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Cancer screening: the over-diagnosis debate goes on.

It seems that the more the issue of over-diagnosis of cancer is debated, the greater the confusion, at least as far as the persons most involved are concerned, namely the patients.

And although, because of the recent media hype surrounding the question of breast cancer over-diagnosis and the argument over the precise value of breast cancer screening, it may seem that the over-diagnosis question is limited to breast cancer, it is becoming more and more clear that the same over-diagnosis issue is applicable to other cancers. The latest to be questioned is the use of CT for the screening of subjects at high risk of developing lung cancer, that is heavy smokers. Leaving aside the ethical question as to whether it is justified to allocate health care resources to heavy habitual smokers who won’t, or more plausibly can’t, give up the practice which is responsible for their high risk of lung cancer, the good news was the publication last year of the results of the US national Lung Screening Trial (NLST). These results clearly indicated that the use of Low dose CT (LDCT) screening could result in an encouraging 20% relative reduction in lung cancer-specific mortality as compared to screening with chest X ray (CXR). Too good to be true? A paper from the NLST Overdiagnosis Manuscript Writing Team (!) (Patz EF et al Overdiagnosis in Low-Dose Computed Tomography Screening for Lung Cancer JAMA Intern Med. 2014;174:269) rings some alarm bells.

As Patz et al say, one of the limitations and potential harms of the LDCT screening is over-diagnosis because it is not clear that all early-stage lesions detected in asymptomatic individuals will progress to cause symptoms and affect long-term outcome. These patients may undergo an invasive diagnostic procedure, have surgical resection, be given a diagnosis of lung cancer, and require multiple sequential follow-up studies when some tumors are potentially clinically insignificant. These cases of over-diagnosis are treated as any other lung cancer because it is generally not possible to distinguish indolent lesions from more aggressive tumors. The conclusions of their analysis of the NLST data were clear: screening for lung cancer with LDCT has the potential to detect indolent tumors, resulting in over-diagnosis. Therefore whereas the NLST trial demonstrated a relative mortality reduction with LDCT, the "limitations of the screening process, including the magnitude of overdiagnosis, should be considered when guidelines for mass screening programs are constructed. In the future, once there are better biomarkers and imaging techniques to predict which individuals with a diagnosis of lung cancer will have more or less aggressive disease, treatment options can be optimized, and a mass screening program can become more valuable".

In practice the question is how such general information is best communicated to the individual patient. While it is dangerous to extrapolate from one pathology to another, there may be some general lessons to be drawn from a recent study of the reactions of British women when questioned about their attitude to the issue of over-diagnosis in breast cancer. (Waller et al. A survey study of women’s responses to information about overdiagnosis in breast cancer screening in Britain. Br J Cancer. 2014;111:1831). One general conclusion was that women in the general population in Britain appear to be less concerned by the prospect of over-diagnosis than some clinicians and despite the sometimes ferocious polemic debate between the professionals in the pro and con screening lobbies, prior awareness of overdiagnosis in breast screening was moderate in the population of women surveyed. More tellingly, the results of Waller et al’s study suggest that, the concept itself is difficult to understand by the women questioned. In fact, the perceived likelihood of overdiagnosis rather than the phenomenon itself maybe more off-putting to the women questioned.

Nevertheless, perhaps because they adhere to the “better safe than sorry” rule, even after receiving additional information on the issue of overdiagnosis most women surveyed indicated that they would continue with their screening program. Most radiologists in the front line anyway have no option. Faced with the person being examined, be it a lung cancer CT screen or a mammography screen, most radiologists focus on maximizing the chance of a successful examination, and leave population-based statistics and over-diagnosis arguments to take care of themselves.

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FROM THE EDITOR
The front cover image shows a coronal gradient echo T1-weighted dynamic contrast enhanced (DCE-MRI) image of the wrist in a patient with non-union of the scaphoid bone 4 months after a transverse scaphoid bone fracture. Brighter colours show highly perfused areas whereas darker red colours represent slower perfusion. Image courtesy of Image Analysis, London, UK.
Routine imaging screening of diabetic patients for heart disease shown to be ineffective

Coronary artery disease (CAD) is a major cause of cardiovascular morbidity and mortality in patients with diabetes mellitus, yet CAD often is asymptomatic prior to myocardial infarction (MI) and coronary death. A recently published study (Muhlestein JB et al. Effect of screening for coronary artery disease using CT angiography on mortality and cardiac events in high-risk patients with diabetes: the FACTOR-64 randomized clinical trial. JAMA. 2014; 312: 2234) showed that among asymptomatic patients with type 1 or type 2 diabetes, the use of coronary CT angiography (CCTA) to screen for coronary artery disease (CAD) did not reduce the composite rate of all-cause mortality, nonfatal myocardial infarction (MI), or unstable angina requiring hospitalization at 4 years. The findings thus do not support CCTA screening in this population.

Instead, high-quality diabetes care is still the most effective way for diabetics to avoid heart attacks, according to the study by researchers at the Intermountain Medical Center Heart Institute in Murray, Utah.

The study is significant because diabetes is the most important risk factor for heart disease. Patients with diabetes often develop severe, but asymptomatic heart disease. The combination of aggressive, asymptomatic heart disease has made it the most common cause of death in patients with diabetes.

Researchers examined whether the use of advanced coronary computer CT angiography screening would result in significant long-term reduction in death, heart attack and hospitalization for these patients.

“We found that the best treatment to prevent heart attacks and death among diabetics is excellent diabetes management,” said Brent Muhlestein, MD, director of cardiovascular research at the Intermountain Medical Center Heart Institute, and lead researcher of the study. “Many diabetics die from heart disease before they ever have any typical heart attack-related symptoms,” he said. “The question was whether screening for the presence of silent heart disease in these patients would be helpful. However, although the screenings did lead to recommended changes of treatment, including surgery in some cases, it didn’t benefit the patients enough to support a change in the current recommended standards of care.”

For the study, more than 900 diabetic patients were randomly assigned to undergo screenings or pursue standard diabetes management, which consisted of continued care from the patient’s physician. Among patients who were screened and found to have silent heart disease, aggressive treatment recommendations were provided, with the goal of more effectively preventing future adverse heart events than might be obtained by standard diabetes management.

Researchers say the screening resulted in a modest number of revascularization procedures and increased the use of cholesterol-lowering statin drugs. After four years of follow-up, however, the occurrence of deaths, heart attacks and episodes of unstable angina did not differ significantly between those who were screened (6.2%), and those who were not (7.6%).

In the past, screening diabetics for heart disease before they had noticeable symptoms was limited to tests that did not yield direct anatomical information. Screens were only able to detect if blood flow to the heart muscle was decreased by a partial or complete artery blockage. The development of 64-slice coronary computed tomographic angiography (CCTA) technology, however, now provides the opportunity to evaluate the actual anatomy of the heart non-invasively and allows physicians to visualize the hardening of the arteries.

“This non-invasive imaging technology that we have is incredibly accurate, however, it does involve additional expense and some radiation exposure,” said Dr. Muhlestein. “Previous studies have shown that CCTA screening is nearly as good as standard invasive heart catheterization in defining coronary arteries. Because of this, we hoped that the new technology would help us identify heart disease in high-risk patients who don’t have symptoms, and thereby allow us to care better for them. However, it turned out that the excellent standard of care offered to diabetic patients is just as effective."

http://tinyurl.com/Muhlestein-et-al-paper

Over-use of head CT in emergency departments?

Fewer than 7.1% of patients presenting to the emergency department with dizziness and 6.4% complaining of syncope or near-syncope benefited from head CT say researchers at Kaiser Foundation Hospital in Honolulu in a recently published report (Mitsunaga MM & Yoon HC. Head CT scans in the Emergency Department for Syncope and Dizziness. AJR Am J Roentgenol. 2015 Jan; 204(1): 24-8.) The purpose of the study was to determine the yield of acutely abnormal findings on head CT scans in patients presenting to the emergency department with dizziness, near-syncope or syncope and to determine the clinical factors that potentially predicted acutely abnormal head CT findings and
hospital admission. The use of head CT as part of a screening examination, rather than as a diagnostic tool, probably stems from increased pressure on emergency physicians to evaluate and differentiate between benign and life-threatening causes of dizziness and syncope.

Head CT scans are not recommended unless the loss of consciousness is suspected not to be syncope. Using CT in cases of uncomplicated syncope should be avoided unless physical or historical features of CNS dysfunction are present. However, use of head CT scans obtained to evaluate patients with syncope in the emergency department appears to be a common practice with little evidence of benefit. “Most patients with mild symptoms of dizziness or syncope do not require a head CT, says Myles M. Mitsu-naga, principal investigator. “If a careful history and physical examination do not find persistent neurologic signs, then a follow-up clinic visit the next day may be all that is necessary”.

http://tinyurl.com/Head-CT-paper

The impact of axillary ultrasound on sentinel lymph node surgery

A recently published study from the Mayo Clinic describes the role of axillary ultrasound in determining which breast cancer patients need to have underarm lymph nodes removed (Boughey JC et al. Axillary Ultrasound After Neoadjuvant Chemotherapy and Its Impact on Sentinel Lymph Node Surgery: Results From the American College of Surgeons Oncology Group Z1071 Trial (Alliance). J Clin Oncol. 2015 Feb 2; pii: JCO.2014.57.8401.)

The study found that not all women with lymph node-positive breast cancer treated with chemotherapy before surgery need to have all of their underarm nodes taken out. Ultrasound is a useful tool for judging before breast cancer surgery whether chemotherapy eliminated cancer from the underarm lymph nodes.

In the past, when breast cancer was discovered to have spread to the lymph nodes under the arm, surgeons routinely removed all of them. Taking out all of those lymph nodes may cause lymphedema and limit the arm’s range of motion.

Now, many breast cancer patients receive chemotherapy before surgery. Thanks to improvements in chemotherapy drugs and use of targeted therapy, surgeons are seeing more women whose cancer is eradicated from the lymph nodes by the time they reach the operating room, says lead author Dr Judy C. Boughey. The current study finds that repeating ultrasound after chemotherapy is a sound way to help determine whether surgeons should remove only a few lymph nodes and test them for cancer, sparing patients whose sentinel nodes are cancer-free the removal of all nodes in the armpit, or take out all of the nodes. “Our goal here is really to try to get away from the idea that, ‘Every patient with breast cancer needs these drugs, and this amount of chemotherapy and this surgery,’ and instead to personalize surgical treatment based on how the patient responds to chemotherapy,” Dr. Boughey says. Avoiding complete underarm lymph node removal when possible means fewer women will experience the complications that can accompany that surgery, and avoiding those side effects should also save health care costs, she says. “That’s one of the really nice things about giving chemotherapy up front: It allows us to be less invasive with surgery, both in terms of breast surgery and lymph node surgery, and to tailor treatment based on response to chemotherapy,” Dr. Boughey says. Most patients with lymph node-positive breast cancer receive radiation treatment after surgery. A new study is under way for men and women with breast cancer whose underarm lymph nodes are still positive for cancer after chemotherapy. It will evaluate which is more effective: removing all of those nodes, or leaving the nodes and treating them with radiation.

http://tinyurl.com/Boughey-et-al-paper

Contrast enhanced MRI suggests blood vessels in older brains breakdown, possibly leading to Alzheimer’s

Advanced image analysis suggests that breakdown in the brain’s memory and learning center can be detected before cognitive loss begins, suggesting important implications for Alzheimer’s and dementia patients.

Advanced image analysis suggests that breakdown in the brain’s memory and learning center can be detected before cognitive loss begins, suggesting important implications for Alzheimer’s and dementia patients.

A recent study from the University of Southern California may have unlocked another puzzle to preventing risks that can lead to Alzheimer’s disease (Montagne A et al. Blood-brain barrier breakdown in the aging human hippocampus. Neuron. 2015 Jan 21;85(2):296-302. doi: 10.1016/j.neuron.2015.01.006.). The researchers used high-resolution imaging of the living human brain to show for the first time that the brain’s protective blood barrier becomes leaky with age, starting at the hippocampus, the critical learning and memory center that is damaged by Alzheimer’s disease. The study indicates that it may be possible to use brain scans to detect changes in blood vessels in the hippocampus before they cause irreversible damage leading to dementia in neurological disorders characterized by progressive loss of memory, cognition and learning. “This is a significant step in understanding how the vascular system affects the health of our brain,” Dr. M. A. Montagne says.
brains,” said Dr. Berislav V. Zlokovic, director of the Zilkha Neurogenetic Institute (ZNI) at the Keck School of Medicine, and the study’s principal investigator. “To prevent dementias including Alzheimer’s, we may need to come up with ways to resel the blood-brain barrier and prevent the brain from being flooded with toxic chemicals in the blood. Pericytes are the gate-keepers of the blood-brain barrier and may be an important target for prevention of dementia.”

Alzheimer’s disease is the most common type of dementia. Alzheimer’s disease is an irreversible, progressive brain disease that causes problems with memory, thinking and behavior. Postmortem studies of brains with Alzheimer’s disease show damage to the blood-brain barrier, the cellular layer that regulates entry of blood and pathogens into the brain. The reasons why and when this damage occurs, however, remain unclear.

