Health Technology TRENDS

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The numerous reasons why children may need an x-ray or computed tomography (CT) exam run the gamut from falling off monkey bars and skateboards to acute conditions like abdominal pain and chronic conditions such as cancer or a congenital disease. But a recent study that University of Michigan (Ann Arbor, MI, USA) researchers conducted suggests that the healthcare system may be overdoing pediatric imaging exams. The average child in the study will undergo 7 CT and/or x-ray exams by age 18. Is this too many? And, is the imaging community doing enough to protect children from the cumulative effects of radiation received during these exams?

Pediatric x-rays, CT rates

Adam L. Dorfman, M.D., and colleagues from the University of Michigan examined records for 355,088 children and adolescents up to age 18 for 3 years (from 2005 to 2007) and found that, on average, a child in the study had 7 exams involving some form of ionizing radiation, mostly plain radiography (x-rays), followed by CT scans (*Arch Pediatr Adolesc Med.* 2011 Jan 3[ePub ahead of print]). Dorfman used payer data from UnitedHealthcare from five U.S. states. A total of 436,711 imaging procedures were performed in 150,930 patients (42.5%). X-rays accounted for the most imaging exams (84.7%), and CT scans accounted for 11.9% of the exams. Overall, 7.9% of children received at least one CT scan and 3.5% received two or more, with CT scans of the head being the most common indication. Researchers did not provide reasons for the exams.

"Imaging tests are a critical component of good medical care, but the high number of tests raises questions about whether we are being judicious in our use of the technology," says Dorfman.

Shocking stats or unremarkable facts?

But are these rates really staggering? "I guess I'm not really surprised by the numbers," remarks David Gregg, M.D., pediatric radiologist at Children's Hospital of Wisconsin (Milwaukee, WI, USA). "I've been doing this for 25 years, and I don't see a real change in the overall trend of imaging in children, other than a decreasing number of CT exams, and increasing ultrasound and MRI [magnetic resonance imaging] exams." He adds, "the number is probably correct and," as Gregg stresses, "it's an average." Gregg considers that the number comprises "some children who go through an intensive care unit who have multiple images versus a child who comes in and has one or two x-rays of the chest for an upper respiratory infection or of an arm because of a fall." Given the data, "I think they're reasonable numbers."

Robert C. McKinstry, M.D., Ph.D., radiologist-in-chief at St. Louis Children's Hospital (St. Louis, MO, USA) and chief of pediatric radiology and director of the Center for Clinical Imaging Research at the Mallinckrodt Institute of Radiology, also wasn't shocked by the rates. "My feeling is that, yes, children get studies involving ionizing radiation. The question is, are they getting them appropriately? And when they do get them, are they getting a child-sized dose of radiation, or are they getting an adult-sized dose?" He adds, "many children who are ill require many x-rays." McKinstry

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Editorial: Pediatric imaging issue

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Articles in this issue of *Health Technology Trends* share a common theme: national trends in pediatric imaging. Concerns about pediatric imaging radiation doses are not new, but they remain prominent on the radars of clinicians and parents. We take a look at the issue in light of research from Adam L. Dorfman, M.D., and colleagues at the University of Michigan (Ann Arbor, MI, USA) who generated some controversy with their findings from analyses of prospective payer data from five states. Dorfman expressed concern over the increase in pediatric exams involving ionizing radiation—namely from computed tomography (CT). To determine whether the controversy gained steam in the pediatric imaging community, in "Are we imaging gently yet?" we interviewed radiologists at top pediatric institutions for perspective on these findings. We also asked what they're doing to reduce radiation exposure.

Not surprisingly, these centers seem to be doing things right, and an ECRI Institute imaging expert points out why and where the real concern should lay. "Pediatric hospitals are well equipped for those patients," says Jason Launders, M.Sc., senior project manager and medical physicist, ECRI Institute. The bigger concern, he says, is at the average community hospital where general emergency department (ED) equipment is not optimized for children, and study protocols are less likely to be optimized for children. As Launders notes, "One really difficult issue is head injury, a major cause of death and long-term injury for children, for which CT is the primary diagnostic tool." CT exams of the head ranked highest in the University of Michigan study. Launders also points readers to a recent article by Lois K. Lee, M.D., M.P.H., Children's Hospital Boston (Boston, MA, USA), and colleagues published in the *Journal of Pediatrics* (2011 Jan 14[Epub ahead of print]). Lee suggests that routine CT imaging in the ED may not always be necessary after head trauma. Numerous resources are available on the latest imaging protocols. This issue includes a table on page 10 listing some of these resources.

