diagnostics, according to Dr. Joe Busch of Diagnostic Radiology Consultants in Chattanooga, TN, which owns two PET/CT scanners.

Other advantages include reductions in the time a cancer patient must be on the scanner table (15 minutes for a typical diagnostic PET/CT today, versus one hour for standalone PET on an older system), which increases both throughput and patient comfort, with the added bonus of incidental findings.

"We used dedicated PET for five years before moving to PET/CT," Busch said. "We realized that cancer patients -- in diagnosing, staging, restaging, and therapy response -- already get CT scans as well as PET, so why not do them on the same machine, at the same time? And why not let the diagnostic scan become the attenuation correction scan? We do the diagnostic CT at the same time as PET scan (simultaneous imaging). We also give IV contrast and oral Volumen on every PET/CT scan, because it enhances the scans by giving lots more information."

Busch believes that IV and oral contrast is necessary to differentiate pathological FDG from normal physiological FDG activity, for example lymph nodes from blood vessels and loops of bowel. In addition, high-resolution

imaging (336 matrix) with IV contrast is essential in head/neck, abdomen, and pelvic cancers to detect sub centimeter metastasis.

Busch, who is a major proponent of producing diagnostic-quality images with every scan versus using CT just for attenuation correction, described a recent case in which they were staging a cervical carcinoma by using PET/CT to stage the lymph nodes. IV and oral Volumen contrast were used, and interpreting the anatomical structures from the CT scan under the functional images from the PET scan, he was able to determine that the cancer was not as advanced as first thought.

"It turned out the patient's right ovary was located against the iliac artery and vein and two loops of the small bowel," he said. "By giving her the IV contrast and oral Volumen, I was able to show the arteries, veins and the ovaries and localize the small bowel activity. I determined that the activity in the ovary was physiological. Hybrid imaging enables us to more accurately localize and distinguish between pathological and physiological structures."

In another case, an incidental finding of an 8-mm breast lesion was detected during the staging of her lung cancer.

Beyond oncology

At Case Western, oncology also represents the majority of the cases Faulhaber and his colleagues see, primarily for diagnosis and staging of cancers but also for radiation therapy planning. In his practice, the leading indications are lung cancer, lymphoma, and head and neck cancer, followed by colon and cervical cancer.

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"One of the limitations of PET/CT is that it is purely driven by what is reimbursable," he said. "Most of us are doing diagnostic CT, followed by PET, because we want to keep the dose as low as possible. The focus of the best way to treat the patient is evolving, but the emphasis is still on using the lowest dose possible." He said new radiopharmaceuticals are being developed that more specifically target tumors versus just sugars, such as amino acids, peptides, and precursors to amino acids. However, while many of these agents are now available, only FDG (in oncology) is approved for reimbursement.

In addition to oncology, about 10% of the cases Faulhaber and his colleagues review are neurology and cardiac imaging -- a ratio that is echoed by most PET/CT centers in the U.S. The leading indication in neurology is brain scans for epilepsy and evaluating dementia. Radiologists in the PET/CT program at Michigan State University in East Lansing, MI, for example, work closely with referring physicians to help diagnose what type of dementia is affecting their patients, according to Dr. Kevin Berger, director of the PET/CT program.

"We happen to serve a referral population with a lot of neurologists and gerontologists interested in differential diagnoses of dementia such as Alzheimer's versus fronto-temporal dementia, which is the most common clinical indication for using PET in neurology," Berger said. Among other things, his department is helping validate diagnosis

Reimbursement cuts could impact PET/CT adoption

Recent reimbursement cuts in PET/CT imaging in the U.S. have now gone into effect, and the changes have many radiologists worried.

In November 2006, the U.S. Centers for Medicare and Medicaid Services announced new payment rates for hospital outpatient services that include sharp reductions in payments for cardiac and oncology PET studies. Medicare reimbursement for multiple-scan heart imaging PET studies fell 71%, to \$731.24, compared to \$2,484.88 in 2006.

Tumor imaging with PET from skull base to midhigh dropped 26%, from \$1,150 in 2006 to \$855.43, while tumor imaging with PET/CT from skull base to midhigh is paid at the rate of \$950, down 24% compared with \$1,250 in 2006. In addition, most of the decrease is in the technical component versus the professional component, which is where most of the revenue that keeps sites viable now comes from.

The change has both short-term ramifications for PET/CT practices, as well as long-term significance for the healthcare system in general, in particular the overall cost to healthcare if PET/CT is no longer readily available to cardiac and cancer patients. The use of the modalities in lung cancer patients, for example, has demonstrated a 13% decrease in overall costs to manage the disease, according to an article in *Molecular Imaging and Biology* (September 2006, Vol. 8:5, pp. 254-261).

"These changes are a big deal in our practice," said Dr. Harry Agress of Hackensack Medical Center in New Jersey. "And it is going to be that much harder for private PET/CT centers, especially those starting up."

— Kathy Kincade

"Having a PET/CT scanner, whether in hospital or outside, is really like setting up a small business."

-- Dr. Harry Agress,
Hackensack Medical Center,
New Jersey

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of PET brain analysis by comparing a patient's brain metabolism to that of a control group, and quantifying the findings.

"This can be difficult to assess statistically if looking at a single patient," he said. "But this approach gives us a quantitative way to communicate to a referring doc that a certain area of the brain is this far away from asymptomatic controls."

Berger's department is also using PET/CT for cardiac imaging -- specifically, evaluating myocardium viability and myocardial perfusion. He cites many advantages to using PET/CT rather than SPECT for these applications, including improved patient throughput (rest/stress studies can be done in less than an hour, versus up to six hours in some cases with SPECT), greater accuracy, lower radiation exposure (especially in patients with chronic cardiac disease who must undergo stress studies for years), and attenuation correction. In addition, because too many diagnostic catheterizations are still being done unnecessarily, there is a push to improve the accuracy of perfusion studies, which is where cardiac PET comes in.

"There is a general perception that cardiac PET/CT is better for overweight patients or large-breasted women, but it is really a better technology across the board compared to conventional SPECT imaging in all patients," said Dr. Kenneth Henson, director of cardiovascular imaging at Imaging for Life in Sarasota, FL. "There is higher accuracy, and you can combine it with attenuation correction to get better outcomes."

With the advent of 64-slice CT, the role of PET/CT in cardiology should expand even further. Dr. Frank Bengel, director of cardiovascular nuclear medicine at Johns Hopkins Medical Institutions in Baltimore, recently upgraded his hybrid unit to a 64-slice CT and says it is "very attractive" for combined morphological imaging of the heart.

"Since I worked with 16-slice previously, I can tell you how much the 64-slice is an advantage for cardiac imaging," he said. "Sooner or later, it will be the standard in cardiac imaging, not just for coronary angiography but for perfusion as well." But Henson doesn't think combining PET with 64-slice CT makes sense from a patient management perspective because he sees the two technologies as sequential, not simultaneous. At Imaging for Life, he uses a 64-slice dedicated CT for coronary angiography and an eight-slice PET/CT for everything else, with the CT only for attenuation correction.

"You use CT to diagnose coronary artery disease and cardiac PET to determine the functional significance of the disease," he said. "But most patients undergoing coronary angiography do not need PET."

In the long run this debate may become moot. The recent cuts in reimbursement for cardiac imaging studies could eventually impact adoption of the technology, according to Henson and others.

"I think the future of this technology will be determined by Medicare, and to some extent the third-party carriers," Henson said. "If they could take a long-term view of this, they would see it is a more accurate technology than the older SPECT studies and that you can substantially reduce the number of cardiac cath procedures."

By Kathy Kincade
AuntMinnie.com contributing writer
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MRI's role expands with new applications



"With CT, you only have one shot at (cardiac imaging). With MR, you have as many shots as you like."

— Dr. Paul Finn,
University of California
Los Angeles

MRI has long been medical imaging's glamour modality thanks to its noninvasive nature and the exquisite soft-tissue detail it provides. MRI will likely continue to occupy the spotlight in years to come, thanks to a host of new clinical applications that are coming to fruition.

While many of these applications were confined to research centers in past years, they are now beginning to find their way into community hospitals and imaging centers. Powerful new systems and increasingly sophisticated software are making the protocols easier to use than ever.

The following describes several of the more promising applications, which include cardiac MRI, whole-body MRI, MR angiography (MRA), and breast MRI.

Cardiac MRI

The rise of multislice CT has drawn much of the attention away from MRI as a noninvasive alternative to cardiac cath for diagnostic applications. But MRI retains a number of advantages, and may one day assume the spotlight again, especially as concerns mount over the radiation dose being delivered by coronary CT angiography studies.

Best suited at 1.5-tesla magnet strength, MRI more than adequately depicts cardiac anatomy and function, valvular function, wall motion, and viability, and can also identify scars from prior infarctions or other kinds of scarring and abnormal enhancement.

"We can do flow quantification with MRI better than any other modality, the main competitor being echo with Doppler," said Dr. Paul Finn, a radiologist in the

Cardiovascular Research Laboratory at the UCLA David Geffen School of Medicine and current president of the International Society for Magnetic Resonance in Medicine (ISMRM). While MRI falls short of CT's capabilities in coronary artery imaging, Finn added that MRI does "an excellent job on functional imaging and on viability imaging" in patients with acquired heart disease.

Physicians at UCLA see many patients with congenital heart disease, most of whom have had surgical or percutaneous treatment, making their situation more complex. "With MRI, we can look at the integrity of the various types of surgical procedures and shunts that have been performed, using cine techniques without contrast," Finn said. "Even more powerfully, we can inject gadolinium and look at time-resolved imaging and get real-time, 3D pictures of how these shunts and vessels are structured."

While cardiac imaging can be performed on 3-tesla MRI systems, Finn believes that there are technical challenges with 3-tesla scanners. "At 3T we are more sensitive to so-called off-resonance factors," he added.

Adjustments can be made on a patient-by-patient basis, but not all clinicians want to take the time to manage the changes. Some aspects could be addressed with hardware

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MRI's role expands with new applications

by generating new types of radiofrequency (RF) transmitters for arrays, but Finn said that advance "is down the road."

In the years ahead, the prevalence of congenital heart disease in adults is expected to grow, giving MRI an increasingly critical role in cardiac imaging. Often in patients with congenital heart disease, CT becomes more difficult to interpret appropriately, because scanning time becomes complicated. "With CT, you only have one shot at it," Finn said. "With MR, you have as many shots as you like."