In the Neuron paper, Zlokovic’s research team examined contrast-enhanced brain images from 64 human subjects of various ages and found that early vascular leakage in the normally aging human brain occurs in the hippocampus, which normally shows the highest barrier properties compared to other brain regions. The blood-brain barrier also showed more damage in the hippocampal area among people with dementia than those without dementia, when controlling for age.

To validate the research method, the USC team examined brain scans of young people with multiple sclerosis without cognitive impairment, finding no difference in barrier integrity in the hippocampus between those of the same age with and without the disease. The researchers also looked at the subjects’ cerebrospinal fluid (CSF), which flows through the brain and spinal cord. Individuals who showed signs of mild dementia had 30 percent more albumin, a blood protein, in their CSF than age-matched controls, further indicating a leaky blood-brain barrier. The CSF of individuals with dementia also showed a 115 percent increase of a protein related to pericyte injury. Pericytes are cells that help maintain the blood brain barrier; previous research has linked pericytes to dementia and aging.

http://tinyurl.com/Montange-et-al-paper

U.S. primary care physicians still unfamiliar with breast density law

Ten months after California legislators enacted a controversial law mandating that radiologists notify women if they have dense breast tissue, researchers have found that half of primary care physicians are still unfamiliar with the law and many don’t feel comfortable answering breast density-related questions from patients. The findings (Khong KA et al Impact of the California Breast Density Law on Primary Care Physicians. J Am Coll Radiol. 2014. doi: 10.1016/j.jacr.2014.09.042) suggest that if the law is going to have any significant impact on patient care, primary care providers need more education about breast density and secondary imaging options.

“Overall, the impact of the breast density legislation probably is not significant if primary care physicians are not educated or aware of it,” said lead author Kathleen Khong. “We should put some emphasis on educating the primary care physicians so that when they get questions from patients, they can be comfortable in addressing the issues.”
their doctors. But the recent study demonstrated that while women and their doctors are receiving the notifications, many of those physicians are unclear about what to do with the information. As a consequence, the researchers said, it appears that relatively few patients with dense breasts are asking questions about their breast density and its implications.

Khong said their survey results were surprising, but acknowledged that many primary care physicians may not feel they have sufficient training to make a clinical recommendation for a particular type of secondary screening. In fact, the study also found that 75 percent of respondents would like more education about the breast-density law and its implications for primary care. http://tinyurl.com/Breast-density-law

**Geographic variation in radiologist capacity and widespread implementation of lung cancer CT screening in the United States**

The newly released United States Preventive Services Task Force (USPSTF) recommendations for lung cancer screening are expected to increase demand for low-dose computed tomography scanning in the United States but health system capacity constraints might threaten the scale-up of screening. A recent study (Smieliauskas F et al Geographic variation in radiologist capacity and widespread implementation of lung cancer CT screening. J Med Screen. 2014;21:207) estimated the prevalence of capacity constraints in the radiologist workforce and resulting potential disparities in access to lung cancer screening. The research group from the University of Chicago combined information from health interview surveys to estimate the numbers of smokers who meet the USPSTF eligibility criteria, and information from administrative datasets to estimate the numbers of radiologists and the numbers of scans they currently interpret in Health Service Areas (HSAs) across the United States. The group then estimated and mapped the prevalence of capacity constrained HSAs - those having a greater than 5% or greater than 25% projected increase in scans over current levels from scaling up screening - and used descriptive statistics and logistic regressions to identify HSA characteristics associated with capacity constraints. The results showed that scaling up lung cancer screening would increase imaging procedures by an average of 4% across HSAs. Of the 9.6 million eligible smokers, 1,023,943 lived in HSAs which would have increases of at least 5% in screening. HSAs that were rural, with many eligible smokers, and disproportionately Hispanic or low-income smokers had significantly higher odds of facing capacity constraints.

The overall conclusion was that disparities in access to lung cancer screening appear likely unless policy makers target HSAs with few radiologists for additional resources. Radiologists should however be able to absorb the workload imposed by lung cancer screening in most areas of the country. http://tinyurl.com/smieliauskas-paper

**Age-adjusted D-dimer test could reduce CT pulmonary angiography tests in suspected pulmonary embolism**

Pulmonary embolism is associated with more deaths annually than breast cancer, HIV/AIDS, prostate cancer, and motor vehicle accidents combined, which means it’s important to get its diagnosis right so the proper treatment can be instituted. “A CT scan is most often used to ultimately rule out a pulmonary embolism, however it delivers radiation and contrast dye to the patient,” said Dr Woller lead author of a recent study (Woller SC et al. Assessment of the safety and efficiency of using an age-adjusted D-dimer threshold to exclude suspected pulmonary embolism Chest. 2014;146:1444). “Elderly patients are at greater risk for inadvertent harm related to the CT scan, and the contrast dye may also impact kidney function. In addition, the scan adds to the cost of the patient’s care. If we can safely and accurately diagnose the patient’s risk of a pulmonary embolism using this sliding D-dimer scale, we can eliminate the need for additional imaging tests”

The new model of D-Dimer test which factors in a patient’s age, more accurately identifies a patient’s risk and can more easily rule out the need for additional, more invasive tests, helping to reduce unnecessary costs.

“When patients come to the ER with the symptoms of a pulmonary embolism, we begin by doing a physical exam and identifying their previous medical history,” said Dr Woller. “Once we get that initial information, we often conduct a D-dimer blood test. If the protein levels are above a certain threshold, we most often order a CT scan to confirm or rule out a pulmonary embolism. However, as we age, D-dimer levels naturally increase, which means when we test D-dimer in elderly patients, we often find an elevated result—even when a clot is absent.” The conventional cutoff used to identify a normal D-dimer value is 500. The new research suggests that patients older than 50 should have the cutoff adjusted upward to a value equal to the patient’s age multiplied by 10. For example, a 72-year old patient would have a normal D-dimer value of less than 720. The approach was validated in a study involving more than 900 patients who came to an emergency department with symp-
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Molecular breast imaging quadruples detection of invasive breast cancer in dense breast

Molecular Breast Imaging (MBI) is a supplemental imaging technology that is capable of detecting tumors that would otherwise be obscured by surrounding dense breast tissue on a mammogram. The technique pioneered at Mayo Clinic nearly quadruples detection rates of invasive breast cancer according to a recently published study (Rhodes DJ et al Molecular Breast Imaging at Reduced Radiation Dose for Supplemental Screening in Mammographically Dense Breasts. AJR Am J Roentgenol. 2015;204:241).

MBI increased the detection rate of invasive breast cancers by more than 360 percent when used in addition to regular screening mammography, according to the study. MBI uses small, semiconductor-based gamma cameras to image the breast following injection of a radiotracer that tumors absorb avidly. Unlike conventional breast imaging techniques, such as mammography and ultrasound, MBI exploits the different behavior of tumors relative to background tissue, producing a functional image of the breast that can detect tumors not seen on mammography.

The study, conducted at Mayo Clinic, included 1,585 women with heterogeneously or extremely dense breasts who underwent an MBI exam at the time of their screening mammogram. Of these women, 21 were diagnosed with cancer—five through mammography alone (24 percent or 3.2 cancers per 1,000 women) and 19 with mammography plus MBI (91 percent or 12 cancers per 1,000 women). Particularly notable was the four-fold increase in detection of invasive cancers (1.9 invasive cancers per 1,000 women with mammography and 8.8 per 1,000 women with mammography plus MBI). Detection rates for noninvasive cancers were not significantly different. The risk of incurring an unnecessary biopsy because of a false positive exam increased in this study, from 1 in 100 women with mammography to 4 in 100 women with mammography plus MBI. (By comparison, recent studies have shown that alternative supplemental screening techniques, such as ultrasound and MRI, generate about eight additional unnecessary biopsies per 100 women.)

“The finding that MBI substantially increases detection rates of invasive cancers in dense breasts without an unac-

**fMRI study sheds light on how children with autism process social play**

In a first-of-its-kind study researchers have studied social play exchanges on multiple levels, revealing associations among brain regions, behavior and arousal in children with ASD. The study (Corbett BA et al Examining the relationship between face processing and social interaction behavior in children with and without autism spectrum disorder. J Neurodev Disord. 2014; 6: 35)

“Play is a fundamental skill in childhood and an area in which children with autism often have difficulty,” said the study’s principal investigator, Dr Blythe Corbett. However, the psychobiological study of play in autism is seldom comprehensively investigated using multiple levels of analysis.” Corbett and colleague Kale Edmiston studied children with ASD using an innovative study design in which participants played with a typically developing child on a playground and then played a social exchange game with either the same child or a computer partner during functional imaging. To measure physiological arousal, salivary cortisol sampling was used before and after the playground protocol.

During a functional MRI (fMRI) scan, participants played a game in which they were asked to cooperate or to compete with a co-player. For half of the game, participants were told they were playing with a child they had just met on the playground. For the other half of the game, children were told they were playing with a computer. However, the children were actually playing with a computer the entire time. “When participants with ASD were in the MRI scanner and thought they were playing with the child they had just met, their brain activation patterns did not differ from when they thought they were playing with a computer,” said Edmiston. “In contrast, typically developing children showed unique activation patterns based on which partner they were playing. This suggests that social agents might not be processed in the brains of people with ASD differently than nonsocial agents.”

Corbett said the findings suggest that “some children with autism not only find social engagement with peers less motivating, but it may be stressful, even aversive.”
ceptably high increase in false positive findings has important implications for breast cancer screening decisions, particularly as 20 states in the US now require mammography facilities to notify women about breast density and encourage discussion of supplemental screening options,” says author Dr. DJ Rhodes. “These findings suggest that MBI has a more favorable balance of additional invasive cancers detected versus additional biopsies incurred relative to other supplemental screening options.”

“Recent studies have reported supplemental cancer detection rates of 1.9 per 1,000 women screened with automated whole breast ultrasound and 1.2 to 2.8 per 1,000 women screened with digital breast tomosynthesis, so our finding of an additional 8.8 cancers per 1,000 women makes MBI a very compelling option for women who elect supplemental screening,” says Dr Rhodes.

“This new study is important because it incorporates many of the advances in MBI pioneered here at Mayo Clinic and shows that studies can be performed safely, with low radiation exposure to the patient,” says Dr Rhodes. “This means MBI is safe and effective as a supplemental screening tool.”

http://tinyurl.com/Rhodes-et-al-paper

Mammographic density: heritability and association with breast cancer susceptibility loci

A recent study published in the Journal of the National Cancer Institute (JNCI), demonstrates the high heritability of volumetric breast density and validates the genetic influence of breast density on breast cancer risk (Brand JS et al Volumetric mammographic density: heritability and association with breast cancer susceptibility loci. J Natl Cancer Inst. 2014; 106(12). Conducted by the Karolinska Institute in Sweden, the study was designed to explore the genetic relationship between breast density and breast cancer risk by analyzing associations with genetic variations, or Single Nucleotide Polymorphism (SNPs), associated with breast cancer.

“While research has shown that mammographic density is a strong risk factor for breast cancer, the relationship between genetics and breast density are not completely understood. Our results confirm the high heritability of volumetric density and support the notion that mammographic density is a risk factor under strong genetic influence,” said Professor Per Hall from the Karolinska’s Department of Medical Epidemiology and Biostatistics. “While this genetic relationship does not fully explain variations in mammographic density, the observed associations with individual SNPs are relevant as they will continue to provide insight into the biological mechanisms leading to breast cancer in women with dense breasts.” KARMA (KARolinska MAmnography Project for Risk Prediction of Breast Cancer) is a prospective cohort study initiated in January 2011 and involves 70,876 women attending mammography screening or clinical mammography at four hospitals in Sweden. In the study, the researchers used software from the New Zealand company Volpara to measure volumetric breast density for 908 full-sisters and 47 half-sisters to evaluate the heritability of volumetric mammographic density. The association of volumetric breast density with 82 established breast cancer loci (SNPs) was assessed in an independent sample of more than 4,000 unrelated women using linear models, adjusting for age, body mass index and menopausal status.

While area-based density measures have been used to identify a genetic relationship to breast density in twins, the Karolinska study is the first to use a fully automated volumetric breast density
measurement tool. Results demonstrated that volumetric density is highly heritable and showed comparable heritability traits as area-based measures.

In another large-scale study also recently published, the Karolinska researchers concluded that automated measurement of volumetric mammographic density using VolparaDensity is a promising tool for widespread breast cancer risk assessment.