"Pediatric imaging: Are the awareness campaigns working?" discusses efforts of professional societies such as the American College of Radiology and the Society for Pediatric Radiology to provide information tailored to specific audiences, such as parents. David Gregg, M.D., pediatric radiologist at Children's Hospital of Wisconsin talked to *Health Technology Trends* about how he balances parental concerns with a child's clinical need for an imaging exam.

Perhaps the push for electronic health records that use some kind of clinical decision support tools could put best practices in the hands of ordering physicians at the point of care. "Can clinical decision support reduce unnecessary imaging?" details how one integrated delivery system was able to reduce unnecessary tests with its in-house system, something that has interested payers as rates of CT and other costly procedures continue to rise.

We welcome your feedback and comments, which can be sent to lgross@ecri.org.

Linda Gross, Editor
Health Technology Trends

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also stresses that the study reported averages.

"Taking into account the limitations in how the study was done and how the data were collected, it didn't surprise me," adds David A. Bloom, M.D., pediatric radiologist at Beaumont Children's Hospital (Royal Oak, MI, USA). Bloom predicts that most radiologists wouldn't be surprised at the numbers. He stresses that the majority were x-rays, while the real concern, if warranted, lies with CT.

What's important to consider, McKinstry explains, is "a standard radiography of the chest gives 20 times less radiation than a standard head CT." He also notes that a head CT is not the exam with the most radiation.

Positive trend

In fact, Gregg says he has seen studies indicating that pediatric CT imaging rates are dropping. "I think that some of it's driven by how we image children now and concern in the pediatric radiology community about keeping radiation exposure as low as you possibly can." In addition, "we're starting to use different imaging modalities that don't involve ionizing radiation," adds Gregg. "It's not that we weren't concerned previously, but I think there's a higher level of concern and awareness among the radiology community."

"Imaging tests are a critical component of good medical care, but the high number of tests raises questions about whether we are being judicious in our use of the technology."

Bloom agrees. "We've always had to deal with good, very good, and maybe not-so-good reasons why tests are ordered. I think we're starting to change those categories a little bit."

Still, no one disputes the issue's importance. "Children are affected by radiation to a greater degree than adults," notes Gregg. "They have a longer time frame to develop a malignancy related to cumulative radiation exposure compared to adults, as well as an increased sensitivity to dividing mitotic cells" in the infant compared to an adult.

Until recently, adult and pediatric protocols were the same. The age and size of the patient were not taken into account, Gregg recalls. "The same technique was used on a 3-year-old as [on] a 14-year-old. We now use age- and weight-based techniques."

Gregg and others who spoke with *Health Technology Trends* credit the American College of Radiology and the Society of Pediatric Radiology for developing readily available literature from the Image Gently campaign, which officially launched January 2008.

As a result, Bloom notes, "you're seeing a lot of dedicated pediatric hospitals and tertiary care centers using more MRI versus CT for advanced, cross-sectional imaging."

Active efforts to reduce

"We have dramatically reduced the number of CT scans that we do at our facility by working with our radiologists and shifting our exams to ultrasound or MRI anytime possible," says Nicole Hardin, M.S., R.T., radiology manager at the Children's Hospital of Omaha (Omaha, NE, USA). Hardin's facility has implemented specific protocols to do so and was the 2008 recipient of ECRI Institute's Health Devices Achievement Award (*Health Devices* 2008 Dec;37[12]:372-5).

"The referring physician puts the order in, and we put a process in place where all of our technologists and radiologists review the orders," Hardin explains. "Once we review the orders, we either change the order or call the referring physician and ask if it's OK to change the order, or we send them notification electronically that this is best practice and this is our protocol and we would like approval to change the order." Overall, she explains, "we divert any type of exam that we can from CT to MRI or ultrasound," depending on the need. For example, "any time we get a CT request for abdominal pain, if at all possible, we do an ultrasound first, and if we don't have to, we don't do the CT."

Hardin says it's been particularly helpful in avoiding CT for appendicitis. "The protocol used to be for many hospitals that you jump right to the CT scanner," she explains. "Another example is enterography studies," says Hardin. "A lot of facilities do CT enterography to look at the colon."

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Hardin says they've recently developed protocols to do MRI enterography "specifically because of the radiation dose" associated with CT.