Functional MRI

Functional MRI (fMRI) has its roots as a brain mapping tool and has demonstrated much of its early value in research studies, such as showing the brain's response to external stimulus. By detecting a patient's brain response as he or she performs certain activities, fMRI helps researchers assess motor and language skills.

But fMRI is also showing potential as a clinical tool, with one early application being presurgical mapping. For example, functional MRI can be used to create surface-rendered views of the brain through an anatomical set of images, which essentially is the perspective a neurosurgeon will see when he or she performs a craniotomy.

"I project the activation area onto the surface of the brain, so I am showing the neurosurgeon what the brain will look like, plus the areas that are responsible for certain motor and language function," explained Dr. Neeraj Chopuri, a neuroradiologist and the radiology department chair at Abbott Northwestern Hospital in Minneapolis. "I also

project the tumor to the surface of the brain, so they realize the relationship of the tumor to important areas of functional activation."

As an example, Chopuri cited the case of a woman in her late 50s who experienced frequent headaches and increasing weakness on the right side of her body. A CT scan found a tumor, and the neurosurgeon designed a treatment plan for Chopuri's review. He noted that the proposed path to the tumor may cross into the area of the patient's speech function.

That suspicion was confirmed with fMRI, and, using the new functional MR image as his guide, the neurosurgeon went 2 cm to the side of the speech activation area. The sizeable tumor was removed successfully and proved benign. Also, a small edema extended into the woman's language activation area, and she experienced some postoperative difficulty with speech. A follow-up MRI after surgery found that the edema also subsided, and the patient was back to full speech function three days after surgery.

"The fact that she had that language deficit transiently and there was some edema in that area tells me that (region) was very important for her language processing," Chopuri said. "If (the surgeon) had gone through there, it may have resulted in a permanent language deficit."

Chopuri believes that the future is now for fMRI as the modality can help map the area around brain tumors and provide a preoperative roadmap for physicians. The modality could have additional uses as well. "Other applications would be to apply fMRI to patients with memory loss,

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possibly to patients with Alzheimer's disease, and possibly in evaluating psychiatric and schizophrenic patients," he added.

Massachusetts General Hospital (MGH) in Boston is utilizing fMRI on pediatric patients to research and understand neonatal and child brain development, which plays a significant role in how brain circuits develop and function long-term. "I think much of that function, especially with genetic tests, is becoming more available for different disorders, identifying them early, and seeing how children develop differently in various genetic situations," said Dr. Ellen Grant, the head of pediatric radiology and the fMRI program at MGH. "I think those areas will become very big in the next five years."

As with many advanced MRI applications, there is debate over whether fMRI is best conducted at 1.5- or 3-tesla field strengths. While research data suggests that more is better, Dr. Bruce Rosen, the director of MGH's Athinoula A. Martinos Center for Biomedical Imaging, believes "we haven't yet turned the corner" on whether 3-tesla MRI definitively is better than 1.5-tesla scanning. "3T provides a level of robustness -- based on its improvement in signal-to-noise -- over 1.5T," he said. "Our preliminary experience at 7T suggests that it is likely to be even better."

Clinicians are learning that analysis, improvement in techniques that correct for motion artifacts, and better techniques to apply stimuli combine to improve MR studies at all field strengths, according to Rosen.

fMRI also provides a better option over CT when radiation exposure is a concern. While MGH opts for a CT perfusion study in stroke cases, Grant described the tactic as "an extreme situation for immediate therapy." CT perfusion would not be performed regularly for functional studies "because you have to interrogate the brain over time and the radiation dose becomes an issue," Rosen added.

Whole-body MRA

Improvements in resolution and contrast-enhanced MR angiography have made the technology quite competitive with invasive vascular imaging techniques, such as catheter-based angiography.

While 1.5 tesla is an adequate magnet strength, the combination of 3-tesla and parallel imaging has been a boon for advanced contrast-enhanced MRA. "When you do parallel imaging, you lose signal-to-noise. With 3T, you buy back the signal-to-noise," said Dr. Patrick Turski, professor of radiology at University of Wisconsin Medical School in Madison. "You end up with a very fast imaging technique that gives you high resolution and provides you with the ability to do temporal imaging for a series of 3D acquisitions."

One UW research group is developing what Turski called a "radial case-based technique" for image acquisition up to 80 times faster than conventional techniques. "With the radial acquisition, we are able to get an entire

3D volume in 0.26 to 0.4 seconds," he said. "It will allow you to study lesions, such as arterial venous malformations and AV fistula, with much higher anatomic delineation," and it reduces the need for catheter-based invasive digital subtraction angiography.

UCLA uses whole-body MRA in patients with peripheral vascular disease. The study generally includes hand and chest, abdomen and pelvis, and the lower extremities. The primary consideration is to acquire a good runoff study to show serious occlusions and stenoses, but image details may not be as adequate as with a dedicated carotid or chest study.

"That's the compromise," said UCLA's Finn. "If we do whole-body MRAs at one sitting, you can only optimize for one or two regions. Because of timing issues, you compromise on the other one, and we tend to compromise on the head and chest."

UCLA clinicians will employ a 20-second breath-hold while performing a dedicated contrast-enhanced carotid MRA, and stay focused on the carotid and chest. When doing a runoff study, the key is to avoid venous contamination in the calves. The time it takes the contrast to travel from the aorta of the chest to the calves varies in each patient. "In lots of cases, by the time you head to the calves, the veins would have filled," Finn said. "You might find yourself with very nice images of the carotids and chest, but poor images of the calves. So you have to prioritize and nail the primary question."

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MRI's role expands with new applications



"As we go forward, it is appropriate for us to use these more complicated -- and, in some cases, more expensive -- tools, because we are talking about treatments that cost 100 times more than an MR breast exam."

— Dr. Bruce A. Porter,
First Hill Diagnostic Imaging, Seattle

Breast MRI

MRI also has become an increasingly influential adjunct to mammography and ultrasound in detecting breast cancer. First Hill Diagnostic Imaging in Seattle uses MRI and/or ultrasound to grade biopsies and stage its patients. The benefits are a shorter time to diagnosis and the ability to tailor the staging of the cancer to an individual patient. There also are economic ramifications as treatment costs escalate.

"The new chemotherapies can be \$60,000 to \$100,000 with marginal benefit to the patient," said First Hill medical director Dr. Bruce A. Porter. "As we go forward, it is appropriate for us to use these more complicated -- and, in some cases, more expensive -- tools, because we are talking about treatments that cost 100 times more than an MR breast exam."

While breast MRI is catching on, its utilization remains in its infancy, primarily because the exam is more complicated and time-consuming than, say, a routine MRI head image.

"Technically, breast MRI is the hardest type of radiology, because there is no anatomy," said Dr. Rebecca G. Stough, the director of imaging at the Women's Center at Mercy Health Center in Oklahoma City. "You have the nipple, the skin, and the lymph nodes. Everything else in between is specific for that woman only. That makes it frustrating and difficult to interpret."

The biggest challenge with breast MRI is the follow-up when a lesion is found. "After you have done (breast MRI) for a while, the number of enhancing nodules you have to follow up begins to decrease," Stough said.

"We always have a mammogram and ultrasound available to problem-solve. That is why I think it is important that a breast radiologist read those, rather than just an MR specialist."

Another reason for the slow adoption of breast MRI is the perception of greater liability. "Whenever anyone thinks of breast imaging, they think of high liability, low reimbursement, and low prestige," Porter said. "With breast MRI, that is not so. This is a very unique and interesting exam; the reimbursement is very good."

While Porter and Stough believe mammography will remain the cornerstone of breast cancer diagnosis for the immediate future, they see MRI as a central component to breast cancer detection because it can provide more information than mammography and ultrasound, especially for more complex patients. The limiting factor, Stough believes, will be the lack of breast MRI specialists.

By Wayne Forrest
AuntMinnie.com staff writer
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3-tesla MRI goes mainstream with powerful new applications

More momentum appears to be swinging toward 3-tesla MR magnets as an increasingly useful tool in a myriad of clinical applications. What may stymie the euphoria of having a new resource to serve patients -- at least at standalone imaging centers -- is reduced Medicare reimbursements triggered by the Deficit Reduction Act (DRA) of 2005.

"When you are imaging small structures, (3 tesla) can benefit quite a bit with the musculoskeletal system, particularly small joints, such as wrists and ankles."

— Dr. Mitchell Schnall,
University of Pennsylvania, Philadelphia

Dr. Suresh K. Mukherji, director of neuroradiology at the University of Michigan (UM) in Ann Arbor, is among clinicians who see a tremendous upside to 3-tesla MRI. With its increased signal-to-noise ratio, Mukherji believes that MR angiography images are "fantastic," and niche applications, such as functional MRI and spectroscopy, are performed faster with more than adequate resolution. All of UM's carotid imaging is handled on a 3-tesla scanner.

"Especially for the brain applications, you can do everything on a 3T MRI that you can do on a 1.5T," he said.

UM performs approximately 20,000 MR scans annually on one 3-tesla MRI system and five 1.5-tesla magnets. Like other facilities, UM balances the need for enhanced patient throughput -- which 3-tesla provides with shorter scan times -- with image quality. "Do you want to push more patients through and make the 3T images look more like 1.5T images? Or do you want to take advantage of the spatial resolution?" Mukherji queried. "We try to do both."

Outpatient lumbar spine images, for example, are completed on the 3-tesla system relatively quickly in three sequences. "With the brain, we won't 'dumb down' the images, so they

look like a 1.5T," he said. "On the other hand, we are not going to maximize resolution, so we try to get a little of both. We have to be cognizant of throughput."

Speed versus image quality

Of course, the primary concern is how well served patients are with 3-tesla MRI. Dr. Mitchell Schnall, vice chair for research in the department of radiology at the University of Pennsylvania in Philadelphia, said the answer isn't necessarily an obvious one. "Say I am imaging a brain. Just because I can make a better image and see the anatomy better, will I find diseases (and) characterize diseases better than I did before? There is some data out there, but it does not answer the question effectively."

If a clinician is imaging a region that is motionless, the difference between a three-minute image and a 90-second image may not make a huge difference in patient turnover. When movement is an issue, Schnall said a clinician must image within a breath-hold or cardiac beat, and "may try to push things faster."

Ultimately, every time a clinician pushes speed, he or she is also pushing resolution, so there must be a balance to meet a certain resolution requirement. "When you

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3-tesla MRI goes mainstream with powerful new applications

“We feel we can do recognizably better work in typically one-third less time with greater consistency exam to exam.”

