Leader of the Pack

Siemens Healthcare formed a partnership with Children's Hospital Boston five years ago to verify that the dose saving features of its interventional radiology system worked just as well in children as in adults. The challenge today is convincing everyone to make the most of it.

By Joanna Downer


SIEMENS

Five years ago, medical physicist Keith Strauss at Children's Hospital Boston (CHB) drove a hard bargain. In negotiating with Siemens Healthcare, he said that CHB would buy and install a number of Siemens Artis zee interventional radiology systems only if the company worked with the hospital to modify the equipment's programming to meet the institution's needs – serving children of all ages.

"All the issues present in interventional imaging of adult patients are perhaps even more difficult or significant in pediatric patients, who can range in size from neonates to adolescents," says Strauss, Director of Radiology Physics and Engineering in the Department of Radiology at CHB. "But companies create standard operational programs based on adult imaging needs, and I knew those programs weren't right for our patients and their clinical needs."

Siemens listened. The company not only committed to a partnership to modify the system to better suit pediatric needs, but also connected Strauss with a Siemens designer – an engineer who knew the Artis zee interventional radiology system inside and out. "I traveled to Siemens' training center, and basically locked myself in a room with the design engineer for a week," says Strauss. "I tried to teach him everything I knew about pediatric imaging, and he tried to teach me everything he knew about the unique design features of Siemens equipment. In the end, we were able to replace the standard anatomical programs that work very well for adults and develop anatomical programs that work for interventional radiology in children."

Interventional radiology uses imaging to provide guidance during minimally invasive procedures, particularly in cardiovascular medicine, cerebrovascular medicine, transplant and oncology, as well as for line placement and other

procedures involved in the diagnosis and treatment of a wide variety of conditions.

When speaking about radiation exposure children may have much greater risks compared to adults, because they have more time for long-term effects to appear and to affect their quality of life. But radiation dose is a concern for patients of all ages. In March 2009, the National Council on Radiation Protection and Measurements reported that radiation exposure per capita more than doubled in the United States in the previous two decades, largely due to increasing use of CT, nuclear medicine imaging, and interventional radiology. Each year, these make up only about 26 percent of the imaging procedures using radiation in the United States, according to the report, but they contribute 89 percent of total exposure from medical imaging. The group is working on a similar report regarding occupational exposure now.

"In some respects, last year's report was a wake-up call for a lot of people," says Strauss, a leader in dose reduction efforts for many years. "I don't think people understood that the use of ionizing radiation had increased as much as it had for both diagnosing and treating illness."

It certainly seemed to awaken the U.S. Food and Drug Administration (FDA), which in February 2010 announced its "Initiative to Reduce Unnecessary Radiation Exposure from Medical Imaging". In late March, it held a two-day public conference on the topic that was attended by all stakeholders – patients, industry, regulators, healthcare providers – including Siemens Healthcare and Keith Strauss – and other groups. One of the goals of the initiative is to reapply the ALARA concept to imaging and interventional radiology in the United States. ALARA says that doses from exposures to ionizing radiation should always be "As Low As Reasonably Achievable". Strauss knows there's an important balance. "The challenge in imaging is reducing the dose to the patient while retaining the image quality necessary to provide appropriate care for all patients – whether they are 300- or 400-pound adults or 3-or 4-pound neonates," says Strauss.

A Focus on Dose Reduction

Siemens has long recognized the need to minimize dose to patients, and its Artis family has long had many dose-saving features. For example, inherent design characteristics of the Artis zee enable ergonomic, streamlined, efficient operation, all of which supports dose reduction. Furthermore, the product line has flexibility that allows users to optimize system parameters such as exposure time, photon energy and others to match clinical needs while reducing dose.

New dose-monitoring features are also on the horizon for the Artis zee. One new feature, CAREguard, provides feedback to the physicians once a certain radiation threshold is reached. Because the threshold is configured by the operator, it can be tailored to departments' needs to help guide decision-making later during the exam. Another new feature, CAREreport, provides the opportunity to collect all relevant parameters related to dose in a standard format – DICOM – that external systems can monitor to report radiation dose. This report may allow healthcare providers to obtain accurate information about a patient's exposure history, which can also help guide clinical decision-making. The Siemens dose-reduction portfolio is based the on the Combined Applications to Reduce Dose (or "CARE package") for the AXIOM Artis and Artis zee family. In short, CARE makes it easy for operators to reduce dose to patients, which also reduces their own dose. Strauss says that it is important for optimized programs and dose-saving features to be easy to use. "Operators need be able to focus on conducting an efficient, high-quality exam that enables them to reach the necessary clinical endpoint while properly managing all aspects of patient care," says Strauss. "Their primary focus shouldn't be dose reduction."