The same active reduction in pediatric CT scans has taken place at McKinstry's institution. "At St. Louis Children's Hospital, we did 10,202 CT scans the year before I started as chief," he recalls. "We attacked the problem head on, and last year we did 6,163 CT scans." The drastic reduction is a result of "a combination of educating the community, educating our hospital-based physicians, and making alternatives available such as MRI and ultrasound."

Appropriate considerations for selecting alternate exams are important, however. Ultrasound can be helpful in a nonsedatable patient, according to Gregg. "An ultrasound can be done while the patient is not completely still. If the child is moving, you can move the transducers and you can acquire the image."

On the other hand, MRI involves some planning. "If you think you can answer the question [with an MRI], then you have to talk about the issue of needing sedation," explains Bloom, because of the exam duration and need for stillness to avoid reimaging. Thus, Bloom explains, "sometimes CT is done over MRI because the risk of anesthesia and sedation is far greater than with radiation, so the doctors, in concert with the radiologists, determine that CT is the way to go."

"We have dramatically reduced the number of CT scans that we do at our facility by working with our radiologists and shifting our exams to ultrasound or MRI anytime possible."

Defensive medicine

Other motivators for ordering a CT exam include defensive medicine. A CT might be ordered not because it's clinically indicated, but because the parents demanded it, notes Bloom. "They read somewhere that you need it, even though the doctor didn't feel that it was medically necessary," says Bloom. "Those pressures can become a little bit overwhelming, and you give in to them and do the exam for medicolegal reasons." In such instances, Bloom says the physician is thinking: "'I don't need a lawyer in court asking me: Why didn't you order a CT scan?'"

"I think there's a medicolegal component to this as well," Gregg concurs.

Nonetheless, "CT still has certain advantages in terms of speed and resolution," according to Bloom. "It also is very good for trauma."

"If you want to know if there is blood inside the head after a fall, CT is the way to go," notes McKinstry. However, he says that by the mid-1990s "it had pretty much been established in newborns and in many neurological conditions in children and adults that CT had limited potential." Thus, "if you want to know if there has been injury to the brain in a newborn, CT is not the way to go," he adds. In this context, McKinstry stresses that dose isn't the primary motivator. "We've really been looking to move beyond what CT can offer."

Radiologists know best

Bloom asserts that one issue of note is who orders CT and x-ray exams. "Who are the medical providers who are ordering these imaging tests, including simple x-rays?" Bloom questions. "That would be the primary care providers and the specialists: the pediatricians, the orthopedist, or the neurologist," for example. "They may be very good at looking at the image and finding the diagnosis from the image, [but] they're not specifically trained in imaging to know what the risks and benefits are for the various tests," including radiation safety and dose issues for a particular exam, Bloom notes.

Bloom says there's not a lot of formal training in radiology, especially in the early years of medical education. The lag time from the lesson to practice can also be substantial. "All of a sudden, you're the one filling out the boxes on the requisition form for a CT, fluoroscopy study, or interventional radiology procedure, and you're really not trained in that." Bloom says at his facility, they often see requisitions for tests that aren't warranted and he wonders if involving a radiologist early might be a better idea, although he concedes "that's very time consuming and slows the process down."

As a teaching institution, Bloom says they do what they can to educate the next

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Pediatric imaging: Are the awareness campaigns working?

Summary

Health Technology Trends *looks at the information available to parents, pediatricians, pediatric radiologists, and others on pediatric imaging and x-ray best practices. Is the information getting into the right hands?*

"I think it's a great idea to have the awareness out there—not just for the physicians or the radiologists performing the exam, but for the parents, or an adult who is keeping track of exposure."

Children's Hospital of Omaha (Omaha, NE, USA) has been "imaging gently" since 2008, according to Nicole Hardin, M.S., R.T, radiology manager. Beyond guidelines from the American College of Radiology (ACR) and literature related to the "as low as reasonably achievable" mantra for all imaging professionals, Hardin says her facility reaches out to radiologists in other pediatric hospitals that are members of the Child Health Corporation of America. But what about providers outside the pediatric network? Are they getting the image gently message?

Image gently

The Image Gently campaign arose from the Society for Pediatric Radiology (SPR), ACR, and other groups collectively known as the Alliance for Radiation Safety in Pediatric Imaging (www.imagegently.org). It began as a committee of SPR in 2006 and officially kicked off as a campaign in January 2008 to raise awareness of the risks associated with the cumulative effects of radiation from imaging in the pediatric population. The literature focuses on computed tomography (CT), interventional radiology, and nuclear medicine exams. Brochures downloadable on the website mostly target parents, encouraging them to question whether exams are necessary and whether a lower-dose exam would be optimal.