— Dr. Lawrence Tanenbaum,
Edison Imaging Associates, Edison, NJ

“If ... you believe that 3T is the new premier field strength in MR -- which I do -- then you don't want to buy another 1.5T, because you will be stuck with it for 10 years.”

— Dr. Val Runge,
Scott & White Hospital and Clinic,
Temple, TX



Steven R. Renard
President and COO
Liberty Pacific Medical Imaging,
Encino, CA

are imaging small structures, it can benefit quite a bit with the musculoskeletal system, particularly small joints, such as wrists and ankles,” Schnall said. In breast imaging, 3-tesla MRI helps Schnall heighten spatial resolution to approximately 0.2 mm.

MRI evolution

Dr. Val Runge, chair of radiology at Scott & White Hospital and Clinic in Temple, TX, has seen the evolution of MRI over 25 years, and has been working with a 3-tesla scanner for the last two years. With one 3-tesla MRI and three 1.5-tesla scanners, Scott & White had adopted the philosophy that all its scanners should be able to do all applications.

Still, there are noticeable differences. “Any imaging that has to do with the brain is markedly superior (with 3 tesla), and the majority of cervical spines are marginally superior,” Runge noted. “In terms of the thoracic spine and lumbar spine, some radiologists prefer the 1.5T to the 3T.”

Spatial resolution takes precedence over speed in procedures, such as contrast-enhanced MR angiography and carotid imaging, which visualizes carotid bifurcation arteriosclerotic disease. “That is currently done as a 20-second breath-hold scan with intravenous gadolinium administration,” Runge said. “On the 3T, we use the entire 20 seconds and go for increased spatial resolution.”

Thinner slices

3-tesla scanning has also greatly enhanced spatial resolution compared to older MRI technology. For example, a head scan with a 0.30-tesla or 0.6-tesla scanner provides sections of 10-mm thickness. A 1-tesla MRI reduces the thickness to 7 mm, and a 1.5-

tesla system thins the sections even further to 5 mm. With 3-tesla, Runge is acquiring sections of the head between 3 mm and 4 mm in thickness, and acquires them in less time than the 1.5-tesla system.

Edison Imaging Associates in Edison, NJ, will perform all appropriate applications at 3-tesla, while there is no specific exam the facility reserves for the 1.5-tesla MRI. “My patients arrive without preselection and I choose which one should go on 3T generally by which exam benefits more or which referring doctor has made the request,” said Dr. Lawrence Tanenbaum, Edison’s section chief of MR and CT neuroradiology.

“We feel we can do recognizably better work in typically one-third less time with greater consistency exam to exam,” he added. “The consistency is due, at least in part, to protocols designed with surplus signal-to-noise.”

By personal choice or because of the lower Medicare reimbursements from the DRA, some imaging facilities choose to use their 3-tesla MRI scans in 20-minute slots to increase patient throughput. “I don’t think you will deliver the same image quality you could on a 3T doing 20-minute slots,” Tanenbaum said, “but you should have no problem in 20 minutes, doing better work than you could on a 1.5T in a 30-minute exam.”

Tanenbaum considers neurovascular imaging as one exam that should always be conducted at 3 tesla. Many of Edison’s referring orthopedic surgeons are “absolutely insistent,” Tanenbaum said, that 3-tesla be used for their exams, because they have seen the boost in imaging quality.

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3-tesla MRI goes mainstream with powerful new applications

Neuroskeletal Imaging of Winter Park, FL, handles 30 to 35 patients per day on its 3-tesla MRI, predominantly performing neuro and musculoskeletal scans. The imaging center also performs spectroscopy, brain tumor imaging, and some functional imaging with its 3-tesla scanner.

Given the choice between greater patient throughput and image quality, Dr. Marc Shapiro, chief of neuroradiology and president of the center, always opts for better images, using ultrathin sections. Brains, for example, are imaged with 1 mm to 3 mm sections.

3T economics 101

As already mentioned, it is impossible to discuss 3-tesla MRI without the issue of reduced Medicare reimbursement, due to the DRA, which reduces Medicare reimbursement for outpatient imaging procedures as of January 1. Most adversely affected are imaging centers, which now are paid less for 3-tesla MRI scans. "My one concern about 3T is reimbursement going down," Shapiro said. "That is the only thing that will stop 3T from replacing 1.5T as a clinical tool -- and it is a major thing."

Shapiro, who has worked with 3-tesla MRI since 2003, estimates the initial cost of the best 3-tesla system is approximately 30% higher than the best 1.5-tesla MRI.

When Encino, CA-based Liberty Pacific Medical Imaging (LPMI) opened its second and newest outpatient imaging center in January, LPMI equipped the Castro Valley, CA, facility with a 3-tesla MRI. When LPMI placed its 3-tesla order two years ago, the financial landscape was considerably different.

Today's environment is more challenging. LPMI President and COO Steven R. Renard estimates that it costs approximately \$500,000 to build a standalone, single-modality MRI imaging center to accommodate a 3-tesla magnet. Of that total, approximately \$60,000 covers the cost of shielding and another \$10,000 for the foundation and ancillary prep work.

One difference is that a 3-tesla room needs to be slightly larger than that of a 1.5-tesla room. "Outside of that, the manufacturers and vendors have done a very good job of making it cost-neutral as far as the development of the room," Renard said. "Having said that, it doesn't preclude the extra money (required) for soundproofing."

LPMI uses standard insulation and adds another four to six inches of dead space between the primary wall and the shielding. If noise is still a concern, the company will add rubber matting underneath the dry wall. Total cost for the additional soundproofing is approximately \$12,000. "If you did all that," Renard said, "it is even quieter than a 1.5T."

All in all, Renard believes the investment in 3 tesla is financially viable. He estimates that an imaging center will need to perform approximately 40 more scans per month to recoup revenues from the lower reimbursement due to the DRA, provided commercial payors don't follow

Medicare's lead. LPMI can perform scans on approximately 30 patients per day on its 3-tesla system, compared with 24 to 26 a day on a 1.5-tesla scanner.

To help facilities meet their 3-tesla investments, vendors are offering operating leases. Renard opted for that option with LPMI's second 3-tesla system. "Operating leases bring the price of the 3T magnets close to what you pay on a capital lease on a 1.5T," he said. "From that standpoint, you have the bandwidth, the marketing capability, the additional procedures, and you are not looking to upgrade in Year 5."

LPMI figures to invest approximately \$2.2 million for its fully loaded 3-tesla MRI, with payments of approximately \$34,000 a month for the operating lease, compared with \$44,000 for a five-year dollar buyout loan.

Given that more facilities are opting for 3-tesla scanning and committing to the greater investment, Scott & White's Runge believes the six- to eight-year replacement cycle of an MRI system will increase. "If that is true and you believe that 3T is the new premier field strength in MR -- which I do -- then you don't want to buy another 1.5T, because you will be stuck with it for 10 years."

By Wayne Forrest
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CT powers up with dual-source scanning

CT developers have tried for years to find the perfect balance between speed and power. But their vision for a device that could combine both was limited by existing technology. The new generation of dual-source CT (DSCT) scanners may have taken a major step toward solving the speed-power conundrum.



“Since (DSCT) eliminates the biggest problem with cardiac CT, the heart rate issue, it makes cardiac CT a regular CT scan.”

— Dr. Elliott Fishman, Johns Hopkins University, Baltimore



Dr. U. Joseph Schöepf, Associate professor of radiology and medicine, Medical University of South Carolina (MUSC) Charleston, SC.

Rather than achieving faster scanning by adding additional detector rows, DSCT instead uses two x-ray tubes and two detector arrays in one gantry, mounted at 90° angles. The result is a system that can take accurate images of the heart without the use of beta-blockers; differentiate between vasculature, bone, and soft tissue; and offer patients who might have previously been ineligible for CT -- such as obese individuals or those with arrhythmia -- access to CT technology.

There’s a price for all this performance. DSCT can cost about twice as much as a 64-slice CT unit. Is it worth it? The answer is yes, if a facility wants to step up its coronary workflow, according to Dr. William Muhr, a staff radiologist at South Jersey Radiology Associates in Voorhees, NJ.

“The CT slice wars have been geared to coronary imaging, no doubt about it,” Muhr said. “Short of coronary scans, the vast majority of CT exams can be done perfectly well on 16-slice. But if you want to do coronary CT and are trying to run a full CT schedule, dual-source will solve a lot of problems.”

To date, DSCT’s benefits have been shown primarily in imaging the heart, one of the most challenging parts of the body to image accurately due to the need to manage

patients’ heart rates with beta-blockers and thus reduce image artifacts. DSCT’s temporal resolution is 83 msec per slice, compared to about 160 msec on a 64-slice CT unit -- and with the use of multisector reconstruction algorithms, the resolution can be reduced even further, to 42 msec. DSCT can acquire a cardiac image in a breath-hold of five to six seconds, rather than the 10 seconds a 64-slice system requires.

This speed allows doctors to image patients without having to lower their heart rates with beta-blockers, which is good news for patients who can’t handle the drugs, such as those with hypotension, asthma, or mild forms of heart failure. DSCT also allows for imaging patients with irregular heart rates, since the better temporal resolution produces motion-free images regardless of the cardiac phase, according to Dr. U. Joseph Schöepf, an associate professor of radiology and medicine at the Medical University of South Carolina (MUSC) in Charleston. Schoepf’s facility began using DSCT in October of last year.

“We had a guy come in within the first few days our DSCT unit was up and running, a fellow radiologist in his 40s, with chest pain, shortness of breath,” he said. “He was on the table, ready for the exam with a nice and slow heart rate in the sixties. When the contrast was administered, he panicked, and his heart

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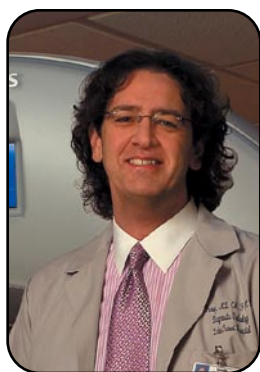
CT powers up with dual-source scanning



Dr. John Lesser,
Director of cardiovascular MRI and CT,
Minneapolis Heart Institute at Abbott
Northwestern Hospital, Minneapolis

“The vast majority of CT exams can be done perfectly well on 16-slice. But if you want to do coronary CT and are trying to run a full CT schedule, dual-source will solve a lot of problems.”

— Dr. William Muhr,
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Voorhees, NJ.



“With the DSCT unit, our cardiac exams take about 10 to 15 minutes from the time the patient arrives in the radiology department.”

— Dr. Ahmed Farag,
Lake Forest Hospital,
Lake Forest, IL

rate shot up to 140 beats per minute. But we still got beautiful diagnostic images. Once I saw that, I thought, let’s just drop the beta-blockers.”