Making a Great System Even Better

At the annual meeting of the Radiological Society of North America (RSNA) in late November, Siemens will be emphasizing the ways in which its interventional radiology systems can meet unique clinical needs while reducing dose. The meeting's theme, "Personalized Medicine: The Pursuit of Excellence," perfectly fits the goal of Siemens' multi-pronged approach, which uses flexible system design, optimized operational programming, the CARE package, and training to reduce dose and maintain image quality in interventional radiology. For example, the Artis zee family can serve patients of various sizes and its predecessor, the AXIOM Artis family, already had considerable dose-saving features in 2005. But Strauss recognized that in order to make the most of these capabilities in pediatrics, the system's operational programs needed to be optimized – almost personalized – for much smaller patients than assumed in the standard programs. Strauss and Siemens focused on the acquisition step, which involves generation of a beam of X-rays that passes through the patient to reach a detector. To reduce radiation dose to the patient, all imaging companies insert filters of copper or another appropriate material into the X-ray beam. "These spectral filters remove the low-energy photons that

contribute very little to image quality, and they are very effective at reducing dose to the patient," says Strauss. However, spectral filters also reduce the number of photons that reach the detector, potentially requiring increased exposure time to compensate for the lost photons. Unfortunately, the benefit of capturing more photons is more than offset by loss of sharpness caused by movement during the longer exposure. "Even in the most cooperative patients, you've got involuntary motion in the organs of the patient's body," says Strauss. "We need very short exposure times to freeze motion, just as if we were photographing a galloping horse." Indeed, Strauss says that exposure times for adults should be no more than 8 msec to 10 msec, and for children just 5 msec to 6 msec – considerably shorter than most systems' factory settings. So in fact, optimizing the Artis zee for pediatrics required the team to actually reduce exposure time. "We realized that we needed to balance the need for photons by removing some of the spectral filters," recalls Strauss. "Doing so allowed us to retain some of the dose savings they provide, but also allowed us to reduce the exposure time and improve image quality for pediatric patients."

After Siemens rewrote the software to provide shorter exposure times, or pulse widths, and to remove thicker filters sooner during the examination, it was installed at CHB for Strauss to test. "With my phantoms that simulate children, I was able to demonstrate that the modified system was performing correctly for children, and the Siemens engineer who installed the program recognized the changes compared to the equipment's operation," recalls Strauss, who received a letter from Siemens a few weeks later saying that the pulse-width modification would also be made available to other customers.

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> Keith Strauss, Director of Radiology Physics and Engineering, Department of Radiology, Children's Hospital Boston, MA, USA

Thus optional dose-saving, image-enhancing software packages such as those developed with Strauss are yet another dose-reduction feature of the Artis zee family. In fact, Strauss reports that his efforts with Siemens enabled CHB to make great strides to reduce dose and maintain image quality during interventional fluoroscopic examinations. "One has the capability to significantly reduce dose if the design characteristics of the machine are optimized for one's clinical needs, available in an easy-to-use way by appropriately trained operators," he says.

Spreading the Word

However, Strauss says he suspects that not too many institutions have done everything possible to reduce dose – even those using the pediatric package – because very few have further optimized the programming for their needs. And even then, the optimized settings need to be easy to apply appropriately and to use. For example, Strauss and Siemens set up their pediatric anatomical programs to be stratified by patient weight, since that is easy to measure and correlates to patient size. Weight also might be an appropriate identifier of optimized imaging protocols for overweight or obese patients.

Strauss says Siemens' partnership with CHB created modifications that fully met the hospital's clinical requirements. "Quality requires effort – quality doesn't just happen," he says. "It takes organization, it takes effort, and it takes resources. This partnership gave the physicians and technologists at CHB an easy way to be satisfied that they've selected the right parameters for their patient's needs. The remaining challenge is to get these principles in practice throughout the healthcare sector." Meeting the challenge will require participation by industry and healthcare providers, patients and the public. It will require increasing awareness and providing additional training. So far, Strauss says that industry is responding to the call. With its longstanding commitment to dose reduction, Siemens has clearly led the pack.

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