According to David A. Bloom, M.D., pediatric radiologist at Beaumont Children's Hospital (Royal Oak, MI, USA), the Image Gently campaign was tailored to parents rather than practitioners. The reason, he explains, is because today's patients are better consumers, due in large part to the Internet. "They want to know about costs, risks, benefits; can I get [an exam] done here versus there? Can the question be answered with a different exam?" As Bloom explains, "if [the patient's] primary doctor is not well versed on some of the latest technologies for imaging, then it's the patient and the parent who has to ask, 'Do we really need this test? Does it have radiation? Is there another test that can be done without radiation? Can you call the radiologist and ask?'"

Bloom says the Image Gently campaign has also been effective in arming the ordering physician with information if a parent insists on a CT scan. "Now if a parent says, 'I demand a CT scan for this,' the physician can say, 'Here's why you don't need it, and do you realize there's a risk related to CT scans?'" Bloom says it may be working to convince such parents that other nonimaging procedures are available to follow a patient, and he believes that the number of CT scans may have gone down as a result.

The perception still exists that CT is optimal, however, and the risks are unclear, notes Bloom. Consider the study in the *Annals of Emergency Medicine* (2010 Dec 10 [Epub ahead of print]). Brigitte M. Baumann, M.D., MSCE, and colleagues surveyed 1,168 participants, 67% of whom were women, with a mean age of 40.7 years, to assess confidence in medical evaluations and knowledge of cancer risk related to CT. Patients were admitted to the emergency department after complaining of abdominal pain. Baumann found that more than 70% of participants underestimated the radiation dose of CT relative to chest radiography, and cancer risk comprehension was poor. In addition, 90% reported more confidence in a medical evaluation that included patient history, physical exam, blood work, and a CT exam, compared to an evaluation without a CT exam.

According to Rohit Inamdar, senior associate and medical physicist, ECRI Institute, physicians often misunderstand radiation risk. Thus, he asks, "Is it surprising that patients misunderstand it?"

Image wisely

Clinicians' perceptions of CT superiority are also at issue, something the adult-sized Image Wisely campaign seeks to

Pediatric scan literature

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Pediatric scan literature
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address (www.imagewisely.org). Image Wisely is an awareness program of ACR, the Radiological Society of North America, the American Association of Physicists in Medicine, and the American Society of Radiologic Technologists. The stated objective is to encourage practitioners to avoid unnecessary ionizing radiation scans and to use the lowest optimal radiation dose for necessary studies.

Patient information on the site includes a dose card that patients can print out to track their exams and dose amounts. The concept was a combined effort of Image Wisely contributors and the U.S. Food and Drug Administration after the agency's investigation of documented overdose cases beginning in 2008 that received extensive media coverage.

Bloom says educational efforts on both fronts are important. Yet he has not seen patients use the information well. "That requires extra paperwork and remembering to carry it around," he says. "It may be that you use it one time but forget it the next time because you're in the emergency room."

Yet Bloom is not critical of the effort. "I think it's a good tool for those patients and parents who are going to be extremely diligent. Such patients can "feel like they're participating in their healthcare." And while its use may not be popular, "I do see it as a nice reminder that we should always be talking about radiation safety. I think it's good in that respect," says Bloom.

"Risk of radiation is judged against risk of the condition."

The Image Wisely site also provides an "equipment resource" page with links to vendors to encourage practitioners to "visit the sites of the equipment vendors . . . for CT dose guidelines tailored to the equipment you use."

There outta be a law

The state of California has taken the lead in legislating awareness of radiation dose, requiring the reporting of dose from CT exams in systems that display dose. Dose is to be recorded on the radiology report. It also contains provisions for reporting errors related to overdose in cases of repeat exams, exams performed on wrong areas of the body, and CT or therapeutic dose exposure to a fetus greater than 50 mSv. The law goes into effect July 1, 2012.

"I think it's a great idea to have the awareness out there—not just for the physicians or the radiologists performing the exam, but for the parents, or an adult who is keeping track of exposure," says David Gregg, M.D., pediatric radiologist at Children's Hospital of Wisconsin (Milwaukee, WI, USA). He says that when the idea first came out, vendors weren't on board because it involved changing software to display dose information at the end of the exam. "But they are coming on board," he observes.