MUSC has subsequently stopped using beta-blockers entirely for patients undergoing coronary CT angiography (CTA) with DSCT.

Not only can DSCT rapidly produce diagnostic images of the heart, it can help ease workflow as well, according to Dr. Ahmed Farag, vice chairman of the department of radiology at Lake Forest Hospital in Lake Forest, IL. The facility’s DSCT unit went live in January, and is the only CT device in the hospital.

“One of the key issues for us in choosing to install DSCT was throughput,” Farag said.

“With a 64-slice CT scanner, we would have to monitor patients once they’d been given the beta-blockers, and wait until their heart rates were low enough to scan. Sometimes it could take as long as an hour and a half, with the patient on the table. With the DSCT unit, our cardiac exams take about 10 to 15 minutes from the time the patient arrives in the radiology department.”

The ability to make cardiac imaging a routine part of a hospital’s overall CT scanning is a boon for radiologists, according to Dr. Elliott Fishman, director of diagnostic imaging and body CT in the department of radiology at Johns Hopkins University School of Medicine in Baltimore, MD.

“The DSCT device is easy to use, and there’s been virtually no downtime,” Fishman said. “And since it eliminates the biggest problem with cardiac CT, the heart rate issue, it makes cardiac CT a regular CT scan.”

Sixty-four-slice technology requires radiologists to look for the heart’s quiet phases to minimize artifacts, according to Schoepf.

“Because there are two tubes in the gantry (of the DSCT unit), the image quality is stable at all heart rates,” he said. “There’s a better chance of capturing a crisp and clear image of the coronary arteries, regardless of the heart phase. We also have a better chance at detecting coronary artery stenosis and visualizing the smaller side branches of the heart. And there are less artifacts from dense calcifications and stents if they move less.”

Not all of DSCT’s users are abandoning beta-blockers, however. Dr. John Lesser, director of cardiovascular MRI and CT at the Minneapolis Heart Institute at Abbott Northwestern Hospital in Minnesota, and his colleagues continue to use them with their facility’s DSCT unit, which has been in service since January. Beta-blockers help decrease micromotion of the coronary arteries and create uniformly excellent studies, according to Lesser.

“If we don’t use beta-blockers, the likelihood of getting a great study drops,” Lesser said.

Like 64-slice CT, DSCT offers the capability of ECG pulsing, or adapting the radiation dose to the heart’s rhythms, decreasing the dose during the systolic phase of the heart’s cycle. But DSCT allows for this pulsing technique no matter what the heart rate, according to Farag. DSCT also adapts the table speed to the patient’s heart rate, so that patients with faster heart rates have a faster table speed, which also minimizes radiation exposure.

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CT powers up with dual-source scanning

Not just for hearts

In addition to heart imaging, DSCT offers other clinical benefits. Angiography, for one, according to Farag.

"With regards to the speed DSCT offers, anything in CT angiography is a huge home run with the technology," he said. "It can do peripheral runoffs from the diaphragm to the toes in 36 seconds." Farag's hospital is already using DSCT to perform angiography exams.

And its speed seems to make DSCT a natural for acute care and emergency room applications -- any situation in which patients can't necessarily hold their breath or lie still for long. DSCT's two imaging tubes offer clinicians a way to better image obese patients by increasing the scanner's energy and therefore acquire better images. And the technology includes scanning features that allow a radiologist to change the tube current on the fly, an important feature for patients with acute chest pain, according to Schoepf.

"When you're using 64-slice for a triple rule-out exam, the radiation dose is increased because you're scanning the entire chest," Schoepf said. "But you can program the DSCT unit to use the full radiation dose when scanning the heart area, and to decrease the tube current, and therefore the dose, when scanning other areas of the chest."

One downside of DSCT's speed is that its scan time can outrun the contrast bolus, Farag said.

"We had to curb the speed of the 64-slice CT scanner to that of a 16-slice to keep pace with the bolus for peripheral runoff studies," he said. "DSCT has the same issue, so you fix the scan time for 30 seconds, and slow it down."

DSCT's next upgrade: dual-energy imaging

DSCT users are awaiting the next development for CT: dual-energy imaging, a software package that can be used with the DSCT device to open up the technology's potential even more by running the unit's two x-ray tubes at different energies depending on the region of interest. The software will take the data and "subtract" the bone from the imaged area from the vasculature, so that the final image displayed just contains the vessels.

Of particular interest will be the possibility that dual energy can characterize tissue and distinguish vasculature, bone, and soft tissue. Other potential dual-energy applications are vascular and tendon imaging, CT angiograms of the brain, tissue differentiation in atherosclerotic plaque and in the liver, and "virtual contrast" liver CT exams, in which the software will produce an initial image without contrast, as well as an image that looks as if contrast were administered.

Even though a dual-energy software package will be available soon, the technique will take some time before it goes mainstream, according to Schoepf.

"Right now, the technology needs more research," he said. "Eventually clinical applications will come from that research."

Even without the dual-energy package, radiologists are finding that DSCT boosts the quality and efficiency of CT imaging in routine clinical settings, and opens up CT to patients who previously would have been ineligible. And these benefits may prove compelling enough to outweigh the technology's high price tag.

"The improvements in cardiac alone are worth the investment," Fishman said.

By Kate Madden Yee
AuntMinnie.com contributing writer
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Equipment Service Part I: Making the most of equipment service personnel and contracts

No matter the size of a hospital, healthcare facility, or imaging center, caring for radiology equipment is a critical component in maintaining uptime, patient care, and revenue. If a CT scanner, MRI system, or ultrasound device goes down, then patients are inconvenienced, healthcare is delayed, and the facility suffers from a loss of revenue and poor public image.

“If we are in a situation where I want a service contract, response time will be huge.”

— Al Gresch,
Aurora Health Care,
Milwaukee

In the first of a two-part Trends in Radiology series on equipment service, we look at how three healthcare systems have crafted their service strategies. These institutions represent the evolution of service in medical imaging, in which straight service deals between equipment owners and vendors are being replaced by more collaborative arrangements in which a facility's in-house staff works with OEM engineers. Many facilities believe these kinds of deals offer the right mix of high response time at an affordable cost.

How much should service cost?

Let's start with the bottom line. How much can a facility expect to allocate for equipment service? The rule of thumb is that an annual service contract will cost between 10% and 15% of the equipment's acquisition cost. “If you can get down below that, you're doing pretty well,” said Al Gresch, corporate manager of clinical engineering for Milwaukee-based Aurora Health Care's 13 hospitals and more than 100 clinics in Wisconsin.

Aurora reorganized its in-house service team in January 2006, making four regional managers responsible for one of four specific groups of modalities. The healthcare system also trained its service staff of 69 full-time-equivalent engineers to become specialists

in one primary modality, with secondary knowledge and responsibility for another modality.

With Aurora handling 85% to 90% of its service calls internally, the new in-house structure has helped maximize both response time and, subsequently, uptime. If outside vendors want a piece of Aurora's service business, they need to offer comparable benefits. “If we are in a situation where I want a service contract, response time will be huge,” he added. “Given the size of our organization, many vendors are reluctant to get that response time to where we would like to have it.”

As Gresch explains, it is one thing for a vendor to promise guaranteed response time in Milwaukee; it is another issue to commit to a response time with an Aurora facility in the far reaches of Wisconsin.

Contract negotiations

OSF Health Care, based in Peoria, IL, is in a similar situation as Aurora. With five hospitals spread across northern Illinois, one hospital in Michigan, and several outpatient facilities with imaging and outpatient surgery capabilities, responding to service calls promptly is a priority, whether it be with internal staff or an outside vendor.



Steve Sellitto, a biomedical imaging lead at Aurora Health Care, services a mammography unit. Image courtesy of Aurora Health Care.

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Equipment Service Part I: Making the most of equipment service personnel and contracts

“An organization will come up with a plan and ideas that it wants to achieve, but without having a skill set of individuals, resources, training, and tools, there can be a large margin of error.”

— Al Moretti,
Loyola University Medical Center,
Maywood, IL



Biomed engineer Chris Warren of OSF Health Care works on an endoscope. Image courtesy of OSF Health Care.

Currently, OSF has six clinical engineers who handle first-call response for 19 MRI systems, 14 CT scanners, two PET/CT units, and more than 100 other pieces of radiology equipment among the hospitals. OSF also has two engineers stationed full-time at each hospital. His service team handles approximately 87% of service calls before relying on outside help.

The absolute best time to negotiate a service contract is at the time of equipment purchase. OSF follows that golden rule, because, as OSF director Dale Surratt noted, “We will lose that negotiating club once we have made the purchase.”

Surratt oversees OSF’s mobile imaging and equipment technology service businesses, and sees the gamut of service deals, from full-service, all-the-time agreements to time-and-materials contracts, based on years of equipment repair and service history.

No matter what the depth of outside vendor involvement in a facility, there are several “must haves” in all service contracts, he believes. These include:

- Parts -- “If you can’t get parts for your equipment, you are in big trouble,” Surratt said. Even if a facility can provide its own labor, if parts aren’t readily available, then the equipment sits idly. Prompt a vendor for fast delivery. “If we call in the morning,” he added, “will we have the part in the afternoon or the following day? It is a big difference to a hospital.”
- Be aware of charges outside of the agreement, such as “special handling.” Make sure special handling is negotiated into the agreement, so there are no unanticipated, extra charges.

- Lock in a long-term contract. “Don’t be afraid to go into a long-term agreement, if you have a good vendor to work with and one you like,” Surratt said. “The vendors love that, too.” Most importantly, chances are much better that the total cost of the contract will be lower over the length of a long-term deal, rather than several short-term pacts.
- Keep track of invoices. A service vendor may be late in billing a facility for overtime on a call -- six or eight months after the job was done -- because the engineer may be late with his paperwork. “We negotiate into agreements that if you don’t get that invoice into us within 90 days, then it is not considered valid and we are not responsible for it,” Surratt said. “It helps the vendor stay on top of things and keeps our administration and accounting in order.”
- Take the time to read the entire service agreement, including the small print, and let an attorney read the proposed contract. A facility also should craft some service-call scenarios to see if its expectations match what the vendor would do in that given case.
- Make sure all the particulars are in writing. “After the equipment is installed and it requires service after five years, you have probably gone through three (vendor) service managers,” Surratt said. “Whatever the first guy promises you, get it in writing.”