“This study is another example of the pioneering work Karolinska researchers are performing to better understand the genetic relationship between cancer risk and volumetric breast density,” said Ralph Highnam, Ph.D., Chief Scientist and CEO, Volpara Solutions. “We are proud that VolparaDensity is an integral part of this research to validate the heritability of volumetric breast density and to help discover how to prevent the development of breast cancer in women with dense breasts.”

http://tinyurl.com/JNCI-paper
http://volparasolutions.com/

New MRI technique (RSI-MRI) improves prostate cancer detection

Prostate cancer (PCa) is the leading cause of newly diagnosed cancers in men and the second leading cause of cancer death in men. A recently published report (Rakow-Penner RA et al. Novel technique for characterizing prostate cancer utilizing MRI restriction spectrum imaging: proof of principle and initial clinical experience with extraprostatic extension. Prostate Cancer Prostatic Dis. 2015;18: 81) from a team of researchers at the University of California, San Diego School of Medicine, describes a novel imaging technique that shows measurable improvement upon current prostate imaging - and may have significant implications for how patients with prostate cancer are ultimately treated. Standard MRI of the prostate lacks sensitivity in the diagnosis and staging of prostate cancer PCa. To improve the operating characteristics of prostate MRI in the detection and characterization of PCa, the group developed a novel, enhanced MRI diffusion technique using restriction spectrum imaging (RSI-MRI). The principles of the new technique were described in a preceding paper (White NS et al. Diffusion-weighted imaging in cancer: physical foundations and applications of restriction spectrum imaging. Cancer Res. 2014;74:4638)

“This new approach is a more reliable imaging technique for localizing tumors. It provides a better target for biopsies, especially for smaller tumors,” said Dr Rebecca Rakow-Penner, the study’s first author.

The technique is also valuable in surgical planning and image staging, said Dr David S. Karrow, the study’s corresponding author. “We now have a non-invasive imaging method to more accurately assess the local extent of the tumor and possibly predict the grade of the tumor, which can help in more precisely and effectively determining appropriate treatment.”

The current standard of care for detecting and diagnosing prostate cancer is contrast enhanced magnetic resonance imaging (MRI). However, many tumors do not significantly differ from surrounding healthy tissues with contrast enhanced MRI and so evade easy detection. The imaging technique known as diffusion MRI has been a standard imaging technique in the brain and an emerging technique in the prostate. But diffusion MRI suffers from magnetic field artifacts that can distort the actual location of tumors by as much as 1.2 centimeters - a significant distance when surgeons are attempting, for example, to assess whether a tumor extends beyond the prostate and into adjacent nerve bundles.

The new approach is known as restriction spectrum imaging-MRI or RSI-MRI. It corrects for magnetic field distortions and focuses upon water diffusion within tumor cells. By doing both, the ability of the imaging process to accurately plot a tumor’s location is increased and there is a more refined sense of the tumor’s extent, said Dr Nathan White, study co-author and co-inventor of the RSI-MRI technique.

In an as yet unpublished paper the same team of researchers reported that RSI-MRI appears to be able predict tumor grade. Higher grade tumors correlate with higher restricted water volume in the cancer cells’ large nuclei.

“Prostate cancer can often be an indolent disease, where a patient may only require surveillance rather than aggressive surgery,” noted co-author Christopher J. Kane, MD, professor of urology at UC San Diego.

“If by imaging we could predict the tumor grade,” added Robert Reiter, MD, professor of urology at UCLA, “we may be able to spare some patients from prostate resection and monitor their cancer with imaging.”

http://tinyurl.com/Rakow-Penner-et-al-paper

New recommendations for use of echocardiography in acute cardiovascular care

Echocardiography is one of the most powerful diagnostic and monitoring tools available to the modern emergency/ critical care practitioner. Currently, there is a lack of specific European Association of Cardiovascular Imaging/
Acute Cardiovascular Care Association recommendations for the use of echocardiography in acute cardiovascular care. In a recently published paper (Lancellotti et al The use of echocardiography in acute cardiovascular care: Recommendations of the European Association of Cardiovascular Imaging and the Acute Cardiovascular Care Association. Eur Heart J Acute Cardiovasc Care. 2015 Jan 29. pii: 2048872614568073.) a working group of European cardiologists describe the practical applications of echocardiography in patients with acute cardiac conditions, in particular with acute chest pain, acute heart failure, suspected cardiac tamponade, complications of myocardial infarction, acute valvular heart disease including endocarditis, acute disease of the ascending aorta and post-intervention complications. Specific issues regarding echocardiography in other acute cardiac care scenarios are also described.

The provision of echocardiography is fundamental to the management of patients with acute cardiovascular disease. Echocardiography can provide important information throughout the whole patient pathway, having been shown to change therapy in 60–80% patients in the pre-hospital setting, improve diagnostic accuracy and efficiency in the emergency room, reveal the etiology of unexplained hypotension in 48% of medical intensive care patients and provide information additional to that obtained from the pulmonary artery catheter. Echocardiography is now included in the universal definition of acute myocardial infarction, and in international guidelines regarding the management of cardiac arrest. In the critical care setting echocardiography can be used to measure/monitor cardiac output and to determine abnormalities of cardiac physiology and coronary perfusion, as well as providing more standard anatomical information related to diagnosis. Although the potential scope of echocardiography is evident, specific recommendations for its use in acute cardiovascular care are currently lacking from the European Association of Cardiovascular Imaging (EACVI) and the Acute Cardiovascular Care Association (ACCA).

http://tinyurl.com/EACI-recommendations

Dense breasts are a risk factor for breast cancer and also make it more difficult to recognize potential problem areas amongst the dense tissue on screening mammograms. Leader of the group, Dr A N Tosteson explained the impact of the research: "Our study is timely because with existing breast density notification laws in some 19 U.S. states, and with national legislation pending, it is critical that we understand what approaches to supplemental breast cancer screening are most effective for women with dense breasts.”

The study estimates that, for every 10,000 women between the ages of 50-74 with dense breasts who receive supplemental ultrasound screening after a normal mammogram, about four breast cancer deaths would be prevented, but an extra 3,500 biopsies would be given to women who did not have breast cancer.

Tosteson and colleagues used data from the Breast Cancer Surveillance Consortium (BCSC) and three simulation models developed independently within the National Cancer Institute (NCI)-funded Cancer Intervention and Surveillance

New study warns that supplemental ultrasound screening of women with dense breasts will increase healthcare costs

Supplemental ultrasound screening for women with dense breasts would substantially increase healthcare costs with little improvement in overall health, according to an analysis carried out by a group at researchers at the Dartmouth Institute for Health Policy and Clinical Practice. in the United States. (Sprague BL et al. Benefits, harms, and cost-effectiveness of supplemental ultrasonography screening for women with dense breasts. Ann Intern Med. 2015 3;162:157.)

The researchers provide evidence on the benefits and harms of adding ultrasound to breast cancer screening for women who have had a negative mammogram and also have dense breasts. The study will help inform the U.S. national legislative discussion about potential regulations requiring health providers to tell women if their mammogram shows that they have dense breasts.
Modeling Network consortium to evaluate the health outcomes and expense of supplemental screening via ultrasound. Because 40 percent of U.S. women from 40 to 74 years old are estimated to have dense breasts, the value of notifying them of their status and recommending next steps in screening for breast cancer is of national significance.

Tosteson and colleagues recently published a separate simulation modeling study using preliminary data on digital breast tomosynthesis that suggested the new technology may provide an effective way to screen women with dense breasts. Tosteson cautioned that, “Those projections were based on very limited data from U.S populations and we are expanding these data through our ongoing NCI-sponsored research within the Breast Cancer Surveillance Consortium and the PROSPR (Population-based Research Optimizing Screening through Personalized Regimens) Consortium”.

http://tinyurl.com/Sprague-et-al-paper

Patients with detectable PSA post-prostatectomy should receive more aggressive radiation therapy

A recently published paper (Wiegel T et al Prostate-Specific Antigen Persistence After Radical Prostatectomy as a Predictive Factor of Clinical Relapse-Free Survival and Overall Survival: 10-Year Data of the ARO 96-02 Trial. Int J Radiat Oncol Biol Phys. 2015 Feb 1; 91:288) suggests that prostate cancer patients with detectable prostate specific antigen (PSA) following radical prostatectomy should receive earlier, more aggressive radiation therapy treatment. The study is a 10-year post-treatment analysis of the German ARO 96-02 trial, a prospective clinical trial that compared a wait-and-see approach versus an adjuvant radiation therapy approach for patients with node negative prostate cancer who had a prostatectomy. ARO 96-02 accrued 388 patients from 1997 to 2004 with pT3-4pN0 prostate cancer with positive or negative margins who had already undergone radical prostatectomy. Prior to reaching an undetectable PSA post-prostatectomy, 159 patients were randomized to a wait-and-see approach (Arm A) and 148 patients were randomized to receive adjuvant radiation therapy (Arm B). Seventy-eight patients who did not achieve an undetectable PSA were moved to Arm C. The final conclusion of the analysis was that a persisting PSA after prostatectomy seems to be an important prognosticator of clinical progression for pT3 tumors. It correlates with a higher rate of distant metastases and with worse overall survival. A larger prospective study is required to determine which patient subgroups will benefit most from which treatment option.

http://tinyurl.com/Wiegel-et-al-paper

FDG PET scans could enable prediction of who is going to respond to psychotherapy

In a recent issue of the Journal of Psychotherapy and Psychosomatics a new study (Roffman JL et al. Neural Predictors of Successful Brief Psychodynamic Psychotherapy for Persistent Depression. Psychother Psychosom 2014; 83: 364) identifies biological characteristics which may predict who is going to respond to psychotherapy. Psychodynamic psychotherapy has been used to treat depression for more than a century. However, not all patients respond equally well, and there are few reliable predictors of treatment outcome. The authors used resting FDG-PET scans immediately before and after a structured, open trial of brief psychodynamic psychotherapy (n = 16) in conjunction with therapy process ratings and clinical outcome measures to identify neural correlates of treatment response. Results showed that pretreatment glucose metabolism within the right posterior insula correlated with depression severity. Reductions in depression scores correlated with a pre- to post-treatment reduction in right insular metabolism, which in turn correlated with higher objective measures of patient insight obtained from videotaped therapy sessions. Pretreatment metabolism in the right precuneus was significantly higher in patients who completed treatment; this correlated with psychological mindedness.

Even though these findings are still preliminary and require replication, they suggested the presence of specific neural correlates of short-term psychodynamic psychotherapy for depression. Resting brain metabolism seemed to predict both clinical course and relevant psychotherapeutic process during short-term psychodynamic psychotherapy for depression. Furthermore, this may be a promise for the use of brain imaging to improve the efficiency of treatment selection, either pharmacotherapy or psychotherapy.

http://tinyurl.com/Roffman-et-al-paper
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Serving its young patients: German hospital installs fully automatic new X-ray system

Located in the Ruhr district in the West of Germany, St Josef’s Hospital is part of the Bochum Catholic Hospital group which with its 1,350 beds is the largest hospital group in the area. In total, the group treats 50,000 in-patients and sees 157,000 more patients on an outpatient basis. The catchment area extends beyond the Ruhr Area into the North Rhine-Westphalia state and beyond. The hospital is the University Hospital of the Ruhr University in Bochum. Recently the Children’s department of the St Josef’s hospital acquired a new fully automatic X-ray system.

There were several criteria involved in Bochum’s choice of the new system, one of which was the ability to have highest quality images at low radiation, which is of course of particular importance for young patients. The hospital finally opted for the ddRFoemula Plus system from Swissray. Thanks to its high resolution and special imaging software, this system provides excellent diagnostic image quality at the lowest possible radiation dose.

NEW RADIOGRAPHY SYSTEM HELPS YOUNG PATIENTS

X-ray imaging at unprecedented image quality is routinely possible with the new system, which has now been in regular and satisfactory use for several months at the University Children’s Hospital in Bochum. The high-performance digital imaging device is specifically tailored to the needs of young patients and also to make the work of the whole health care team much easier and more efficient. As a general rule, in German hospitals particular attention is paid both to having adequate control of the imaging systems and to the ease-of-use by the radiographers and convenience for the patients. The new ddRFormula Plus system fits all these requirements. In addition, for the young patients of the University Children’s Hospital there are several other advantages one of which is the very high image resolution, which is due to the system’s powerful flat panel detector. The excellent detail enables examination of even the finest bone structures or early changes in the lung tissue and airways to be identified.

INNOVATIVE TECHNOLOGY AT THE SERVICE OF THE PATIENT

The hospital’s senior physician in pediatric radiology, Dr. Leo Rossler is more than satisfied with the new system. “The images are even better than we had expected. The new system allows us to carry out even innovative X-ray diagnoses in the pediatric clinic at the highest standard.”

The director of the clinic director, Prof. Dr Eckard Hamelmann: is also full of praise. "We fought long and hard to get this new technology which is not only absolutely necessary for the clinic but also a sensible investment. We owe a great deal of thanks to the charitable foundation “The Children’s Center of the Ruhr” whose generous support enabled the financing of the project."

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Designing CAD systems for appropriate trust

This article presents a summary of a recent literature study that showed that radiologists often have an inappropriate level of trust in computer-aided diagnosis systems. Several ways are proposed to facilitate more effective trust calibration.

Computer-aided diagnosis (CAD) systems use image processing and artificial intelligence techniques to detect and/or evaluate abnormalities in medical images. The aim of CAD systems is to assist radiologists during image interpretation and thereby increase their diagnostic performance. An example of a typical CAD system is shown in Figure 1.