Children's Hospital of Omaha's Hardin is aware of the law; however, she questions whether parents or adult patients would keep track of their exams to the point where they could say, "'I've reached my lifetime limit, so I'm not going to have any more scans done.'"

Of course, as ECRI Institute's Inamdar notes, there is really no "lifetime limit," and it is (or should be, at least) the patient's medical condition that drives the radiologic imaging need. "Risk of radiation is judged against risk of the condition," he notes.

It's also not clear what the information really means. "Estimating a dose from an ionizing radiation exam is a challenge," notes Robert C. McKinstry, M.D., Ph.D., radiologist-in-chief at St. Louis Children's Hospital (St. Louis, MO, USA) and chief of pediatric radiology and director of the Center for Clinical Imaging Research at the Mallinckrodt Institute of Radiology. Dose measurement is controversial. There are no standards across vendor equipment models, and the administered dose is not necessarily the absorbed dose when factoring in size, anatomy, age, and other variables.

Still, California has been known to set legislative precedents in the past. In addition, "California is a giant market, and anything California imposes will probably diffuse throughout the system," McKinstry predicts. "Vendors are probably not going to implement one solution for California and a different solution for the rest of the world."

Editor's note: *A table on page 10 provides links to some of the recent literature published by professional societies and experts on best practices in pediatric and adult imaging.*

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generation of practitioners. "We try to address this issue at a local level for our medical students when they rotate with us . . . We try to teach them when it's appropriate and inappropriate to order an exam, so that they're ordering the best test possible for their patient based on the specific clinical question."

In addition to a lack of awareness of appropriate exams and associated risks, McKinstry notes that pediatricians, for example, are swamped. "Practicing pediatricians are seeing patients every 7 to 12 minutes all day long," he explains. "They need very simple decision support that helps them to make those decisions right on line when the patient is in the office," he adds (see article on clinical decision support). "[It's not enough] for us to sit in our [academic] ivory towers and tell the practicing pediatricians they have to follow the guidelines. We have to help them."

In orthopedics, low-dose scanning technology emerges

Summary

Health Technology Trends *spoke with a pediatric academic medical center that invested in an orthopedic scanning solution to further reduce radiation exposure for routine x-ray exams. The machine produces three-dimensional images without the high level of ionizing radiation associated with three-dimensional computed tomography.*

Professional societies continue to educate primary care practitioners, pediatricians, parents, and others on the risks related to the cumulative effects of radiation in the pediatric and adolescent population undergoing computed tomography (CT), interventional radiology, and nuclear medicine exams. This is of special concern to orthopedic surgeons who treat young patients with spinal deformities and other musculoskeletal disorders who require regular exams to monitor their conditions. *Health Technology Trends* spoke with a pediatric orthopedic surgeon who uses the EOS ultralow-dose two-dimensional/three-dimensional imager (EOS Imaging, Paris, France) as an alternative to traditional radiography studies.

Alternative for scoliosis management

Scoliosis, often diagnosed following a growth spurt in female adolescents, requires frequent imaging exams. Regular exams allow specialists to monitor the condition, recommend braces, and determine whether the condition has progressed to a point where corrective surgery is warranted.

Routine x-ray exams are the current gold standard for monitoring scoliosis, and they are often taken of the front and side of the patient. CT exams may provide a better image but at the cost of a much higher dose of radiation, an issue of high importance at a pediatric teaching facility such as Children's Hospital of Wisconsin (Milwaukee, WI, USA).

"With the scoliosis population, we will sometimes have to get x-rays twice a year on these girls for several years throughout their growing years," according to J. Channing Tassone, M.D., orthopedic surgeon at Children's Hospital of Wisconsin and assistant professor of orthopedic surgery at Medical College of Wisconsin. "Scoliosis as a disease entity is a three-dimensional problem, and historically the problem with x-rays is you get two dimensions," he explains.

"Being a pediatric-specific hospital, [our institute] does remarkably well in having the lowest possible radiation exposure for kids getting the x-rays." Still, Tassone and his colleague, John Thometz, M.D., medical director of orthopedic surgery at Children's Hospital of Wisconsin and professor at Medical College of Wisconsin, learned of an option to further reduce radiation: the EOS ultralow-dose two-dimensional/three-dimensional orthopedic digital imaging system, which was being used in France and Canada. (EOS Imaging was then called Biospace Med. The company changed its name in November 2010). EOS takes simultaneous frontal and lateral images.

The company credits its patented technology in part to physicist Georges Charpak's 1992 Nobel Prize winning particle detector technology. EOS received U.S. Food and Drug Administration 510(k) clearance in October 2008.