Collaborative efforts

Since joining Johns Hopkins Hospital in Baltimore 21 years ago, Michael Harris, head of radiology, physics, and engineering in the hospital’s radiology department, has seen an evolution in the working relationship between

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Tom Horner, Aurora biomedical imaging tech, works on a CT scanner. Image courtesy of Aurora Health Care.

in-house service staff and outside service vendors.

"When I first started here, we had full-service agreements that covered all of the components, but they were very expensive and it was more of an adversarial approach between the internal service group and outside vendor," Harris recalled. "Over the years, my thought was that this was unacceptable."

Harris met with outside vendors to craft a collaborative approach to equipment service, sharing the mutual benefits and the risks. In the contractual arrangement, Johns Hopkins, like many healthcare facilities, handles the first response on service calls for the majority -- if not all -- of its imaging equipment. In turn, the outside vendor rushes needed parts to the facility right away and offers assistance on critical problems.

"We have value by being inside the institution with the ability to respond to calls much quicker," Harris said, "while they have wider resources and they manufacture the parts."

Today, Johns Hopkins' internal staff handles approximately 80% of its service calls, while outside vendors take care of the rest. The remainder includes the most severe equipment issues and covers for in-house engineers when they are consumed with other calls.

"We have such a strong collaboration with all our equipment suppliers that they cooperate very highly with us," Harris said. "With the large number of devices we have -- and since they are largely high-end devices -- it is impractical for a small group (of service technicians) to be trained on every system, other than to have a knowledge

well enough to determine that the problem is so severe that it needs intervention by outside engineers."

Have no fear

Aurora also has various service contracts and options spread across its facilities, and has been as creative as possible in crafting plans with OEM and third-party service vendors.

"We push the vendors hard to provide us with greater service offerings than they did in the past," Gresch said. "Usually you either had full service that offered 24/7 coverage with all parts provided, or there was a step down to full parts and coverage Monday through Friday from 8 to 5. Maybe there was some level of in-house ability where you did the (preventive maintenance).

Gresch said a key piece of advice is to "never allow fear to make decisions for you." "Collect the data and make decisions based on that data," he advised. The vendor may offer a service contract for, say, \$15,000 per year, asserting that if a component goes bad, the facility has justified the expense.

"That is a reasonable argument, but if I have 20 of those devices, is that part going to fail on all 20 devices?" Gresch said. "What has been the failure rate on those boards? Look at the rate of parts failure and how much it costs to replace it. Then make the decisions based on that data, not on fear."

Strategic planning

Loyola University Health System, based in Maywood, IL, also relies heavily on its in-house staff for service to handle more than 90% of its calls.

Within Loyola, more than 300 imaging devices, ranging from new to mature

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technologies, are spread among the main campus -- Loyola University Medical Center -- and 15 primary care centers and one major imaging center throughout the greater Chicago area. Loyola's outpatient clinics offer mammography and general radiography, while the offsite imaging center features MRI, CT, and general radiography.

The service staff of 23 clinical engineers is divided into four units: imaging, OR/biomedical, general biomed, and laboratory. Three divisions have seven technicians, while the laboratory group has two technicians.

"We are the primary service provider internally," said Al Moretti, Loyola's director of clinical engineering. "We, in turn, work through the OEM for their respective

devices. We do very little third-party service at all, because our role is to do 95% of the work internally."

In devising a service plan, Moretti evaluates the strategy by modality and its requirements in light of Loyola's clinical and business goals. Then the plan is broken down to show the return on investment for each device in terms of the true cost of internal service, rather than using an outside vendor.

"We have a large installed base, but we are able to employ staff onsite that are of OEM caliber," Moretti said. "It may not be the model for every institution. If you are a smaller institution with a smaller installed base, you may have to look at other objectives on how to save time and costs."

Moretti's advice to other healthcare institutions is to understand the facility's business plans for the imaging modalities, understand the capabilities and resources on hand, and understand what you can achieve for a service with the available resources. "Without looking at those three, that's when the failures come about," he added. "An organization will come up with a plan and ideas that it wants to achieve, but without having a skill set of individuals, resources, training, and tools, there can be a large margin of error."

By Wayne Forrest
AuntMinnie.com staff writer
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Equipment Service Part II: Equipment uptime and workflow efficiency begins with service

The old adage that “time is money” may be most applicable in healthcare. When radiology equipment is not in use, patients are not receiving essential care and the facility itself is not making -- and, perhaps more likely, is losing -- revenue.

“If you have a system down for a few days, everyone will remember that for a year.”

— Stan Trojanowski,
Medical University of South Carolina,
Charleston

With healthcare facilities imaging more patients in shorter amounts of time and extending hours of daily operation, equipment uptime is a critical component to patient throughput and department efficiency. Equipment uptime of 97% is the norm -- but many facilities are pushing that boundary in the quest for greater efficiency.

Standard uptime at the Medical University of South Carolina (MUSC) in Charleston is 98%. While that number looks good on paper, chances are there still may be some unhappy patients and caregivers in the remaining 2%.

“We try to go beyond those figures, but perception is everything,” said Stan Trojanowski, MUSC’s manager of biomedical engineering. “If you don’t communicate with your customers, then they will be unhappy, regardless of the fulfillment of uptime. If you have a system down for a few days, everyone will remember that for a year.”

For Trojanowski, the biggest challenge in maintaining equipment uptime is scheduling preventive maintenance (PM). The goal, of course, is to perform PM as needed without adversely affecting patient exam time. MUSC looks to perform as much PM during regular daytime hours as possible, coordinating in advance with radiology staff to schedule a one-hour window. In some cases at MUSC, overtime and extra charges are paid by the

user department to motivate staff to be more flexible in making the equipment more available for PM.

Tough choices

Of all medical imaging modalities, the department least able to be flexible is the cath lab. “PM work, especially in cardiology, is most difficult, because one hour is so many thousands of dollars,” Trojanowski said. “The argument that they are losing revenue (when the cath lab is offline for preventive maintenance) is a strong one.”

The same situation holds true for Allina Health System of Minneapolis. Its service and maintenance arm, Allina Clinical Equipment Services (ACES), coordinates with the radiology department on the PM schedule about 45 days in advance to find a time during the day when the equipment may not be in use or if the clinical staff is away for training. Not only does advance scheduling minimize downtime, but it also can save money with by eliminating overtime.

“We can get in so there is no off-hour overtime,” said Steve Bursaw, technology manager at ACES. “If we are bumped, we have to either work with our service provider -- who is under agreement do some of the servicing -- or our in-house folks will alter their schedules to accommodate the department.”

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Service technician Kevin Emerson works on the removal of an older cardiovascular imaging device, as Allina makes more room for the installation of a new flat-panel system. Image courtesy of Allina Clinical Equipment Services.

“We are seeing fewer true component failures, but when they do fail, the cost can be high.”

— Steve Bursaw,
Allina Clinical Equipment Services,
Minneapolis

Allina follows the vendor-recommended schedule for preventive maintenance. In some cases, technicians will service a CT scanner in phases -- one or two portions of the device every couple of months, so over the course of the year, the whole scanner is serviced.

Multiple vendors

Allina’s network includes 12 hospitals and more than 40 clinics in Minnesota, and one clinic in Wisconsin. Allina offers a full complement of imaging services, and it has nine service engineers dedicated to radiology. The only two modalities that Allina does not handle internally are MRI and digital mammography.

The decision whether to service equipment internally or through an outside vendor is made by ACES’ Vendor Management department, which works with vendors to determine the best course of action for service. The evaluation takes into account service contract cost, time and materials costs, training availability, number of devices requiring service, and vendor service resources.

Bursaw estimates that his in-house staff covers approximately 65% of service calls, with the remainder handled by outside service vendors. The cost of an OEM service plan is the “primary concern,” he said. “We look for some flexibility from our outside service vendors in terms of their ability to offer some nonboilerplate-type plans that would help us, considering we do have the internal resources.”

That flexibility runs the gamut from parts-only service agreements to full-service deals. “Generally, we are trying to get an agreement that provides all the parts we need, extended

hours of service until 9 or 10 o’clock at night, and service engineer support when we are beyond our capabilities,” he added.

Parts availability

The OEM service provider’s greatest contribution to uptime and department efficiency is in parts availability and the ability to ship parts overnight or the same day an order is received. “We get them (the OEMs) to think of us as if we were their service people,” Bursaw said. “We also get specific passwords to order the parts.”

Needless to say, if parts are not available quickly, an inoperative imaging device becomes a huge, expensive paperweight.

John Davidson, president of New England Health Imaging (NEHI) of Concord, MA, described NEHI’s service agreement with one of its vendors as an “insurance policy.” “We pay a premium that covers necessary parts to keep the MRI systems going,” he said.

NEHI provides MRI services with four fixed sites in Massachusetts, and three fixed sites and two mobile MRI scanners in Maine. The company employs one full-time engineer in Massachusetts and another full-time service technician in Maine.

NEHI partners with one OEM service contractor, which fills the service gaps by helping NEHI service engineers with issues they cannot solve and by providing prompt parts availability and shipping. The vendor also trains NEHI service engineers on its MRI equipment and covers service calls when they are on vacation or busy on another assignment.

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The combination of in-house and outside service options results in greater uptime for NEHI's MRI systems, optimum patient care, and more revenue for the company. "If you have more uptime, you don't have any cancellations when patients come in and you don't have to reschedule," Davidson said.

Under its contract with the vendor, NEHI technicians are the first responders to service calls, as is the case in many service agreements. The so-called "reduced maintenance agreement," Davidson said, provides cost savings to NEHI, which more than offsets the cost of NEHI having its own in-house service engineer.

Combining resources

MUSC uses a combination of in-house and OEM service to support its radiology department, which, in turn, supports a 600-bed hospital and three outpatient centers. MUSC plans to open a cardiology hospital next year and, as a result, increase its total number of angiography rooms from five to nine and its catheterization/EP labs from five to seven.

The annual service budget for imaging equipment is approximately \$4 million, and its imaging equipment comes primarily from three multimodality OEMs. MUSC has service contracts with all three vendors, with one OEM acting as lead service provider and supplying an onsite service manager to help coordinate service management.

In terms of dollars, the breakdown is about 70% to 30% in-house staff versus outside vendors. The internal service staff also dominates total labor hours. MUSC staff handles first response on the first level of service calls on imaging equipment, such as portable x-ray and C-arm service, with its lead OEM providing parts and supplemental outside labor with an annual cap on service cost. No matter what the service cost over the year, MUSC will only pay that amount to its lead OEM. Above that figure, the OEM will reimburse MUSC for its staff's labor at set rate per hour.