Various studies have shown that CAD indeed improves radiologists’ diagnostic performance (e.g. [1–3]). However, the performance of radiologists assisted by CAD is often lower than that which might be expected based on the individual performances of the radiologist and the CAD system in isolation [4,5]. There are even studies that showed that CAD did not improve radiologists’ performance at all (e.g. [6,7]). Other studies showed improved sensitivity but reduced specificity (e.g. [8,9]), and yet other papers showed reduced sensitivity of radiologists for difficult cases [10]. Such findings indicate that the interaction between radiologists and CAD is not optimal, which prevents CAD from reaching its full potential.

Jorritsma, Cnossen and Van Ooijen [11] recently examined the role of trust in the radiologist-CAD interaction. They performed a literature study in which they linked findings from the human-computer interaction literature to results from observer studies with CAD. Based on this literature study, they suggested ways to improve the output of CAD so that it allows radiologists to calibrate their trust in the CAD system more effectively. This article briefly describes the results of their study.

INAPPROPRIATE TRUST IN CAD

Research in the field of human-computer interaction has shown that the quality of interaction between humans and automated aids (such as CAD) depends greatly on the amount of trust the humans place in the aid [12]. A higher level of trust leads to a higher level of reliance on the aid’s decisions. However, humans often show an inappropriate level of reliance on automation, caused by an inappropriate amount of trust in the automated aid.

Too little trust in a useful aid can lead to under-reliance, which means that the aid’s full potential is not being used. On the other hand, too much trust in an aid, can lead to over-reliance, which means that the aid causes humans to make errors they would not have made without it.

Various examples of under-reliance can be found in the CAD literature. Radiologists often ignore a substantial amount of true positive CAD marks (ranging from 20 to 84%), are more likely to ignore correctly marked large lesions than correctly marked medium and small lesions, and sometimes do not even reach the stand-alone performance of the CAD system.

Examples of over-reliance in the CAD literature include
decreased specificity caused by a high number of accepted false positive CAD marks, decreased sensitivity in data sets containing a large number of CAD false negatives, and decreased sensitivity for difficult cases.

Designing for appropriate trust

The results of observer studies with CAD indicate that radiologists often have an inappropriate level of trust in CAD. Jorritsma et al. argue that the reason for this is that the output of CAD systems is often presented to radiologists in such a way that it is impossible for them to establish an optimal level of trust in the system. They suggest four ways to improve the output of CAD so that it facilitates more effective trust calibration:

1. Presenting a confidence rating for the decisions made by the CAD system,
2. Providing a global rationale for the decision-making process used by the CAD system,
3. Providing a local rationale for each specific CAD decision, and
4. Informing radiologists of the performance levels of the CAD systems in different contexts.

**CONFIDENCE RATING**

Most CAD systems present their decisions in a binary way: a structure is considered normal or abnormal. They do not distinguish between structures that exceed their decision threshold by a large amount (for which they have a high 'confidence' that they are abnormal) and structures that barely exceed the threshold (for which they have a low confidence that they are abnormal).

Presenting a confidence rating for each CAD decision might facilitate more appropriate trust, because it allows radiologists to adapt their trust in a specific CAD decision to CAD's confidence in this decision. This could lead to less under-reliance, because false-positive CAD decisions likely have a smaller negative impact on radiologists' trust in the entire CAD system when they know that the system did not have a high confidence in this decision. Their trust in high-confidence decisions can then remain at a high level, causing them to dismiss fewer true positives. The confidence ratings could also lead to less over-reliance, because radiologists will probably be less inclined to trust false-positive decisions when they know CAD has a low confidence in them.

There are CAD systems that already provide confidence ratings for their decisions. For example by having the size or color of a CAD mark correspond to CAD's confidence in the mark. Promising results have been obtained with these systems, but there are currently no studies that have compared the effectiveness of CAD systems that provide confidence ratings and CAD systems that do not. Although confidence ratings have been shown to improve trust calibration in other domains, more research is needed to determine whether they are also effective in radiology.

**GLOBAL RATIONALE**

Another approach is to provide radiologists with a global rationale for CAD's decisions in the form of a set of instructions. These instructions should explain the mechanisms that determine CAD's behavior and the specific circumstances in which it is likely to make an error.

A better understanding of the CAD system could mitigate the negative effect of errors that seem obvious to radiologists on their trust in the system. For example, if radiologists are aware of the fact that a CAD system places an upper bound on the structures it evaluates, the observation that the system always misses obvious large lesions likely has a smaller impact on their trust in the system than when they are unaware of this limitation.

An understanding of CAD's behavior could also reduce over-reliance. For example, radiologists who detect a nodule near the chest wall but are not very confident in their decision might be less inclined to change their decision based on a false-negative CAD decision when they know that CAD is likely to miss nodules near the chest wall.

While this approach seems intuitive, there is little research that has evaluated its effectiveness. Preliminary findings indicate that great care should be taken in formulating the rationale, so that it facilitates appropriate trust and not just more trust. The means of presenting the rationale is also important, because different means (e.g. a textual explanation of errors versus pictures of errors) differentially affect trust.

**LOCAL RATIONALE**

An approach that has been shown to facilitate more appropriate trust in automated aids is to provide a local rationale for each of its decisions. However, because CAD's decision-making process is highly complex and can differ greatly from that of a radiologist, it is difficult to present the rationale for a CAD decision in a way that is meaningful for the radiologist.

One possibility is to display, for each decision, the subset of features CAD extracted from the image that contributed most to the decision. Some CAD systems already provide such a type of local rationale. For example, by outlining the central density of detected structures or by displaying measurements derived from certain image regions. However, the effectiveness of this approach for trust calibration has not yet been studied in the CAD domain.

**PERFORMANCE LEVEL**

Appropriate trust occurs when the level of trust matches the performance level of the CAD system. It is therefore important that radiologists are informed of a CAD system's past performance so that they can effectively calibrate their trust in the system. Because the performance of CAD systems can differ between different types of lesions and different image acquisition protocols, it is vital that the performance information presented to radiologists differentiates between these different contexts of operation. This could allow radiologists to calibrate their trust for each specific context and might reduce both under- and over-reliance by mitigating the effects of negative and positive CAD experiences in one context on trust in CAD in other contexts.
Despite the potential benefits of this approach, there are no studies that have properly evaluated its effectiveness. Also, there are currently no standardized approaches for evaluating and reporting CAD performance levels.

CONCLUSION
Radiologists often have an inappropriate level of trust in CAD, which leads to suboptimal diagnostic performance of the radiologist-CAD team. Radiologists sometimes under-trust CAD, thereby reducing its potential benefits, and sometimes over-trust it, leading to diagnostic errors they would not have made without CAD. The four approaches discussed above have great potential to facilitate more appropriate trust in CAD and thereby improve the performance of the radiologist-CAD team. However, the effectiveness of none of these approaches has been directly studied in radiology. Future research should determine whether these approaches truly improve trust calibration in the radiologist-CAD interaction, and to determine the best way to implement them.

Most CAD research is currently focused on improving CAD’s performance. While this is of course valuable, the full benefits of this research are only harnessed if the increase in performance is matched by an equivalent increase in trust. It is therefore vital that more research is devoted to the radiologist-CAD interaction, and specifically the role of trust therein. Without this kind of research, CAD will never reach its full potential.

REFERENCES

Book review
Critical Observations in Radiology for Medical Students
by Katherine R Birchard, Kiran Reddy Busireddy, Richard C. Semelka
Pub by Wiley-Blackwell 2015, € 43.50

Critical Observations in Radiology for Medical Students is an ideal companion for medical students and clinicians, with a focus on medical learning and patient management to support clerkship rotations and internship training. This brand new title delivers comprehensive radiological illustrations of various pathologies on different modalities, guiding the reader through the processes of understanding different imaging techniques, requesting the most appropriate medical imaging modality and procedure in order to reach a clinical diagnosis. With a simple approach to a wide-range of organ-based important pathologies from an imaging point of view, this comprehensive illustrated volume uses a simple consistent categorization scheme. The book includes: • In-depth evaluations of the strengths and weaknesses for each modality. • Explanations of the basic physics of different imaging modalities. • An accessible overview of the current FDA and ACR guidelines for imaging safety, radiation risks, with special guidelines for imaging children and pregnant women. • An exploration of a wide-range of organ-based pathologies from an imaging point of view. The book is a timely, manageable and concise learning resource, with broad topic coverage and enhanced learning features to help students and clinicians answer the question, ‘which test should I order?’ and confidently diagnose and manage conditions.
What does surgery 2.0 look like? To Professor Florian Gebhard, Director of the Department of Orthopedic Traumatology, Hand, Plastic, and Reconstructive Surgery at the University Clinic of Ulm, Germany, it is about revolutionizing the operating room. With a special positioner-navigator combination, surgeries in a hybrid operating room can now be conducted in a more precise and less invasive way. This novel approach to surgery pays off as it saves time in the operating room and increases the success of operations. Minimizing the length and number of procedures required not only lowers costs and creates more value for money, but also increases patient satisfaction.

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University Clinic of Ulm

| Location: | Ulm, Germany |
| Innovator: | Professor Florian Gebhard |
| Specialty: | Orthopedic Traumatology, Hand, Plastic, and Reconstructive Surgery |
| Technology: | Artis zeego® positioner, Brainlab Curve™ Navigator, syngo® DynaCT |

The statements by Siemens’ customers described herein are based on results that were achieved in the customer’s unique setting. Since there is no “typical” hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption) there can be no guarantee that other customers will achieve the same results.
Handheld probe for ultrasound/photoacoustic dual modality imaging

In this article we present a recently developed portable imaging system designed for point of care diagnostics. The system provides two imaging modalities: the well known ultrasound technique which provides anatomical and structural information and the newly emerging technique called photoacoustics which provides vascular bed and functional information, all in a portable and cost-effective scanner. The system was recently described in full (Optics Express 2014 doi: 10.1364/oe.22.026365.)

INTRODUCTION

Over the last decade, photoacoustic (PA) imaging has become an important field of investigation triggering tremendous interest among biomedical researchers and clinical physicians.

Photoacoustic imaging is based on the photoacoustic effect, that is the generation of ultrasound waves by the means of light. A short pulse of light is absorbed by a tissue chromophore. The volume containing the chromophore (e.g. blood vessels) will experience an instantaneous increase in temperature and volume and will consequently build up pressure via the thermoelastic effect. This pressure will propagate through the tissue and can be detected by an ultrasound transducer array placed at the tissue surface. An image reconstruction algorithm can then be utilized to ascertain the location of the ultrasound sources allowing for three-dimensional visualization of chromophore distribution. Unlike other optical techniques such as Optical Coherence tomography, or Diffuse Optical Tomography, photoacoustics has the ability to probe optically diffuse media with high penetration depth and ultrasound sub-millimeter resolution. Photoacoustics is capable of imaging the blood vessel network with sub-millimeter resolution at a depth of several centimeters in tissue, without use of contrast agents, which is particularly important in revealing angiogenesis around tumors [1]. The use of multiple wavelength photoacoustics can further detect the presence of different tissue chromophores such as hemoglobin, lipid and melanin, thanks to their physiologically specific absorption signatures.

More importantly, with spectroscopic measurements, photoacoustics can quantify hemoglobin oxygen saturation within single vessels, providing metabolic information about the microcirculation. The potential of PA has been demonstrated in several applications ranging from macroscopic to microscopic scale [2] such as oncology [3], ophthalmology [4], dermatology and cardiology [5].

The recent interest on photoacoustics was materialized by the development of commercialized imaging systems by several spin-off and existing companies. However, unlike ultrasound (US), which of course is well established in clinical use and applications, photoacoustics still has some limitations such as lack of real time imaging, high cost and impracticability due to the imposing dimensions of the lasers used [6]. These constraints are limiting the widespread use of photoacoustics and prevent it from being a standard imaging modality for point of care and treatment monitoring.

PROJECT RATIONAL

Our work was motivated by the necessity to develop photoacoustic imaging systems that are compact, affordable and offering real-time imaging (translation of research into clinical practice). We have focused on these aspects with the objective of bringing photoacoustics into clinical practice. The project started as collaboration between our research group (BioMedical Photonic Imaging) led by Prof. Wiedelt Steenbergen and three European companies: ESAOTE, the manufacturer of ultrasound systems, Quantel Laser Diodes, a manufacturer of solid state lasers, and SILIOS Technologies, a manufacturer of optical equipment.

To overcome the limitations mentioned above we designed and developed a handheld probe integrating an ultrasound transducer array and pulsed diode laser that combines photoacoustics and ultrasound imaging modalities. The key innovation which allowed shrinking the size of the system is the use of a diode laser instead of solid stat lasers. We took advantage of the continuing development of efficient and cost-effective pulsed diode lasers and their use as a source for photoacoustics.
The imaging system is composed of a laptop sized ultrasound scanner with a 12” full touch-screen display developed by Esaote (MyLab One) and the hybrid probe attached to it. The probe integrates both ultrasound and laser modules in small and ergonomic design [Figure 1]. The scanner can be easily transported between rooms in clinical sitting.