"The Nobel Prize-winning part of it is on the receiving end," explains Tassone. "The beam goes through the patient, and then the radiation is collected on the other side." On the receiving end, Tassone explains that an amplifier "amplifies the radiation and allows the image to be obtained with much less radiation going through the patient."

According to Tassone, "we had our physicists do the numbers, and it's roughly 14 times less radiation per image than we had with our lowest possible [x-ray] dose."

Rather than taking two separate front and side x-rays, "the EOS device allows us to get those images simultaneously, and it allows some three-dimensional modeling of the spine to occur, which will hopefully help us more in the understanding of the disease process itself," says Tassone.

Tassone and Thometz partnered with Variety-The Children's Charity of Wisconsin and raised more than $500,000 needed to acquire the system in the fourth quarter of 2010.

Alternative to traditional x-rays

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Can clinical decision support reduce unnecessary imaging?

Summary

Clinical decision support systems may be key to reducing overuse of computed tomography and other imaging exams. This is of interest to those who want to cut costs and reduce the amount of ionizing radiation to which patients are exposed.

"These are very early days for this type of technology."

If referring physicians were required to fill out computerized forms when ordering imaging studies—and they were notified that the order did not match decision rules developed at the institution—would unnecessary exams be eliminated? That's the $64,000 question for which a new study provides some promising, albeit preliminary, evidence.

Results from a retrospective study published in the *Journal of the American College of Radiology* (2011 Jan;8[1]:19-25) suggest that unnecessary exams can be reduced with evidence-based clinical decision support (CDS) technology, as demonstrated at one integrated network, according to researchers at Virginia Mason Medical Center (Seattle, WA, USA).

In 2005, the institution integrated a CDS system with a computerized physician order entry system. Researchers chose three indications associated with frequent use of magnetic resonance imaging (MRI) and computed tomography (CT) studies, according to observations from radiologists. They chose to focus on brain MRIs for migraine, lumbar MRIs for lower back pain, and sinus CTs for sinusitis. Head CT was used as a control group.

Imaging utilization before and after the interventions was determined using billing data from a regional health plan and data from the institutional radiology information system.

According to C. Craig Blackmore, M.D., and colleagues, evidence-based guidelines informed the CDS feedback the referring physicians received after an order was placed. If the order did not match decision rules developed at the institution, it was denied.

Blackmore and colleagues examined overall imaging use before and after practitioners used CDS. They found that CDS was associated with substantial decreases in the utilization rate of lumbar MRI for low back pain (risk ratio [RR], 0.77; 95% confidence interval [CI], 0.87-0.67; p = 0.0001); head MRI for headache (RR, 0.76; 95% CI, 0.91-0.64; p = 0.001); and sinus CT for sinusitis (RR, 0.73; 95% CI, 0.82-0.65; p

Thus, after implementing CDS, imaging rates for

- sinus CT decreased by 26.8%,
- low back pain lumbar MRI decreased by 23.4%, and
- head MRI decreased by 23.2%.

Blackmore said CDS tools provide real-time feedback to healthcare providers ordering imaging tests, including information on whether a test is appropriate for certain medical conditions. Therefore, he asserts that CDS systems could be an ideal way to improve evidence-based use of imaging; and, in the case of CT, it can reduce exposure to ionizing radiation. The findings are also of great interest to payers that wish to lower healthcare costs.

The evidence-based guidelines related to imaging for the CDS system at Virginia Mason were developed internally, as was the computerized physician order entry system.

ECRI Institute perspective

ECRI Institute's Rohit Inamdar, senior associate and medical physicist, suggests that the American College of Radiology's Appropriateness Criteria lays the groundwork for many of the evidence-based imaging protocols. Still, Jason Launders, M.Sc., senior project officer and medical physicist, ECRI Institute, stresses, "these are very early days for this type of technology." He adds, "moving from three very specific studies to the whole range of studies normally performed is not an insignificant step." Furthermore, "other complications are the type of patient and setting" such as inpatient, outpatient, and emergency department, and a different ordering system is used based on the setting.