MUSC also takes advantage of remote diagnostics provided by its lead OEM, which monitors the imaging network. The OEM service center receives signals from the major modalities, such as CT, MRI, and cath lab equipment, and detects and anticipates percolating problems.

MUSC has cooperative pacts with its other two OEMs, with MUSC responsible for first response.

Extended service

Allina occasionally will opt for extended service agreements with its vendors to cover off-hour service and repairs, though that option may come at an additional cost.

Though Allina -- like many healthcare facilities -- is responsible in most cases for handling a service call initially, the healthcare system relies on its outside vendors to commit to their standard response time of two to four hours when needed. A four-hour maximum response time is more acceptable during off-hours or in the evening.

While new imaging technologies have been influential in improving uptime and increasing patient throughput with shorter scan times, the advance hasn't necessarily made the lives of service technicians more relaxed. A hospital can perform more scans and handle more patients with a 64-slice CT system, but Allina has not seen a reduction in service calls for the technology.

"We are seeing fewer true component failures, but when they do fail, the cost can be high," Bursaw said. "That's one of the reasons we have agreements with the vendors to supply the parts." To help manage that cost, Allina includes a parts guarantee as part of its OEM service contract.

Bursaw estimates that Allina has held steady with an imaging equipment uptime rate of 96% to 97% over the last five years. Its linear accelerators are in the 98% to 99% uptime echelon. Compared to five years ago, clinicians are using the modalities more hours in the day, and more patients are being served.

By Wayne Forrest
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New breast ultrasound techniques may find more cancers

Valued as a noninvasive imaging modality that is well-tolerated by patients, ultrasound has played an important role in breast imaging as an adjunct to conventional mammography, particularly for women with dense breasts.



“Breast imaging is not totally a science, but an art.”

— Dr. Stamatia Destounis, University of Rochester/Elizabeth Wende Breast Imaging Center, Rochester, NY



“Better resolution means breast imagers can see lesions with ultrasound that they couldn’t see before.”

— Dr. Jay Baker, Duke University Medical Center, Durham, NC

Ultrasound helps clinicians determine whether a suspicious lesion is a cyst or a solid nodule, as well as whether these masses are malignant or benign. This ability to differentiate between cysts and solid nodules cannot only save many women from undergoing unnecessary biopsies, but can alleviate their anxiety more quickly as well.

Ultrasound transducer technology has improved in the past two decades, making the modality a clear candidate for research and development of new technologies, according to Dr. Jay Baker, chief of radiology at Duke University Medical Center in Durham, NC.

“Fifteen years ago it was a 7-MHz transducer, and now we’re up to 10 or 15,” he said.

“The higher the frequency, the better the resolution, and better resolution means breast imagers can see lesions with ultrasound that they couldn’t see before.”

With this increased strength come new possibilities for ultrasound, and a variety of new techniques and technologies -- from elastography to compound imaging to ultrasound computer-aided detection (CAD) -- have appeared on the horizon. The hope is that as breast ultrasound continues to be developed, these technologies will offer new ways to add specificity to mammography, reduce biopsies, and even standardize

ultrasound’s use, therefore addressing its primary limitation, dependence on operator skill.

But the future isn’t entirely rosy. There is an ongoing shortage of breast imagers, in part due to low levels of reimbursement and also because of legal fears, according to Dr. Thomas Stavros, chief of ultrasound and noninvasive vascular services with Radiology Imaging Associates and a long-time radiologist at Invision/Sally Jobe Breast Network, both in Denver. Ultrasound’s reliance on operator skill is becoming a disadvantage, he believes.

“We don’t have the (human) resources for handheld ultrasound,” he said. “This shortage of personnel will almost certainly increase interest in automating the process.”

“Buttonology”: Boosting B-mode

Some of ultrasound’s cutting edge may already exist as buttons on the console. One advanced technique, compound imaging, combines images from multiple lines of sight to create a single B-mode image. One of compound imaging’s key benefits is that if what is being imaged is a real structure, it will show up on each line of sight and will be reinforced in the final image, while if what you’re seeing is an artifact, it will only show up on one line of sight and will be therefore be less evident in the final picture.

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New breast ultrasound techniques may find more cancers



Dr. Richard Barr, Ph.D.,
Professor of radiology,
Northeastern Ohio Universities
College of Medicine
Rootstown, OH

"Compound imaging is a way of reinforcing real information, real structures," Baker said.

But compound imaging can also make useful information more difficult to interpret, he cautioned. When an ultrasound beam is attenuated so that it can't pass through a mass, the image reflects this with a shadow behind the mass, which can help doctors recognize a potential cancer. Similarly, ultrasound images of cysts tend to have a bright band behind the cyst. Compound imaging can make both these effects less obvious, making it more difficult to identify what's actually being imaged. One solution is to scan twice, once without compound imaging and again with it to be able to see the contrast better, according to Baker.

Color and power Doppler can be useful for looking at blood flow; some researchers have found that there are vascular differences between cancerous and healthy tissue. Doppler imaging can also be used with contrast agents, but it remains unclear as to whether this combination is necessary or effective in breast imaging.

Some researchers have used Doppler imaging with contrast and have found breast lesions that originally seemed avascular (when imaged without contrast), but later proved to be vascular, according to a review article on breast ultrasound authored by Chandra Seghal, Ph.D., director of ultrasound research at the Hospital of the University of Pennsylvania in Philadelphia (*Journal of Mammary Gland Biology and Neoplasia*, November 2006, Vol. 11, pp. 113-123).

With another advanced imaging technique, tissue harmonic imaging, the ultrasound scanner "listens" for multiples of the

fundamental frequency, which give more image data and can reduce artifacts, therefore improving resolution. Since lower frequencies penetrate deeper into the body, what the sonographer "hears" back from a scan with harmonic imaging is the higher frequencies of the sound waves. Harmonic imaging's usefulness is limited in breast imaging, Baker said. "Since we're not penetrating all that deeply anyway, high-frequency transducers can penetrate the tissue deeply enough without the additional boost from harmonic imaging."

Tissue elasticity imaging: Finding marbles in Jell-O

The techniques described above improve image quality of breast ultrasound. But tissue elasticity imaging, or elastography, adds a whole new dimension, according to Dr. Richard Barr, Ph.D., professor of radiology at Northeastern Ohio Universities College of Medicine in Rootstown, OH. Elastography measures the relative stiffness of tissue caught in the ultrasound frame via mild tissue compression (the woman's respiration usually creates enough compression to produce an elastographic image; if more compression is needed, the sonographer can apply gentle palpation with the transducer).

If the breast imager finds a well-defined lesion in the B-mode image, elastography can help determine whether a mass is benign or malignant. Elastography also seems to show promise in detecting lobular cancers, which are characterized by cancer cells that grow in fine lines that can be palpated but are often missed on x-ray-based mammography or B-mode ultrasound.

"Think of a marble in Jell-O -- if you compress the Jell-O, it deforms, but the marble doesn't,"

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New breast ultrasound techniques may find more cancers

Barr said. "Elastography applies grayscale to the changes in hardness between healthy and cancerous tissue -- on our system, soft tissue is lighter and lesions are darker -- and can determine whether something is malignant or benign."

At the 2006 RSNA conference in Chicago, Barr and his colleagues presented results from a study they believe shows that elastography could decrease the number of biopsies performed on BI-RADS 3 lesions and could change the status of BI-RADS 4 lesions to "close follow-up" rather than "go directly to biopsy." Their study found that elastography was able to locate metastatic disease.

Barr and his colleagues also noticed that malignant lesions appeared three to four times their size than in the B-mode image when elastography was applied. Could it be that more aggressive tumors have more dramatic size changes?

"We're trying to design some studies that will perform detailed histological evaluations so we can decipher what's really going on," Barr said.

One of elastography's limitations is that the breast imager has to get a well-defined image of a lesion in B-mode before elastography will be helpful or accurate, since the technique is based on the relative stiffness of tissues. Some ultrasound vendors have included in their device software a feature that "veils" the image on the computer display if the

Ultrasound breast screening: Too soon?

With all these new techniques and technologies, the question remains: Can ultrasound be used for breast cancer screening?

Perhaps for women at high risk who have dense breasts, according to Dr. Wendie Berg, Ph.D., head of the American College of Radiology Imaging Network (ACRIN 6666) on whole-breast ultrasound screening. The ACRIN 6666 trial, more than half of which is funded by the Avon Foundation (the remainder of its funding is from the National Cancer Institute via ACRIN), consists of 2,809 women; researchers began enrolling participants in April 2004 and ended in February 2006.

Each woman is given a mammography exam and a breast ultrasound exam at entry, then again at 12 months and 24 months. The breast imager that does the ultrasound exam is blinded to the mammography exam, Berg said. The first results are expected this fall.

"The main issue is whether the combination of screening ultrasound and mammography is better than mammography alone for this population," Berg said. "We already know that ultrasound is not going to replace mammography, but it's important to give it a fair and objective evaluation."

Other studies have been conducted to evaluate breast ultrasound, and their results were promising: Breast ultrasound found three to four more cancers per 1,000 women not found in mammography. But these previous studies had a few limitations, according to Berg:

- They centered on average-risk, rather than high-risk, women.
- The breast imagers that performed the ultrasound exam were aware of the results from the woman's mammogram, which opens up the potential for bias.
- They didn't evaluate and/or report results for the women in subsequent years.

One of the exciting characteristics about breast ultrasound is that it not only appears to find cancers mammography misses, but 86% of the cancers it finds are node-negative, Berg said. "For breast cancer screening tests to be effective, they have to find the cancers that haven't yet spread," she said. "It's fair to say that if ultrasound can find these cancers, using it should save lives."

-- Kate Madden Yee

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sonographer is not in the right place, so that the image won't be used.

"Obviously, if the person scanning doesn't notice that he or she has missed the lesion, applying elastography won't be effective," Barr said.

Whether elastography evolves into a routinely used clinical tool depends on if the technique can help doctors decide whether masses should be biopsied or not. If the technology could be quantified enough so that ranges of tissue hardness could be assigned a numerical value, it could offer more data as to whether a lesion should be investigated further.

CAD: Can breast ultrasound be quantified?

As CAD technology has become widely used with mammography and increasingly accepted with MRI, interest in pairing it with ultrasound has also spread.

"Ultrasound CAD is in its infancy right now and emphasizes computer-assisted diagnosis," said Dr. Wendie Berg, Ph.D., head of the American College of Radiology Imaging Network (ACRIN 6666) multicenter trial that is evaluating whole-breast ultrasound for breast cancer screening. "And the fact is, in breast ultrasound, detection is usually a greater challenge than interpretation."