The integration of both ultrasound/laser modules in small and ergonomic design involved the investigation of several aspects. These included the optimization of the beam illumination shape and ultrasound detection, generation of short high energy pulses with low heat dissipation, miniaturization of the diode driver, communication between the laser module and ultrasound acquisition system, and the suppression of electrical noise generated by the proximity of the diode driver and ultrasound detector. The emitting source consists of highly efficient diode arrays (Osram, Regensburg, Germany) mounted in a stack and emitting light at a wavelength of 805 nm. The total delivered energy is around 0.56 mJ per pulse. The diodes are driven by a customized laser driver (Brightloop, France), allowing a pulse width of 130 ns at half maximum and a maximum 10 kHz pulse repetition rate which allows high frame rate imaging.

The undesirable pronounced divergence of diode lasers was overcome by a meticulous optical beam shaping design composed of cylindrical micro-lenses and diffractive optical elements composed of 400 µm diffractive cells and 8 discrete phase levels placed in front of the diodes. The beam, is afterwards deflected by means of a glass prism illuminating the medium at an angle. At the front-end of the probe we obtain a homogenized beam of 20 mm by 2.5 mm. On the other hand, the scanner underwent substantial modifications to allow photoacoustic imaging. This was done first by providing an external signal to trigger the laser driver in order to synchronize between the detection and illumination, then by allowing the blocking of the US transmission during photoacoustic measurements to switch between ultrasound and photoacoustic imaging and finally by modifying the ultrasound beam-forming reconstruction allowing image reconstruction of both imaging modalities.

One of the important questions to investigate when developing a new imaging system is the resolution and imaging depth. The latter point depends mainly on the pulse energy and averaging. Unfortunately there are regulations in term of maximum permissible exposure which restrict the illumination features. It depends on the laser energy per pulse, the illumination area and laser pulse repetition frequency. This is one of the limitations when combining high laser pulse energy and high frequency repetition rate. Taking into account these limitations, we have investigated the imaging depth of our system in tissue mimicking phantom. The phantom used for these experiments consists of a bulk of Agarose gel with a mixture of Intralipid 20% and Ecoline black in water, leading to a tissue mimicking reduced scattering coefficient and absorption coefficient. Polyethylene tubing of 0.58 mm inner diameter was embedded at eight different depths. The measurement showed a possible imaging depth of 10 to 15 mm for a frame rate of 0.5 Hz. This depth reduces to 4 mm in real time imaging of 20 frames.
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per second. To achieve a high penetration depth and real time imaging a measurement strategy can be used by firing the laser at high repetition rate during short time lapse. We also investigated the system resolution in different axes in a phantom study. The results showed a lateral resolution of 0.4 mm which degrades to 0.6 mm with depth and the position off axis due to limited numerical aperture of the ultrasonic transducer, whereas the axial resolution was around 0.28 mm with negligible variation.

The in vivo testing of the combined ultrasound and photoacoustic imaging system was performed on proximal interphalangeal (PIP) finger joints of a healthy volunteer. Figure 2 shows the combined PA/US images of the sagittal and transverse plane of the PIP joint. The transverse slice is located near the joint gap. The image shows a detailed absorption distribution alongside the anatomical structure of the finger joint. Several blood vessels can be seen lying under the skin running parallel to the finger which are difficult to pinpoint in ultrasound images.

The encouraging results obtained with the new portable system and the potential of PA technique to become essential in medical diagnosis and therapy monitoring has encouraged the team to take part in a European consortium composed of several industrial and academic partners to take the next steps. The project which is named FullPhase, standing for “Fully integrated real time multi-wavelength photoacoustics for early disease detection”, (http://www.fullphase-fp7.eu/) is aiming to upgrade the system to several wavelengths with the increase in blood flow during the inflammation, Oncology, cardiovascular disease and burn wounds are other areas where the approach is being investigated.

**FUTURE OUTLOOK**

Photoacoustics is emerging as an essential tool in both biology and medicine at multiscale imaging. PA is expected to find broad applications in medicine. Some of them are in advanced stage of research such as breast imaging [7], melanoma detection, endoscopic imaging and intravascular catheter imaging. The number of research groups and published articles reflects its rapid development. The size and cost of the available systems are yet factors hindering the wide spread clinical use of photoacoustics, however with the new imaging system we hope to overcome these limitations.

The team has received funding from several European and national funding bodies to support the development of the new system. The project which is named FullPhase, standing for “Fully integrated real time multi-wavelength photoacoustics for early disease detection”, (http://www.fullphase-fp7.eu/) is aiming to upgrade the system to several wavelengths with higher pulse energy to allow photoacoustic multi wavelength functional imaging.

**REFERENCES**


Retrospective spectral analysis: workflow considerations and dose management

CT has become an essential diagnostic tool worldwide, with many millions of CT scans being performed annually. While advances in multi-energy CT promise sophisticated analysis techniques enabling clinicians to quickly reach reliable diagnoses, certain trade-offs remain with regard to special modes, image quality and dose penalties*, resulting in the need for upfront decision-making. Until now, these compromises have inhibited the realization of the full clinical potential of spectral imaging.

Philips IQon Spectral CT ** features iconic color quantification and heralds a new era in CT technology. Not merely a modification of an existing CT system, IQon Spectral CT is the first and only spectral detector CT system built from the ground up. As such it provides advantages in color quantification, workflow, and dose management.

** HOW DOES IT WORK? **

Traditional grayscale Hounsfield CT images are limited by their inability to discern contrast agents and to discriminate between body materials. Color quantification adds spectral resolution to image quality, delivering not just anatomical information but also the ability to identify and characterize structures based on material content. Just as white light consists of an entire spectrum of colors, so also the X-ray photon beam produced by CT scanners consists of a spectrum of photons with a range of X-ray energies from low to high. The Philips IQon spectral detector has the ability to simultaneously distinguish between such X-ray photons of high and low energies. This spectral analysis allows the discrimination of materials such as iodine or calcium characterized by specific atomic numbers. Various elements are assigned individual colors, allowing them to be visually distinguished on CT scans.

** WORKFLOW CONSIDERATIONS **

With IQon, prospective and retrospective spectral results are acquired within a single scan without the need for special modes. Because the acquisition of spectral data is dependent on the detector rather than the X-ray tube, there is no need to decide in advance of the scan whether or not to use a spectral protocol. This means the user can adhere to tried-and-trusted established workflows. The patient is scanned as usual and a conventional anatomical image can be generated and interpreted. Should the clinician decide that spectral information would be of additional value in a particular region of interest, the spectral information acquired during the single spectral scan can be easily accessed for retrospective, on-demand spectral data analysis.

** Retrospective spectral reconstruction **

Using the Philips IQon Spectral CT, the personalized quantitation of spectral CT data can be seamlessly integrated into established scanning and reading workflows. Because there is no pre-scan determination of use, if any incidental abnormalities are encountered there is no need to call the patient back for additional imaging. On-demand spectral analysis of a Region of Interest allows the physician to further interrogate incidental findings.

** The value of retrospective interrogation of incidental findings **

A recent study evaluated the clinical impact of retrospective spectral analysis in establishing a diagnosis [1]. Forty-three patients were included in the study and were scanned using a Philips spectral CT prototype. In 11 patients, retrospective reconstruction was used to improve visualization of unexpected incidental findings. Additionally, spectral CT data helped to achieve a diagnosis for 19 patients (44%). In eight of the patients, clinical history suggested that spectral data would be useful prior to scanning. The authors of the study concluded that the option to use retrospective spectral reconstruction may offer a clinical advantage in patients for whom spectral imaging is not indicated based upon clinical history.

* Dose penalties are defined as taking on additional radiation dose relative to a best care baseline.
** IQon Spectral CT is not yet CE Marked. Not available for sales in all regions.
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Enhanced spectral visualization

After reviewing a conventional grayscale CT image, what happens if the clinician decides that spectral information would be of additional value in a particular Region of Interest? Spectral data acquired during a single scan can easily be accessed from the PACS for retrospective, on-demand, spectral data analysis.

Spectral Magic Glass

This tool is superimposed on the conventional CT image to provide a color view of an area of special interest. Materials such as iodine, calcium, water, or fat can then be visually distinguished.

DICOM 3.0 compliance

Data generated during scanning with the IQon Spectral CT is fully DICOM 3.0-compliant and images can be sent to the PACS for archival for retrospective spectral reconstruction and evaluation. DICOM 3.0 compliance provides lossless image compression/decompression during storage and retrieval, as well as compatibility with other DICOM 3.0-compliant equipment such as workstations and printers. The XPI-format images impose a minimal burden on image storage capacity.

DOSE CONSIDERATIONS, IMAGE QUALITY AND PATIENT-CENTERED CT

Effect of IMR on dose and image quality

For conventional scans, Iterative Model Reconstruction (IMR) can generate images that are virtually noise-free. Besides improving on the quality of conventional imaging, studies using phantoms suggest that IMR may reduce patient dose by 60–80% depending on the clinical task, patient size, anatomical location, and clinical practice*. Phantom studies suggest that Philips iDose improves spatial resolution and/or noise reduction at low dose.

DoseWise strategies offer tools

Philips IQon Spectral CT adheres to the Philips DoseWise approach to dose management, which is an array of techniques and programs based on the ALARA (As Low As Reasonably Achievable) principle. During scanning, tube current modulation is used to change the X-ray dose from location to location, attenuating the dose by body region.

Image quality for each diagnostic task is specified by the DoseRight Index (DRI) for various scanning regions, to allow for the appropriate dose and image quality within a single acquisition. Among the features are:
- Personalized doses for individual patients are suggested by the DoseRight automatic current selection.
- Longitudinal dose modulation is achieved using the DoseRight Z-DOM, which adjusts the tube current-time product (mAs) in the z-axis according to a patient’s size and shape.
- DoseRight 3D-DOM (three-dimensional dose modulation) combines angular and longitudinal patient information to modulate dose in three dimensions (x-y-z-axis). It incorporates modulation of tube current-time product (mAs) according to changes in individual patient’s size and shape in the transverse (x-y-axis; angular) direction during helical scans, in addition to changes in the craniocaudal or caudocranial (z-axis; longitudinal) direction, as the tube rotates.
- Dedicated pediatric protocols offer high-quality conventional images at low doses taking into account the pediatric patient’s size and clinical indication.

Through the detector-based approach of the IQon Spectral CT, the user has full access to all the dose management tools in spectral scanning normally available in conventional scanning mode. This means that valuable tools such as dose modulation are not discarded in order to perform spectral exams.

Patient-centered CT imaging

- iPatient is an advanced platform that facilitates the patient-centered approach to CT imaging and has the flexibility to support future innovations. It includes methods to adapt scan protocols and techniques such as dose modulation and iterative reconstruction for individual patients and diagnostic tasks. Using patient-specific methods, iPatient facilitates optimal management of image quality and radiation dose.
- ExamCards for the Philips IQon Spectral CT are individualized protocols, fully equipped with spectral capabilities, that allow planning to be based on the desired result, rather than just the scan. For each ExamCard, in addition to results such as axial, coronal, sagittal, MPRs, and MIPs, spectral results for the specific clinical question can be added. ExamCards can be designed for each clinical question. Results are automatically reconstructed and can be sent for viewing without any additional work from the operator. Protocols can be shared, allowing scan-to-scan consistency.
- Scan Ruler provides the operator with a clear interactive timeline of events during the study, such as acquisition, bolus tracking, and injection.
- DoseRight Index (DRI) is an image-quality reference parameter, designed to simplify adjustments to specify the required image quality for a particular diagnostic task. Increasing DRI decreases image noise and increases volume CTDI while decreasing DRI increases image noise and decreases volume CTDI. So, for example, DRI allows a controlled increase in suggested noise levels for larger or obese patients and a decrease in noise for smaller adults. Decreasing DRI (increasing) by -1 (+1) decreases (increases) the average tube current by 12% while increasing (decreasing) the image noise by 6%, if other settings remain unchanged. DRI is a convenient tool to manage low-dose (ALARA) scans. After the appropriate number of cycles and due consideration of the results, adjustments to the DRI and iterative reconstruction technique settings can be incorporated into the Exam Card to manage individual patient examinations.

REFERENCE


* In clinical practice, the use of IMR may reduce CT patient dose depending on the clinical task, patient size, anatomical location, and clinical practice. A consultation with a radiologist and a physicist should be made to determine the appropriate dose to obtain diagnostic image quality for the particular clinical task. Lower image noise, improved spatial resolution, improved 3D contrast detectability, and/or dose reduction were tested using reference body protocols. All metrics were tested on phantoms. Dose reduction assessments were performed using 0.8 mm slices and tested on the NTRA CT iO Phantom (ICT2013, The Phantom Laboratory), using human observers. Data on file.