Clinical decision support for imaging
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Resources for pediatric and adult imaging safety

Sponsor/Author	Publication	Who the information targets	Purpose
American Academy of Pediatrics	Imaging and Medical Radiation Safety: Important Information for Parents http://www.aap.org/sections/radiology/RadiologyParentPage.pdf	Parents of patients	General information on x-ray, computed tomography (CT), and nuclear medicine exams
American College of Radiology (ACR)	RadiologyInfo.org http://www.radiologyinfo.org/	Patients	Provides overview of radiologic exams and contextual information on dose
ACR	ACR Appropriateness Criteria http://www.acr.org/secondarymainmenucategories/quality_safety/app_criteria.aspx	Referring physicians and other providers	Evidence-based guidelines for providers to order appropriate imaging or treatment for a specific clinical condition
ACR, Radiological Society of North America (RSNA)	Image Wisely www.imagewisely.org	Imaging professionals/Patients	Covers radiation safety in adult medical imaging
ACR, RSNA	Links to vendor information: http://www.imagewisely.org/Equipment-Resources.aspx	Imaging professionals	Links to GE Healthcare, Hitachi, Philips, Siemens, and Toshiba. Information varies and requires further surfing once on the vendor sites.
ACR	Information on California's radiation dose documentation requirement: http://www.acr.org/HomePageCategories/News/ACRNewsCenter/California-State-Senate-Bill-1237.aspx (A link to the bill itself is at http://www.leginfo.ca.gov/pub/09-10/bill/sen/sb_1201-1250/sb_1237_bill_20100929_chaptered.html)	Healthcare providers, including hospitals, radiology department managers, and imaging professionals	Information on California law on recording dose
Medina and Applegate	*Evidence-based Imaging in Pediatrics* (2009 Springer)	Pediatricians and other clinicians	A 655-page reference guide on evidence-based pediatric imaging
RSNA	ALARA in Pediatric Interventional and Fluoroscopic Imaging White Paper 2006 http://radiology.rsna.org/content/240/3/621.full	Radiologists/ Interventional radiologists	Covers the As Low As Reasonably Achievable principle in pediatric interventional and fluoroscopic imaging
Society for Pediatric Radiology (SPR), American Association of Physicists in Medicine, ACR, American Society of Radiologic Technologists	The Alliance for Radiation Safety in Pediatric Imaging's Image Gently campaign http://www.pedrad.org/associations/5364/ig/.	Parents of patients	Encourages parents to be informed about exams and to question necessity of high-dose exams
SPR et al. The Alliance for Radiation Safety in Pediatric Imaging	Step Lightly http://www.pedrad.org/associations/5364/ig/index.cfm?page=584	Parents of patients	Similar information to Image Gently with general information on interventional radiology exams
Society of Nuclear Medicine, SPR, ACR	North American Consensus Guidelines for Administered Radiopharmaceutical Activities in Children and Adolescents http://www.pedrad.org/associations/5364/files/Pediatric_dose_consensus_guidelines_Final_2010.pdf	Nuclear medicine professionals	Consensus guidelines on dose administration for pediatric population
U.S. Food and Drug Administration	Reducing radiation from medical x-rays www.fda.gov/ForConsumers/ConsumerUpdates/ucm095505.htm	Patients	Information similar to radiologyinfo.org. General information on exams and chart on radiation dose administered for each exam

Alternative to traditional x-rays
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"We're also utilizing it to get x-rays of legs, pelvises," and other bone structures, according to Tassone. "It's different than a CT scan in that it only works for bone imaging and creates a three-dimensional model," Tassone explains, "whereas a CT scan can be utilized for soft-tissue imaging. It can't truly replace a CT by any stretch of the imagination, but the three-dimensional capabilities do give us some insight like CT."

Tassone also notes it can be used for preoperative planning, and its use isn't restricted to children. "We have a heightened awareness of the risks of radiation exposure in all patients," says Tassone. "We're making an effort to minimize the risks in any way that we can." He speculates its popularity in the pediatric and adolescent population is driven in part by parents' awareness of radiation exposure issues.

Standing room only

The scanner does require that the patient stand for an exam, but Tassone says they're working on devising a method so that wheelchair-bound patients can also use the scanner. "We are actively trying to figure out a way to adapt the technology to be able to put in some kind of device where a child could sit in it, because radiation exposure is radiation exposure and we should minimize it for everybody." There is also a size limit, Tassone notes. "It's kind of like getting into a phone booth. A very large patient might not be able to fit into it."

According to Jason Launders, M.Sc., senior project manager and medical physicist, ECRI Institute, the device could be used for any upright study, but it is not suited for most general radiographic studies. However, as ECRI Institute's Rohit Inamdar, senior associate and medical physicist, notes, because the patient stands, this device models spinal deformities under weight-bearing conditions, something other x-ray devices cannot currently do.