Some studies have posited that a lack of real-time analysis has made the adoption of ultrasound CAD difficult; studies of ultrasound CAD have used static images that are then analyzed.

This lack of real-time data makes developing CAD for ultrasound more challenging. Operator variability complicates things as well, according to Dr. Stamatia Destounis, a clinical associate professor at the University of Rochester and a staff member at the Elizabeth Wende Breast Imaging Center in Rochester, NY.

"Each radiologist may classify lesions a bit differently," she said. "When we do reader studies, invariably there are differences between individuals as to where the lesion is marked. Breast imaging is not totally a science, but an art."

Despite its limitations, breast ultrasound offers real benefit, particularly for women with dense breasts -- the very women who need extra technological support in diagnosis and screening. The possibility of catching early cancers in at-risk women may prove more compelling than the possibility of increased false positives, according to Berg.

"With the high rate of so-called interval cancers in women with dense breasts -- cancers that show up before the next screening exam -- we really need to be doing something more than we currently are," she said.

Ultrasound's mix of low cost, noninvasive nature, and rapidly improving image quality means it will continue to play a role as the primary adjunctive imaging modality to mammography for years to come.

By Kate Madden Yee
AuntMinnie.com contributing writer
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Refurbished equipment helps imaging facilities do more with less

Farida Razvi was facing a dilemma. As manager of the nuclear medicine department at Mount Sinai Hospital in Chicago, she wanted to replace the hospital's aging single-head gamma camera, a Prism system of Picker International vintage. But as a nonprofit community hospital, Mount Sinai faced serious budget constraints in terms of how much money it could commit to acquiring new technology.

"We had all the latest software of whatever we were doing on the processing side."

— Farida Razvi
Mount Sinai Hospital,
Chicago

The solution? Refurbished equipment. By purchasing a preowned system, Razvi was able to upgrade Mount Sinai with a dual-head variable-angle gamma camera at a significant discount to what a new unit might cost. Mount Sinai purchased the system from a multimodality OEM, and the unit came with a one-year warranty identical to that available on new systems, giving Razvi peace of mind about her purchase.

Razvi said the new system has enabled the department to double its throughput, and Mount Sinai is now looking at expanding its activities in molecular imaging by acquiring a PET/CT scanner for the first time -- also a refurbished system.

A changing market

Mount Sinai's example illustrates the changing face of the refurbished equipment market. Once dominated by mom-and-pop companies, refurbished equipment once carried a whiff of disfavor colored by horror stories of "spray-and-pray" outfits that foisted barely functioning equipment on unsuspecting customers.

How times have changed. The major multimodality OEMs have taken a page from the auto industry, setting up programs

in which they take equipment on trade-in, have it refurbished and updated, then sell it packaged with warranties designed to protect their customer's investment. At the same time, independent refurbishing companies are seeking to burnish the industry's image through self-policing programs.

The growth in refurbished equipment is aided by the rapid replacement cycle in medical imaging, in which technology that was considered state-of-the-art just a few years ago is frequently jettisoned by sites that must have the latest and greatest. Going the refurbished route can be a great deal for those who don't have to be on the bleeding edge, with preowned equipment costing 30% to 50% less than brand-new systems.

According to Diana Upton, president of the International Association of Medical Equipment Remarketers and Servicers (IAMERS), preowned equipment can be broadly categorized into two main segments: equipment sold under OEM warranty plans and equipment sold on an "as is, where is" basis from an equipment broker. Brokers specialize in using their industry contacts to match sites that want to sell an older piece of equipment with other facilities looking for preowned systems.

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Refurbished equipment helps imaging facilities do more with less



"I truly feel that I have a brand-new piece of equipment at probably 50% of the price."

— Dr. Mark Lopiano,
Medical Director,
Medical Imaging Center of Fairfax
Fairfax, VA

Many of these equipment brokers are small mom-and-pop outfits, and there remains an element of "caveat emptor" for those looking to purchase preowned systems through independent firms. Still, buyers who do their homework and are diligent about researching their purchase can be rewarded with good deals.

"The 'as-is, where is' market is viable for some folks, and you can get equipment that is very good if you know what you're doing," Upton said.

IAMERS was formed in 1993 to provide a means for independent equipment brokers to police themselves. The group charges \$700 for an annual membership, and provides a dispute-resolution mechanism for buyers who feel they got a raw deal. Brokers can be thrown out of the association if they're found to be conducting business in an unethical manner. Some 110 companies are members of IAMERS, including a few large OEMs that operate their own refurbishing businesses.

The OEMs get interested

The entry of the OEMs represents an interesting new wrinkle to the refurbished equipment business that's developed in just the last few years. Large multimodality vendors have set up their own programs to accept equipment on trade-in and process it through their own facilities or through third-party refurbishers. The equipment is then certified by the OEM and carries a warranty of up to one year -- just like what's available on new equipment (see sidebar, "The OEM refurbishing process").

This kind of warranty appealed to Dr. Mark Lopiano, medical director of Medical Imaging Center of Fairfax in Fairfax, VA, a site that's part of imaging center operator InSight

Health Services of Lake Forest, CA. The facility, located in a suburb of Washington, DC, serves a population of more than 1 million people.

Competition for imaging services in the region is fierce, Lopiano said, and the facility was having trouble generating much volume for its CT service -- probably because the system was an outdated single-slice model. Due to its low CT volume, InSight management suggested the site acquire a refurbished rather than new system, and Lopiano last year began examining a 16-slice system under an OEM warranty program.

Lopiano soon found there's a lot to like about buying refurbished equipment. In addition to a one-year warranty, Lopiano was able to ask the vendor to make a number of enhancements to the system during the refurbishing process, such as the addition of a more powerful x-ray tube that isn't commonly available on a 16-slice scanner. That gives Lopiano's scanner a faster rotation time and achieves more body coverage without generating more heat units. Lopiano also negotiated to get a workstation with the latest software for performing advanced applications.

"If the vendor is going to refurbish (the scanner) anyway, they can pull the standard tube and put in a higher tube, or a new generator. They can put the latest software on it," Lopiano said. "I truly feel that I have a brand-new piece of equipment at probably 50% of the price."

Like Lopiano, Razvi at Mount Sinai also requested modifications to the dual-head gamma camera that her facility purchased, including a new crystal and new workstation software.

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“The crystal is the important part, and that was new. That is basically what you want,” Razvi said. “We had all the latest software of whatever we were doing on the processing side.”

What can you get?

Much of what’s available on the preowned equipment market varies based on modality. Some technologies, such as CT, have seen rapid advances recently, and as a result it’s easier to get technology that was state-of-the-art just a few years ago.

In molecular imaging, there’s little market anymore for dedicated PET systems, as hybrid PET/CT units have taken over this segment. In addition, some brands, particularly those of the larger multimodality OEMs, tend to hold their value versus lesser known marques, Upton said.

Protecting yourself

What’s the best way to make sure you don’t get a lemon when buying refurbished equipment? If you purchase through an independent broker, first make sure the broker is a member of IAMERS in good standing, Upton said. Then make sure you perform a comprehensive site inspection of the equipment you’re buying.

In most cases, this inspection shouldn’t necessarily be conducted by a radiologist, but rather by someone who is familiar with the technology. In particular, try to inspect the equipment while it is still installed and running at the previous owner’s facility, she advised.

The OEM refurbishing process

So exactly what happens to a piece of medical imaging equipment when it’s refurbished? The process varies based on who’s doing the refurbishing, but in the case of OEM refurbishing operations, it can be fairly extensive.

1. **System selection:** The OEM vendor first must decide whether there’s a potential market for a system that’s being deinstalled. The age and condition of the equipment are taken into consideration, as well as whether the scanner’s software and hardware can be upgraded. In addition, some OEMs prefer not to accept equipment that is under service by third parties.
2. **Deinstallation:** The system is inspected prior to deinstallation, then packaged in original packing materials to prevent damage during shipment to the refurbishing facility. Deinstallations are typically conducted by third-party companies that are certified by the OEM.
3. **Refurbishing:** Equipment is shipped to a central refurbishing facility, where it is cleaned, disinfected, and painted. The vendor checks the system and subsystems thoroughly, and performs software updates. Some vendors typically have a “standard kit” of parts that are automatically replaced on all systems they refurbish. This can include bearings, cables, and covers on radiography-fluoroscopy equipment, for example.
4. **Reinstallation:** The system is transported to the customer site and installed by a third-party service provider that’s certified by the OEM. The equipment is started and tested to ensure it works properly.
5. **Service and warranty:** OEM refurbishing programs typically offer equipment warranty programs that in some cases are equivalent to what’s available on new systems (this can vary by modality). Customers can also receive equipment financing and applications training, as well as guarantees for spare parts for up to five years.

The length of time for the entire refurbishing process varies based on modality, ranging from two to three weeks for CT systems and gamma cameras to 10-12 weeks for MRI scanners.



Calibration and testing of CT scanner.



Additional testing after adjustments are made.



Calibration within the power cabinet.



Packing and shipment of system after refurbishing is completed.

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One common misunderstanding that Upton runs into regards buyers who aren't exactly clear on what's included in the package of equipment they are purchasing. For example, is the chiller used with an MRI scanner included in the deal, or does the hospital consider it a part of its facility that it is going to retain? If there is a second workstation used with the system, will that workstation be included? Make sure that everything you're expecting to get is specified in the contract, Upton advises.

Both Razvi and Lopiano, who purchased their refurbished systems under OEM programs, said they felt comfortable enough with the vendor warranties that they didn't need to conduct system inspections. Both, however, advised those who are buying through OEM programs to take advantage of the chance to customize their systems.

Both say that purchasing refurbished equipment helped them modernize their facility, increase throughput, and make their services more competitive. At Mount Sinai, the nuclear medicine department doubled its throughput, which has laid the groundwork for starting a PET/CT service, Razvi said.

Lopiano feels that, at least in his case, the concerns about refurbished equipment are a thing of the past.

"Don't worry about looking at refurbished equipment if you stay with a reputable vendor," Lopiano said. "I felt very comfortable going with a big company."

By Brian Casey
AuntMinnie.com staff writer
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Obesity forces radiology to supersize



“The minute you start hitting 250 lb, you start to see difficulties in imaging.”

— Dr. Raul Uppot,
Massachusetts General Hospital,
Boston

It's no secret that the U.S. is struggling to cope with a rising tide of obesity as sedentary lifestyles and poor eating habits prompt Americans to pack on the pounds. Obesity's cost to the healthcare system is well known, as heavier patients experience a wide range of medical conditions, from diabetes to heart problems.