** “Optimal” refers to the use of strategies and techniques that facilitate the management and control of both image quality and dose.
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Thursday, March 5
12:30-13:30
Room E1 (level 0)

Bracco Satellite Symposium
Evolving Needs in CT Imaging: a Patient-Centered Approach

Moderator: Lorenzo Bonomo, Rome, Italy

- Advanced CT Technology: How to Minimize Patient Dose
  Mathias Meyer, Mannheim, Germany
- Standardization of Scanning Protocols and Patient Diversity: Oil and Water?
  Mathias Prokop, Nijmegen, Netherlands
- Tailoring CT Scans to Individual Patients: Design and Validation
  Angelo Vanzulli, Milan, Italy

A light lunch will be offered

Friday, March 6
12:30-13:30
Room E1 (level 0)

Bracco Satellite Symposium
Imaging in Oncology: What can MRI do Today and Tomorrow?

Moderator: Luis Marti-Bonmati, Valencia, Spain

- Diagnosis and Early Detection of Pancreatic Cancer: Current and Future Perspectives
  Riccardo Manfredi, Verona, Italy
- MRI in Prostate Cancer Management: an Evolving Role
  Aytekin Oto, Chicago, USA
- Breast Cancer Screening: Who, When and How
  Christiane Kuhl, Aachen, Germany

A light lunch will be offered

Saturday, March 7
12:30-13:30
Room M (level 1)

Bracco Satellite Symposium
Contrast-Enhanced Ultrasound in the Imaging of Patients at Risk of Developing Malignant Lesions

Moderator: Christian Stroszczynski, Regensburg, Germany

- The Role of CEUS in the Detection and Diagnosis of Liver Metastases
  Marie Beermann, Stockholm, Sweden
- Surveillance of Patients with Liver Cirrhosis: is there still a Role for CEUS?
  Vito Cantisani, Rome, Italy
- Quantification on DCEUS: New Trends and Developments
  François Tranquart, Geneva, Switzerland

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Radiation dose and acquisition times in TAVI planning examinations using a new generation 512-slice CT compared to standard-of-care 128-slice CT

Transcatheter Aortic Valve Implantation (TAVI) is a promising new technique in the treatment of aortic stenosis and has the potential to supersede conventional surgical replacement procedures [1]. To be successful, TAVI requires many detailed measurements to be made prior to surgery. Such measurements include the valve plane diameter, the diameter of both the ascending and descending aorta, the diameters of valve sinuses and the distance from the valve plane to the coronary ostia. These measurements can be determined using CT imaging [2, 3]. This article describes a study of image quality, radiation doses and acquisition times in such TAVI planning examinations using an innovative acquisition mode on a new 512-slice CT machine compared to standard 128-slice CT system.

This retrospective study involved 54 patients, of whom 33 (group A) were scanned using standard-of-care 128-slice CT with prospective or retrospective gating mode. The other 21 patients (group B) were scanned on a new generation 512-slice CT system (Revolution CT from GE Healthcare) using a novel technique combining 2 wide gated axial volumes for the thoracic aorta and helical non-gated mode for the aorta through to the iliac arteries [Figure 1].

All data (measurements of ascending & descending aorta, coronary arteries and ostia, and also valve measurements) were obtained with one injection and one acquisition. Image quality, dose and acquisition time were evaluated in groups A and B and compared.

RESULTS

The mean body mass indices (BMI) for patients in groups A and B were 28±7 and 27±5 respectively. Mean Dose Length Products (DLP) were 3355±1112 and 589±144 mGy.cm respectively while mean coverage was 691±45 and 729±199 cm respectively. The mean acquisition time was 28±3 and 6.6±0.5 seconds for group A and B respectively.

Radiation dose was reduced by 82% in group B compared to the standard-of-care, group A, even with longer coverage, while acquisition time in group B was four times less than in group A. Image quality was diagnostic standard for all examinations. Thanks to the 0.28s rotation speed and the 160mm detector, for patients in group B the whole heart image was acquired in a single beat and the coronaries were motion-free. Furthermore, patients in group B presented a higher level of contrast in iliac arteries. Figure 2 shows typical images acquired via the new CT scan system.

CONCLUSION

The acquisition of TAVI data requires ECG synchronization to visualize coronaries and the ascending aorta. Given the coverage needed, this either requires long breath-hold times or two injections.

With the new technique high quality exams could be achieved four times faster, with 82% lower dose and in one injection, thus making it suitable also for the investigation of aortic dissections.

REFERENCES


The authors will be presenting a fuller version of this work at the upcoming ECR congress March 5th - 8th.
Changes in Siemens Healthcare

Early February, Siemens announced major restructuring plans involving cutting 7800 jobs (about 2% of the total workforce) across all divisions of the conglomerate which is involved in engineering fields as varied as offshore wind turbine construction, turbines for power generation, power transmission solutions and automation, drive and software solutions for industry.

Of course the company—which is Europe’s largest engineering company—is also a leading provider of medical imaging equipment and a leader in laboratory diagnostics as well as clinical IT. Up until relatively recently, the financial results of the healthcare division—which was once a prized asset of the group—were so positive that they offset revenue declines in other divisions. Now, although the revenues of the healthcare divisions are growing annually, profitability is decreasing. Last year Siemens announced that the healthcare unit would operate as a stand-alone entity and decided to divest the company’s hospital information systems and microbiology businesses.

Now the company has decided to change the top healthcare management.

Hermann Requardt is stepping down from the Managing Board and from his position as Healthcare CEO—a position he has occupied for nearly nine years—by mutual consent to enable a generation change at the launch of the new Healthcare company. Siemens’ CEO Joe Kaeser said “Mr. Requardt and the managers and employees of Healthcare can be quite proud of their highly successful work together over the past years. We are now setting up Healthcare as a separately managed business within Siemens in order to pave the way for an equally successful future in a highly dynamic market and innovation-driven environment”.

Bernd Monntag, previously head of the Imaging and Therapy business has been appointed CEO of Siemens Healthcare.

Carestream celebrates shipping 15,000th CR System

Continuous innovation in CR technology has enabled thousands of facilities across the globe to convert to high-quality digital imaging with Carestream Vita CR and Point-of-Care systems. The company has just announced that it has shipped its 15,000th Vita CR System and has installed almost 30,000 tabletop CR systems since the company’s first Point-of-Care system became available. These easy-to-use and highly reliable tabletop systems make it possible for small to mid-size hospitals, clinics and practices to achieve the convenience and flexibility of excellent quality digital images at an affordable price. Carestream’s Vita CR systems perform general radiology and long-length exams and are also suitable for military, mobile, veterinary and other diverse imaging environments. Carestream’s Vita CR family includes the Vita, Vita LE, and Vita XE CR Systems. Throughput ranges from 30 to 69 plates per hour for 14 x 17 inch cassettes.

“Our portfolio of CR systems enables imaging services providers to expand their workflow and capabilities by migrating from film to CR systems and then to our family of DR systems that produce digital images in seconds,” said Heidi McIntosh, Carestream’s Marketing Manager for Global X-ray Solutions. “We have designed our imaging solutions with a modular approach that is right for today and ready for tomorrow.”

Carestream’s Image Suite software allows patients to be registered on-site or remotely using a Web-based interface, and each X-ray system’s touch screen allows users to quickly and easily select desired body parts and views to speed the imaging process. Technique information can be acquired automatically, eliminating the need for manual entry and the possibility of inconsistent X-ray exposures among different users.

Carestream software also allows images to be enhanced using slide bars on the screen to adjust brightness, contrast or detail. Specialised measurement tools provide diagnostic information for chiropractic, orthopedic or mammography imaging. Imaging providers can use automatic or manual stitching to paste individual images together to create the long-length view that is desired. Radiology reports can be generated on multiple workstations throughout a facility and optional software allows facilities to manage and view images from CT, MR and ultrasound imaging.

Carestream Rochester, NY, USA
www.carestream.com
Saudi Arabian Military Hospital invests in new diagnostic displays

The prestigious Saudi Arabian Al-Hada Military Hospital has recently installed Barco’s Coronis Fusion 6MP diagnostic display system, together with its online MediCal QAWeb management service. Al-Hada Hospital is part of the larger Al-Hada Hospital Rehabilitation Center, which comprises four medical care facilities located in and around the city of Taif, Saudi Arabia. Administered by the Medical Services Department (MSD) of the Saudi Arabian Ministry of Defense and Aviation (MODA), all four hospitals and clinics serve uniformed military personnel, their dependents and other entitled staff. As every hospital and clinic sets great store to providing the highest quality of healthcare services, they invest in the best physicians as well as the best medical equipment and technology on board. As a long-term Barco customer, the hospital has been using Barco’s Nio 2MP and 5MP display systems since 2006, throughout their imaging department. The addition of the Coronis Fusion 6MP display systems helps the radiology team to make confident and faster diagnoses.

The Nio 2MP and Nio 5MP diagnostic grayscale display systems were used to read CT, MR, and X-ray images. Now the imaging department has decided to order nine Coronis Fusion 6MP wide-screen color display systems. Dr. Attar Abdullah Head of Radiology Department said: “The Coronis Fusion display system addresses both our grayscale and color imaging needs. It allows our radiologists to read CT, MR, cath and echo cardiogram images, or any other combination, side by side on one single diagnostic screen, raising the accuracy of our diagnoses as well as our productivity.”

Fujifilm enters the PET radiopharmaceutical market

FUJIFILM has announced that it is entering the market for PET radiopharmaceuticals, used in the functional diagnosis of various diseases including brain / heart diseases and tumors. The company will invest around 6 billion yen (approx. 45 million euros) to establish R&D sites in the Saito Western area (Ibaraki City, Osaka, Japan) and Tonomachi area (Kawasaki City, Kanagawa, Japan) precincts, designated as a part of Japan’s Comprehensive Special Zones for International Competitiveness.

PET involves administering a radiopharmaceutical, i.e. a compound marker labeled with a nuclide such as $^{18}$F (fluoride), to a patient receiving a CT examination, and is useful in functional diagnosis of various diseases. It has a higher sensitivity and spatial resolution than conventional nuclear medicine examinations and provides functional images suitable for diagnostic purposes, thereby serving a major role in the diagnosis and prognosis of patients as well as determining treatment policies.

In the field of brain disease, the aging of society has led to an increase in people suffering from Alzheimer’s disease. One of the suspected causes of Alzheimer’s disease is the abnormal build-up in the brain of protein called amyloid-beta, with studies finding that this protein build-up starts 15-20 years before the manifestation of dementia symptoms. There are high expectations for the use of PET radiopharmaceuticals to detect amyloid-beta, as an effective approach to improving diagnostic accuracy for Alzheimer’s disease. Through its wholly owned subsidiary, FUJIFILM RI Pharma, Fujifilm has already been active in the radiopharmaceutical field of SPECT. The company now plans to expand its business into the PET field with R&D on a pharmaceutical agent that targets amyloid-beta.

Last year FUJIFILM RI Pharma signed an agreement with Eli Lilly for a joint development of Lilly’s PET radiopharmaceutical “florbetapir ($^{18}$F) injection” in Japan for which Eli Lilly has obtained approval for the world’s first radiopharmaceutical that visualizes amyloid-beta plaque in the brain. Already approved in the United States, E.U. countries and Switzerland, the drug is used on suspected Alzheimer’s patients with cognitive impairment to help in diagnostic assessment.

Unfors RaySafe signs agreement with Philips on Dose Management Solution

At the end of last year, Unfors RaySafe, which was acquired by Fluke Biomedical earlier in 2014, announced that it has signed an exclusive agreement with Philips to license out its Patient Dose Management System, RaySafe S1. This is a cloud-based patient dose tracking system that helps healthcare institutions lower patient dose, improve process quality and increase productivity in imaging workflow while reducing costs. In an effort to accelerate market reach and better support healthcare institutions to avoid unnecessary radiation RaySafe has searched for a strong partner. Philips is launching ground-breaking initiatives to provide solutions that
lower dose and create a safer environment for patients as well as medical staff. Each year approximately 3.6 billion x-ray examinations are carried out worldwide, leading to earlier and more accurate diagnosis of medical diseases. However, considerable concern has been raised on the impact of radiation on both patients and medical staff. It is important to ensure the proper performance of x-ray equipment and of keeping the dose to medical staff and patients as low as reasonably achievable.

"We are committed to providing innovative products and offerings to help avoid unnecessary risks. Moreover, we believe that only a holistic approach to radiation safety can effectively reduce unnecessary radiation exposure to patients and medical staff. As a consequence of this agreement Unfors RaySafe will discontinue marketing and selling the RaySafe S1 solution," says Magnus Kristoferson, CEO of Unfors RaySafe. "We will continue to develop innovative and ease-of-use solutions to provide a safer healthcare and within Radiology, specifically strengthen our focus on quality assurance solutions and real time dosimetry."

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**French cancer centre orders Proton Therapy system and plans to collaborate on carbon therapy system**

The Belgian-based company Ion Beam Applications, (IBA) a leading provider of proton therapy solutions for the treatment of cancer, announced end of 2014 that it has signed a contract with the French consortium CYCLHAD (a CYCLOtron for HADron Therapy) for the installation of its single-room proton therapy system Proteus ONE in Caen, France. The contract includes the delivery of the Proteus ONE equipment as well as a 15 year maintenance agreement, which together will have a value of between EUR 43 and 48 million. The delivery of the equipment is expected to take place in 2017.