When Children's Hospital of Wisconsin acquired its scanner, it announced it was only one of two U.S. facilities in possession of the technology. In November 2010, EOS announced that Barnes-Jewish Hospital (St. Louis, MO, USA), New York University (New York, NY, USA), and University of Iowa (Iowa City, IA, USA) have adopted the EOS device for musculoskeletal imaging suites.

Clinical decision support for imaging
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Government incentives, research for CDS

CDS is an optional part of the U.S. government's incentive package for hospitals establishing "meaningful use" of electronic health records, under the Health Information Technology for Economic and Clinical Health Act, enacted as part of the Recovery Act of 2009. Computerized physician order entry implementation is a requirement, but the priority for now is ordering medications, noted Launders. "Imaging is a long way down on the list of priorities."

That's not to say the largest U.S. payer hasn't been interested in reducing unnecessary exams. In July 2010, the U.S. Centers for Medicare & Medicaid Services announced its Medicare Imaging Demonstration Initiative involving computerized CDS to eliminate inappropriate imaging exams. The project will address MRI, CT, and nuclear medicine procedures, including positron emission tomography. The agency announced that it is providing up to $10 million for the two-year project, slated to begin January 1, 2011. The Medicare Improvements for Patients and Providers Act of 2008 authorized the demonstration project.

Guidelines finalized for radiopharmaceuticals in pediatrics

Summary

New guidelines have been issued for the administration of radiopharmaceuticals in pediatric and adolescent populations.

While computed tomography overuse in the pediatric population has garnered much attention, exposure to the radiopharmaceuticals used to enhance imaging is equally concerning. Nuclear medicine physicians, technologists, and physicists in North America addressed this issue by recently publishing consensus guidelines to limit radiopharmaceutical radiation exposure in children. The just-finalized guidelines are now available for nuclear medicine professionals on several professional society websites.

Meeting a need

The guideline development effort began in 2008 after findings from a survey conducted at 13 premier pediatric hospitals in North America indicated that administered radiopharmaceutical activities in children varied widely and that the greatest variability in administered dose existed among the youngest, smallest, and most vulnerable patients (*J Nucl Med.* 2008 Jun;49[6]:1024-7). According to S. Ted Treves, M.D., chief, nuclear medicine and molecular imaging, Children's Hospital (Boston, MA, USA), and colleagues, dose administration is generally based on the recommended adult dose adjusted for body mass.

"Of concern is that the minimum administered activity varied on average by a factor of 10 and as much as a factor of 20 for one procedure," according to Trevers, who cochaired the Pediatric Dose Reduction Workgroup with Michael J. Gelfand, M.D., chief, Section of Nuclear Medicine at Cincinnati Children's Hospital Medical Center (Cincinnati, OH, USA), and Marguerite T. Parisi, M.D., associate professor, pediatric radiology, University of Washington, Seattle (USA). A total of 20 pediatric radiology professionals participated in the effort.

The workgroup's efforts, supported by the Society of Nuclear Medicine's (SNM) Pediatric Imaging Council, the Society for Pediatric Radiology, and the American College of Radiology, took place during three consensus sessions in 2009 and 2010. SNM will further disseminate the guidelines as it incorporates them into an ongoing update of its guidelines for radiopharmaceutical doses, said Dominique Delbeke, M.D., Ph.D., SNM president and director of nuclear medicine and director of positron emission tomography (PET) at Vanderbilt University Medical Center (Nashville, TN, USA).

The "North American Consensus Guidelines for Administered Radiopharmaceutical Activities in Children and Adolescents," finalized in October 2010, address radiopharmaceutical doses for 11 radiopharmaceuticals commonly used in pediatric single photon computed emission tomography and PET imaging. The guidelines specify that dose determination is based on body weight alone (not body surface area or other methods), except for nuclear cystogram and gastric emptying studies. The guidelines state that they differ significantly from the European Association for Nuclear Medicine Pediatric Dose Card issued in 2007. Differences, as stated in the new guidelines, are as follows:

1. The administered activities are slightly lower for infants and small children.
2. Administered activities for technetium-99m-labeled dimercaptosuccinic acid (99mTc-DMSA) and 18F-fluoride are considerably lower.
3. Administered activities for orally administered 99mTc-labeled radiopharmaceuticals and for radionuclide cystography provide a range of administered activities for each type of study rather than an administered activity/kg.
4. The consensus guidelines are intended to more closely represent clinical practice in North American pediatric centers.