But obesity's impact on radiology is just beginning to get the attention it deserves. Once a rare occurrence, imaging facilities are finding that an increasing number of patients simply do not fit on imaging equipment designed for “average-sized” patients, or that conventional imaging parameters are not sufficient to penetrate extra layers of patient fat.

That's a conundrum, because obese patients with their associated comorbidities frequently require more imaging studies. The rising popularity of bariatric surgery -- which frequently uses imaging to confirm the placement of gastric bands -- is also leading to an influx of obese patients into imaging suites.

Fortunately, imaging vendors are beginning to adjust with equipment modifications that include higher table weights, wider scanner bores, and other features that make scanning obese patients more practical. Imaging facilities are also developing new tactics and imaging parameters for handling the new supersized generation of patients.

A special set of challenges

Statistics underline the obesity epidemic. At Massachusetts General Hospital (MGH) in Boston, the number of obese patients being admitted nearly doubled in 10 years, going

from 9% of admissions in 1991 to 16% in 2001, according to MGH radiologist Dr. Raul Uppot.

“We started noticing about two years ago that increasingly, when dictating our radiology reports, we were saying ‘limited by body habitus,’” Uppot said. “It affected our department's ability to transport people to radiology, put them on CT or MR scanners, and interpret these images.” In a study published in *Radiology* in 2006, Uppot found that 15% of radiology reports were habitus-limited (*Radiology*, June 2006, Vol. 240. No. 2, pp. 435-439).

Two main issues arise with imaging obese patients, the first being the attenuation properties of human tissue, which typically begins to become a factor in patients weighing 250 lb and over. “The minute you start hitting 250 lb, you start to see difficulties in imaging,” Uppot said. This is particularly true for projection x-ray and ultrasound, he said.

Problem two is the sheer difficulty of handling large patients, many of whom aren't able to move themselves. Five documented employee injuries resulted when one 500-lb man spent several weeks at a Kaiser Permanente Hospital in Fresno, CA, in 2000. Patients sometimes don't fit into scanner bores, or

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may be too heavy to be supported by patient tables that can't handle the strain.

What happens when a patient doesn't fit on conventional imaging equipment? In one case at MGH, a patient with abdominal pain suspicious for appendicitis wouldn't fit on the hospital's CT machine, so the person was just observed for several days, then sent home. In the most extreme cases, patients who can't be imaged undergo exploratory surgery instead, a practice all but abandoned since the introduction of CT.

In bariatric imaging, the modality of choice is usually fluoroscopy due to its ability to visualize contrast flow in real-time. Fluoroscopy is used to confirm the placement of laparoscopic gastric bands, in post-op barium studies, and to monitor post-op complications. It's also used in preoperative placement of vena cava filters and in transjugular intrahepatic portosystemic shunt (TIPS) procedures. TIPS placements help diabetics control glycemic levels with a stent placed in the middle of the liver to reroute blood flow.

But these procedures in many cases require special handling. In Uppot's latest research, published in the February 2007 issue of the *American Journal of Roentgenology*, he wrote: "Obese patients may also require high doses of weight-based sedative medications, which may put them at risk for respiratory depression.... If patients do not tolerate the

The skinny on obesity

The incidence of obesity has doubled over the last two decades, quickly making it one of the most serious health problems in the U.S. In the 1970s, some 32% of adults were overweight (BMI > 25) and 15% obese (BMI > 30). By 1999, 61% were overweight, with 27% of those characterized as obese, according to statistics from the U.S. Department of Health and Human Services.

The Agency for Healthcare Research and Quality (AHRQ) reported that from 1996 to 2004 hospital stays of obese patients increased by 112%, from 797,000 to 1.7 million. Nearly all such patients weighed at least two times more than their ideal weight.

Meanwhile, bariatric surgeries increased from 13,365 in 1998 to more than 120,000 in 2004 (*Journal of the American Medical Association*, October 19, 2005, Vol. 294:15, pp. 1909-1917) and represent one of the fastest-growing hospital procedures (*Medical Care*, August 2006, Vol. 44:8, pp. 706-712). The American Society for Bariatric Surgery found that gastric bypass weight-loss procedures alone increased from 63,000 in 2002 to 100,000 in 2003.

Bariatric post-op complications include leaks, fistulas, and obstructions. The complication rate among the 2,522 surgeries covered in the AHRQ study was 21.9% during initial surgical stay. The report stated that "the rate increased by 81% to 39.6% ... over the 180 days after discharge." Among patients without 30-day complications, 10.8% developed complications between 30 and 180 days.

In addition to complications of bariatric surgery, more than 30 medical conditions (including heart disease, cancer, diabetes, and musculoskeletal disorders) are associated with obesity. Obesity-related comorbidities increase with age and account for 300,000 premature deaths per year, according to recent studies.

-- Sydney Schuster

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Bill Broaddus RT (R)
Director, Radiology Services
Central Baptist Hospital,
Lexington, KY

administered doses of sedatives, the use of a mix of different active sedatives" may be necessary. If a patient isn't a good candidate for conscious sedation, general anesthesia may be mandatory (*American Journal of Roentgenology*, February 2007, Vol. 188, No. 2, pp. 433-440).

Fortunately, healthcare providers and vendors alike are scrambling to develop techniques and equipment that will penetrate body habitus, support heavier patient weights, and prevent radiation burns from the increased dosages.

Tips for handling obese patients

Aurora Sinai Medical Center in Milwaukee has seen a 20% jump in bariatric procedures from 2005 to 2006. The center has developed a number of work-arounds for patients who exceed the weight limits on its equipment, according to Joylyn Kralik, supervisor of diagnostic radiology.

"When the table can't support the patient's weight for the preoperative screening of bariatric gastric bypass, we'll attempt to do the fluoro and postfilms with the patient standing," Kralik said. "The studies routinely performed are chest x-ray, UGI (upper gastrointestinal imaging), and gallbladder/limited abdominal ultrasound."

Uppot says MGH sometimes uses the standing method in very large patients, with a static chest x-ray to confirm gastric banding placement. But projection radiography is far from ideal because it lacks the ability of fluoroscopy to view anatomy in real-time, he said.

In other modalities, a standard method for improving image quality in obese patients can be stated simply: turn up the power.

"You can improve the image quality," Uppot noted. "For CT, you increase the kVp and mAs, and decrease the gantry rotation speed. For ultrasound, you have to try to position the patient properly and use the lowest-frequency transducer. For MRI, use the machine with the most power. A 3-tesla machine will probably generate a better image than a 1.5-tesla."

Industry responds

With bariatric surgery booming, more radiography vendors have introduced tables and openings that support larger patients.

Uppot noted that some MRI scanners now accept patients weighing up to 550 lb and have a bigger bore, and some CT systems accept up to 680 lb and have a gantry diameter of 90 cm. Some fluoroscopy equipment is even available with weight limits as high as 700 lb. With 27% of the U.S. population being obese, some manufacturers view this market as an opportunity, Uppot quipped.

In x-ray instrumentation, digital fluoroscopy has an edge over analog radiography/fluoroscopy (R/F) in penetrating body habitus. "There's less motion, and anatomy is well penetrated during live fluoro," Kralik said. Flat-panel detectors also are less bulky than image intensifiers, leaving more room to accommodate larger patients. Uppot recommends using pillows and sandbags to stabilize patients.

"Imaging becomes more difficult to do because of the amount of radiation that's needed to penetrate these patients."

— Dr. Daniel Croteau,
Henry Ford Hospital, Detroit

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The newest generation of x-ray systems offers boosted kVp and mAs needed to penetrate thicker layers of tissue. It helps if your x-ray tube has a high heat capacity, because it may run at high levels for long periods of time.

Aurora Sinai recently acquired one of the new generation of digital pulse fluoro systems. Kralik has found that "the mAs and kVp parameters haven't changed due to the 80-kW generator and the pulse fluoro feature."

"The parameters employed in routine general radiography, however, have increased about 25% to 30% due to our utilization of CR for image processing," she said. "For example, a PA chest view on a patient with an average habitus is imaged at 109 kVp and 16 mAs, compared to an obese patient who is imaged at 109 kVp and 20-plus mAs."

Dr. Daniel Croteau, an interventional radiologist at Henry Ford Hospital in Detroit, is juggling an influx of new patients since the hospital's designation last year as a Bariatric Center of Excellence by the American Society for Bariatric Surgery and Blue Care Network. The hospital has performed more than 1,000 bariatric surgeries since opening in 2002,

including open and laparoscopic Roux-en-Y gastric bypass and laparoscopic adjustable gastric banding.

Croteau specializes in placing preoperative vena cava filters, with image guidance provided by flat-panel digital subtraction angiography (DSA) systems. With DSA, he said, "We optimize visualization of the vessel, even in large patients, by subtracting the background. The flat-panel detectors do a really nice job, with all the automatic exposure settings, of obtaining a good quality image regardless of what type of body habitus we are penetrating."

"With things that are more complex than a simple filter insertion, the imaging becomes more difficult to do because of the amount of radiation that's needed to penetrate these patients," Croteau continued. "We have ongoing dose amounts that are set into the machine. On one machine, for example, we have a percent of 2 Gy, and then a dose-area product calculation that's ongoing, so that we know how much dose the patient's receiving over the time of a procedure. Another machine is similar, except it's calculated in mGy. When we start getting high percentages, if we can do oblique imaging, we'll actually move the tube around so that the radiation dose isn't coming in at the same area from the same projection, and that decreases the chance of skin burns. That's a help with radiation protection of the patients and the operators."

Croteau added, "There's no angio suite we're looking at purchasing ever again with a weight limit lower than 440 lb. Occasionally, we'll have to do a filter placement in the operating room because of table limit. We actually brought an OR table down into our angio suite and configured it there for a patient who weighed 500 lb."

Bill Broaddus, director of radiology services at Central Baptist Hospital in Lexington, KY, said, "Historically, UGIs and barium enema studies have been our biggest challenge, because of the need to move the patient on and with the table to acquire all the images involved."

Broaddus said a lot of retakes were required with his bariatric patients until the hospital acquired two new heavy-duty R/F systems with flat-panel detectors. "The weight capacity is 500 lb with table movement, and 600 lb static. The tabletops are larger than the ones on our older units, and the distance between the tabletop and the fluoroscopy tower is wider. If you're buying new fluoroscopy equipment today and not looking at DR flat-plate technology, you need to take a second look."

By Sydney Schuster
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