The contract represents the seventh installation of a ProteusONE. The Proteus ONE system has been developed by IBA to allow more patients globally to access proton therapy. Proteus ONE is a smaller, less expensive and faster to install solution, encompassing the latest in proton therapy technologies, including Pencil Beam Scanning.

In a second phase of the development of the center, IBA will collaborate with several French industrial partners and semi-public institutions, to develop the potential of carbon beam therapy. Within this collaboration, IBA will provide support and expertise for the development of a prototype carbon therapy system based on an advanced 400 MeV superconducting isochronous cyclotron able to accelerate carbon ions used in hadron therapy. Carbon ions have the same physical characteristics as protons, but also have the advantage of being particularly effective compared to other radiotherapy techniques for the treatment of radiation-resistant tumors.

Olivier Legrain, Chief Executive Officer of IBA commented: "This contract reinforces the success of IBAs new compact proton therapy solution, Proteus ONE, which is simpler to install, operate, and finance. In addition, IBA is pleased to be collaborating with industrial partners and semi-public institutions in the French area of Basse-Normandie with the objective of improving treatment techniques that have the potential to improve patient health."

Daniel Guerreau, President of CYCLHAD, said: "We are pleased to collaborate with IBA, the global leader in proton therapy who have the most experienced and talented team to develop the future of this unique technology. The signing of this contract with IBA also enables CYCLHAD to create in Caen a research center dedicated to hadron therapy and related technologies. Thanks to the Basse-Normandie region, this proton therapy center will be the third in France. Today, only 1% of cancer patients treated by radiotherapy benefit from this unique technology. The need for proton therapy is largely superior, particularly to treat cancers for which it is important to preserve the healthy surrounding tissues and organs. These indications include eye, brain, spinal cord and pediatric cancers. We are very pleased to collaborate with IBA and industrial partners to develop a carbon ion accelerator that CYCLHAD wants to install during the second phase of the development of the center."

**IBA**
**LOUVAIN-LA-NEUVE, BELGIUM**

www.iba-worldwide.com

**Selctra’s cloud-based VNA solution chosen to handle all radiology images in Sweden’s capital region**

End of January 2015, Stockholm County Council (SLL) in Sweden announced that it has ordered Sectra’s cloud-based IT service for the handling of all radiology information. SLL is responsible for the care of the approximately 2 million people living in the region. This service will make it easier for healthcare providers to collaborate on patient care and for patients to change or use multiple healthcare providers. Another result is that the patient will receive lower radiation doses since fewer new examinations will be required, Increased patient integrity and improved information security are some of the positive effects that can be achieved by making radiology information available in a shared location. When changing healthcare providers, patients will only need to give their consent for the new provider to access information from earlier radiology examinations. For healthcare providers, the new service from Sectra will entail more efficient work processes since the time-consuming task of finding and sending radiology images will be eliminated.

**SECTRA**
**LINKÖPING, SWEDEN.**

www.sectra.se
UK hospital upgrades existing X-ray rooms

The Yeovil District Hospital, part of the Yeovil Hospital NHS Foundation Trust in the UK, has upgraded two existing X-ray rooms having opted for Agfa’s DX-D 30C direct radiography (DR) Retrofit solution. Implemented as part of Agfa’s “Fast Forward to Digital Program”, the solution has improved imaging speed. The 345-bed Yeovil District Hospital provides a full range of clinical services, including general medicine, cardiology, general surgery, orthopedic surgery, trauma and pediatrics. Serving South Somerset, North and West Dorset and parts of Mendip each year, it handles around 20,000 emergency admissions, 3,500 elective admissions and 18,000 day cases. The Fast Forward program gives healthcare facilities a path to DR, which offers a host of benefits including improved workflow and reduced examination time, immediate verification of patient positioning and image quality, improved accuracy of patient identification and the potential for dose reduction with cesium iodide (CsI) detectors. “We strive to keep patient waiting times throughout the hospital as low as possible, by meeting and exceeding the standards demanded of us through national targets,” says Fiona Rooke, Radiology Manager of Yeovil District Hospital. “Upgrading our existing X-ray rooms to DR supports us in achieving our goals. We chose the DX-D 30C DR Retrofit because it offered us the ease of use, image quality and potential for patient dose reduction we were looking for.”

“We are very pleased to have this opportunity to support Yeovil District Hospital to continue to provide top-quality healthcare to its patients, with a solution that allows it to maximize the investment already made in its existing X-ray rooms,” said Grant Witheridge, General Manager of Agfa HealthCare UK.. “The goal of our Fast Forward to Digital Program is to make it possible for every hospital – whatever size or budget – to achieve the advantages of DR, in order to provide the best possible care and service to patients.”

AGFA HEALTHCARE
MORTSEL, BELGIUM
www.agfa.com

Elekta plans to introduce MRI-guided radiation therapy system in 2017

Elekta, the Swedish company that develops sophisticated state-of-the-art tools and treatment planning systems for radiation therapy, radiosurgery and brachytherapy, has announced that it plans to introduce the first generation high field MRI-guided radiation therapy system in 2017. The company has been collaborating with several years with Philips and the University Medical Center (UMC) Utrecht in The Netherlands and has already installed the initial components of the world’s first high-field magnetic resonance imaging (MRI) guided radiation therapy system at UMC Utrecht. At the heart of the system is the integration of an advanced Philips 1.5 Tesla MRI system with an Elekta radiation therapy system, enabling simultaneous imaging during beam delivery. This should allow clinicians to adapt radiation therapy during the procedure, increasing treatment accuracy, potentially reducing side effects and enabling increases in the therapeutic dose. This marks a significant milestone toward the development of a clinical system capable of capturing highly detailed MR images of tumors and surrounding normal tissues as a patient receives radiotherapy. Development of the high-field MRI-guided linear accelerator (linac) is the mission of the MR Linac Research Consortium headed by Elekta and supported by Philips. Niklas Savander, President and CEO of Elekta said “We are pleased with the progress we are making, closely cooperating with our clinical partners in the Atlantic consortium and our MRI technology partner Philips. We are creating a new paradigm within the field of radiation therapy and a superior approach to treating cancer. Consequently, I expect Atlantic will positively impact the treatment patients receive, the cancer centers that deliver it and the market potential for radiation therapy.”

The first commercial orders are planned to be taken in 2017 with deliveries in 2018, subject to the applicable regulatory clearances. Elekta estimates there will be 75 orders and deliveries during the ramp-up phase until 2019. This number includes the systems for the members of the consortium.

Savander anticipates that high field MRI-guided radiation therapy will be standard of care within the next 10 years. He also indicated that the price of an MRI-guided radiation therapy system will be about four times the price of Elekta’s current high-end treatment machine, Versa HD.

ELEKTA ,
STOCKHOLM, SWEDEN
www.elekta.com

Konica Minolta to distribute SuperSonic’s ultrasound systems in Japan

The French company SuperSonic Imagine has just signed an exclusive partnership with Konica Minolta, Inc. to distribute its ultrasound system, the Aixplorer, in Japan. This partnership significantly increases SuperSonic Imagine’s geographical coverage. Japan is the third largest ultrasound market in the world and

Left to right: Penny Parcel, Superintendent Radiographer, Yeovil District Hospital; Ges Shilvock Agfa; & Angela Todd, Senior Radiographer Yeovil District Hospital
is a key part of the company’s global expansion strategy. “The Aixplorer surpasses the limits of traditional ultrasound,” said Keijiro Asayama, General Manager, Ultrasound Business Unit from Konica Minolta. “Its pioneering technology is in alignment with Konica’s mission to provide innovative, high quality products to our customers.” SuperSonic Imagine’s Aixplorer is unique with its UltraFast software platform which can acquire images 200 times faster than conventional ultrasound systems. The speed of the UltraFast platform enables SuperSonic Imagine’s Aixplorer to assess and quantify tissue stiffness in real time which can help to identify potentially malignant or other diseased tissue. “SuperSonic Imagine is very proud to be working with Konica Minolta, a prestigious company and ideal partner for expanding the use of our ultrasound technology in Japan,” said Jacques Souquet, Founder and CEO of SuperSonic Imagine, “Our technology provides detailed, real-time information important to the Japanese general imaging marketplace and can be used in a broad range of applications such as breast, thyroid, liver and musculoskeletal exams.”

**Hologic’s revenues up**

Hologic has announced that it expects total revenues for first fiscal quarter of 2015 to reach approximately USD 653 million—7% more than the year before. The estimated revenue increase is shared among all Hologic business segments including diagnostics, $304 million (an increase of 6.4%), breast health $ 242 million (an increase of 6.9%). This latter was primarily driven by a 10.9% increase in breast imaging and service revenue, as customers continued to adopt Hologic 3D mammography, while interventional breast revenue declined 2.3%. Other business segments are surgical gynecology $ 84 million (up 7%), and skeletal health $ 22 million (up 4.54%).

**Zonare gets clearance for ultrasound system in Canada**

ZONARE announced that its Z.One PRO ultrasound system has received clearance from Health Canada, the healthcare regulatory body for that country. The system is designed to provide an economical, high performance imaging system for a wide variety of applications. The clearance of the Z.One PRO enables access to the system by clinicians and patients across Canada. “The most recent addition to our product line will provide very high image quality without the price tag normally associated with such quality,” said Vince Arsenault, managing director of ZONARE Canada. “Like our other products, the Z.One PRO is based on proprietary ZONE Sonography Technology (ZST) which allows us to continue to upgrade the system now and in the future.” ZST brings cutting-edge ultrasound technology to clinical environments, providing unique continuous transmit focus. Unlike conventional beamformer, line-by-line imaging, ZST uses software-driven, large zone acquisitions, rendering an entirely new and different approach to ultrasound data acquisition and image formation. The result is more imaging detail with consistent, superb resolution and uniform imaging at depth from the smallest to the largest of patients throughout the field of view. ZST is also a “Living Technology” enabling constant upgrades to the platform.
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Please visit our booth at ECR, 5 - 8 March, Extension Expo A, Booth #3

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Translating Advanced Imaging and Quantitative Imaging Biomarkers from Clinical Research into Clinical Practice

Medical imaging impacts on virtually every aspect of clinical practice and is one of the key elements in diagnosis, monitoring, and in many cases image guided therapy. Rapid development in clinical research is producing a continuous stream of new knowledge of disease processes, new therapeutic targets and the complex relationship between an individual's symptoms and the actual disease state. There is often however a disconnect between use of medical imaging in clinical practice and clinical research. The former requires rapid error-free reading using the quickly acquired imaging data, normally showing structural damage. In clinical research, thorough analysis of images, often guided by computer-aided tools allows in-depth understanding of the disease, with prime focus on detecting pre-structural changes.

One of the examples of differences between imaging in routine clinical practice and in clinical research would be inflammatory joint diseases, such as rheumatoid arthritis or psoriatic arthritis. In clinical practice, there is still a preference for a quick X-ray scan which will show presence or absence of an erosion. Over the last decade, clinical research was focused on understanding pre-erosive changes, which would be assessed by measuring inflammatory activity. Thus, while the newly developed treatments aim to reduce the inflammation and therefore to prevent erosions, the clinical assessment of the effect of such treatments will typically be measured using X-rays, which lack the ability to visualize or measure inflammatory changes at early stages. Consequently if a clinician does not possess sufficient information about the effect of the treatment, a number of patients will be exposed to a potentially ineffective treatment. Should then advanced imaging be utilized in clinical practice for the sake of safety as well as efficacy of treatments?

The appropriate selection of imaging and corresponding outcome measures in cancer research has been widely debated. Many believe that the imaging modality should be chosen in a manner that maximizes the usefulness and meaning of the clinical trial in terms of addressing the burden of disease. The economic desire for quicker answers and less costly imaging often utilized in clinical practice may not deliver valid and reliable measures of effectiveness and safety.

From the regulatory point of view, the success of a clinical trial should be based on patient related outcomes. While there is no doubt that it is important to show that at the later stages of rheumatic disease, a patient does not develop more erosions or in the case of cancer, patient survival rate is sufficient to approve a new treatment. However, how can we make the decision on effectiveness of treatment early enough to give a patient the best chance of pain-free life and progression-free survival. The answer is of course in finding the right tools and ways of assessment for early disease detection and early prognosis.

While the selection of cheaper imaging methods and the use of less definitive endpoints may allow for less expensive trials and easier measurements, they may not yield useful information about the treatment effect. Ultimately they will require more time, more money, and more patient participation. Such a waste of resources can be avoided by selecting, at the outset of testing, outcomes that provide the clearest indications of the
true efficacy and harms of the intervention being examined.

Furthermore, the success of treatment as measured by various regulatory agencies is often based on clinical outcomes. It is of course critical to ensure patient wellbeing, equally it is critical to measure early efficacy of treatment. There are no data available on how many patients are being exposed to ineffective treatments because advanced imaging is not widely used in determining the earliest efficacy of treatment.

It is critical that clinicians as well as radiologists have the knowledge of the appropriateness and limitations of the various imaging techniques irrespective of which field they ultimately wish to specialize in.

In particular, clinicians should be comfortable with the knowledge when to request novel functional imaging techniques, which can help quantify real-time physiologic and metabolic processes at the cellular or molecular level, supply valuable information to assess the stage of the disease, select and monitor treatment, gauge prognosis, and measure outcomes. In clinical research advanced quantitative imaging endpoints have long become the primary biomarkers for all phases of new drug discovery. The challenge is to translate this knowledge back into clinical practice.

**DYNAMIC CONTRAST ENHANCED MRI**

A truly translational imaging modality, which allows to connect quantitative clinical research and early disease assessment in clinical practice is Dynamic Contrast Enhanced (DCE)-MRI. DCE-MRI is well known as a clinical instrument for staging and monitoring different malignant tumors (1,2,3) and can also be applied within the field of musculoskeletal diseases for diagnosing and monitoring inflammatory disease activity (4).

DCE-MRI is based on sequential acquisition of T1-weighted MRI sequences prior to, during and after an injection of a contrast agent. Following the intravenous injection of the contrast agent, which is preferentially taken up at sites with high perfusion, a temporal variation of the MRI signal intensity occurs. The signal intensity corresponds to the underlying changes in tissue concentration of contrast agent. Signal intensity versus time curves (ITC) with rapid and extensive enhancement and washout is therefore typical for tissues with high perfusion such as inflamed tissues. In this way the distribution of the...
contrast medium can be used to differentiate between healthy tissues and tissues with hyperperfusion.

In clinical oncology trials, the ability of DCE-MRI to assess blood flow in terms of degree and rate of early tumor contrast enhancement is increasingly used as an indicator of tumor vascularity. Since tumors need to be near a blood supply to metastasize, vascular disrupting agents are a new class of anti-cancer drugs designed to prevent nutrient supply to the tumor, thereby leading to the necrosis of solid tumors such as breast cancer, prostatic tumor, carcinomas, cervix cancer or colorectal tumors. These anti-angiogenic agents can be effective anti-tumor therapies, particularly in combination with other drugs. Vascular changes can be observed and quantified with DCE-MRI, which allows earlier assessment of drug efficacy and saves time and money in the drug development process. In rheumatological studies, DCE-MRI has been shown to visualize erosions 2 years prior to them being visible on X-ray. However, since erosions are a late manifestation of previous inflammatory tissue damage, the main advantage of MRI is its ability to visualize inflammatory pre-erosive changes.

With bone marrow edema (BME) believed to be one of the most reliable predictor of subsequent erosive changes, and synovitis to be the earliest indicator of disease activity, it is crucial to measure these inflammation driven disease manifestations at diagnosis and quantify the changes in follow-up examinations.

The latest clinical research confirms that the use of DCE-MRI in studies increases the study’s discriminative power, helps identifying non responders early and helps reduce the number of patients and study sites. Furthermore, use of DCE-MRI helps shorten drug development time, as the efficacy can be accurately demonstrated within much shorter time than with conventional radiography.

While the analysis of DCE-MRI requires advanced software to characterise the changes in signal intensity over time as the contrast flows in and out, with appropriate software the interpretation of the images can be done in a fully automated manner reducing human bias on the treatment effect. Dynamika, developed by Image Analysis, UK [5] is an example of such software helping to automatically turn DCE-MRI sequence into a set of imaging biomarkers.

The use of highly optimized algorithms in a reliable software platform is critical to successful translation of comprehensive imaging modalities into clinical practise. The software must reproducibly calculate the volume and severity of inflammation and use these to provide an overall inflammatory score for a rheumatology patient or tumor assessment for an oncology patient. Further, since DCE-MRI is acquired over time, patient movement during the scanning has to be accounted for prior to any quantitative analysis. Scoring systems, such as RAMRIS and DEMRIQ in inflammatory arthritis and measurements of tumor texture and volume should be carried out with a high degree of automation, otherwise the measurements will be subject to reader variability.

Many studies have evaluated DCE-MRI results as predictors of clinical outcomes, including treatment response to chemotherapy in tumors as well as Disease-modifying anti-rheumatic drugs (DMARDs) and biological treatments for Rheumatoid Arthritis. DCE-MRI results have also been compared to conventional diagnostics as predictive biomarkers. Some studies have shown vascular changes on serial DCE-MRI to be predictive of disease progression and/or malignant transformation of tumors.

Despite some challenges to employing DCE-MRI, the imaging method is rapidly becoming integral to drug development trials and early phase clinical research. Successful integration of functional imaging techniques such as DCE-MRI in a clinical trial requires thoughtful orchestration and rigorous standardization to reduce variability. DCE-MRI will be increasingly employed and its role will become better established over time. Ultimately, DCE-MRI will prove to be a widely recognized and reliable predictive biomarker for clinical outcomes.

REFERENCES

5. Dynamika software is available from Image Analysis, UK www.imageanalysis.org.uk
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Advanced visualization company joins up with enterprise-wide content management unit

In the beginning of January it was announced that the US company Lexmark would acquire the Canadian-based company Claron Technology, a leading provider of systems for medical image viewing, distribution, sharing and collaboration software technology.

We wanted to find out about the consequences and implications for European end-users of Claron products and the future strategy of the combined group, so we spoke to Claudio Gatti, CEO and co-founder of Claron Technology.

Q. First of all a bit of history regarding Claron. We know you're a young and rapidly growing company, but exactly when were you founded? 
I co-founded Claron Technology in Toronto, Canada back in 2001 with my partner Doron Dekel. For a good part of Claron’s life we have worked exclusively in the business-to-business market. Our software is embedded in many medical applications from partners like Philips, and McKesson. We always had a global reach with our products, since we supplied large multi-nationals with international distribution.

In the last five years Claron has indeed experienced rapid growth, and has continued to expand the range of technologies we offer while expanding our customer base. On the basis of our 5-year revenue growth, Claron has been recognized on four separate annual occasions as one of Canada's fastest growing companies.

Q. Claron's activities are in image processing, which covers many fields. In which specific sectors is the company most active?
We are focused on medical image processing and specifically on Advanced Visualization and Medical Image Viewers. Our Enterprise Imaging group has been at the forefront of the field of distributed visualization for many years. We developed three generations of thin-client viewers, which have been very successful in the market and are now in wide use. At each iteration of the product development cycle, the client side of our systems became smaller and smaller, until it disappeared completely in our flagship product, Nil the zero footprint viewer. With Nil, we have also changed our strategy and started to offer the system both directly to end-users and through partners.

Q. All this sounds very positive so what's the rationale for the need to join up with Lexmark? Isn't Lexmark more known for non-medical imaging activities such as computer printers and accessories?
Lexmark has been very active in the area of Enterprise content management and it has a strategy to offer the quality of Claron’s advanced visualization systems is renowned.
unique, interoperable vendor neutral solutions that among other things help eliminate silos that exist today within healthcare organizations. Lexmark’s vision and strategy are in sync with the direction we were pursuing with Claron Technology. We felt it was the right time to join forces with a larger organization to be able to make an impact on a global scale.

Functionally we will become integrated with the Perceptive Software division of Lexmark

Q. What is the Perceptive division of Lexmark generally known for?

Perceptive Software is a division of Lexmark that builds process and content management software that closes the information gaps that exist throughout every organization. This extends from classical enterprise content management to vendor neutral storage and management of all imaging data.

Q. What are the likely practical implications of the acquisition for existing or future customers? Will there be any changes in marketing priorities, e.g. geographical? Claron already had a significant European installed base and had plans to develop into the Middle East. What will be the effect of the merger with Lexmark on this set-up/future plans?

While the Claron team and our commitment to our customers remains unchanged, our capabilities have expanded greatly with the acquisition. The Nil family of Enterprise and Diagnostic viewers will continue to be a vendor neutral solution for all image viewing needs of our end-users. Our WIF advanced visualization platform and our clinical engines will continue to be the solution of choice for partners looking for time to market and unique clinical functionalities. Our products are also going to be integrated and will be available as add on to Perceptive’s Enterprise Content Management (ECM) and Vendor Neutral Archive (VNA) to enable Enterprise and Diagnostic image viewing across the clinical enterprise.

Q. And what about the future directions and overall strategy of the new group?

Claron has become the Visualization division of Perceptive Software and this division will enable Perceptive Software to further expand its medical content management strategy. The combination of Perceptive Software’s content and process management platform together with industry-leading VNA functionality to enable centralized storage, management and medical imaging sharing plus the Nil Enterprise viewer, will enable Perceptive Software to offer unique, interoperable solutions with vendor neutrality that help eliminate the silos that exist today within and between, healthcare organizations. The result will be improved access to content and ultimately to better patient care.

Q. Finally on a personal note you were one of the two co-founders of the Claron company. Any regrets/ nostalgia in seeing your baby swallowed up?

I am very proud of what we built at Claron Technology over the years, and of the amazing team we assembled. But I am as just as excited about this new phase of the business as I was when I developed Claron Enterprise Imaging business from the ground up. With Lexmark focus and commitment, the wide portfolio of technologies it owns and the disruptive changes happening in the market, I see a strong opportunity to have a much larger global impact within the new home for the business.
Radiology in East Flanders, Belgium — more than just routine

The University Hospital of Ghent (UZG) in the Belgian province of East Flanders is one of the biggest in the Flemish speaking part of Belgium. With more than 1000 beds and large outpatient clinics, the hospital has a necessarily big, busy and efficient diagnostic radiology department. In addition, there are active research programs, principally in the field of neuroradiology. The department recently installed a new PACS system. We spoke to Prof. Rik Achten, head of the department of radiology.

Q. Let’s start with the facts and figures. Please tell us about your hospital.

OK First, the facts and figures. Of course as I hope to show you, there is a lot more to a modern, efficient radiology department than just a list of cold statistics.

We are located in the city of Gent, in the Flemish-speaking Belgian province of East Flanders. UZ Gent — Universitair Ziekenhuis Gent — is one of the largest hospitals in Belgium, Overall the hospital has around 1,000 beds, more than 6,000 employees and has all the medical departments and specialities that you can expect from a large modern university hospital.

And of course, since it is nearly impossible for modern medicine to function without access to central radiology services, UZG has an appropriately well-equipped radiology department serving the rest of the hospital. And it’s not just internal departments who call on our expertise — we get referrals from our large hinterland of the Belgian province of East Flanders and beyond. So the hospital receives rare and difficult cases from a wide geographical area. Also, to ensure that the most appropriate service is provided to patients, we have close bi-directional cooperation with several hospitals in our hinterland and the other University Hospitals in the Flemish region of Belgium, namely Antwerp, Leuven and Brussels.

But let’s get back to radiology in UZ Gent. In the diagnostic radiology department alone we have all imaging modalities available. So we have no fewer than seven X-Ray systems, four ultrasound systems, dedicated mammography systems three diagnostic CT scanners and, the cherry on the cake, four MRI systems, two of which are 1.5 Tesla and two 3 Tesla.

The fact that the department is necessarily big doesn’t however mean that it gets in the way of good professional collaboration. On the contrary we have extremely good — and mutually beneficial — relations with other departments who rely on imaging, for example nuclear medicine for multimodal imaging exams (PET/CT, SPECT/CT) and vascular and interventional radiology (which also includes interventional neuroradiology).

Q. So with all this imaging capacity available, how many patients do you see?

I dare say that we are well-equipped but we need the systems we have got: we carry out many more than 200,000 examinations per year. For example there is a heavy demand for MRI so our routine MRI systems operate from 7.00 am up until 10.00 pm. And even with this there may be a waiting period for non-urgent cases of more than six weeks. Of course we keep some capacity...
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available for urgent cases which means that we have to use flexible and creative scheduling to make sure that there is a minimum of unused capacity.

And while inevitable budgetary restrictions mean that we can’t just buy every new imaging system that comes on the market, we do try and invest appropriately in new equipment so that we can benefit from the advances in technology. For example two of our four MRIs are 3 Tesla. Not only do these give us very high quality images and improved signal to noise ratios but they also have the advantage that a typical 3.0 Tesla scan will only take approximately 20 minutes compared to the 30 minutes with a 1.5 Tesla system, so providing a significant improvement in workflow and throughput.

And in addition to that we have the luxury — no, privilege — of being able to allocate one of our 3.0 Tesla MRI systems essentially to non-routine, research-oriented studies.

Q. Before we get on to that, what about the staff you have in your department to run all these machines?

Yes, as I said there is a lot more to a radiology department than simply the machines. The key is to have an efficient staff to run the whole complex operation. All in all we have a total of 130 staff members of whom nearly 50 are radiologists. There are 20 full-time radiologists in diagnostic radiology, four in interventional radiology and we also have 8 part-time radiologists who come to our department from other hospitals for one or two days a week. In addition to these we have 16 residents. The remaining 80 or so of our personnel are radiographers, technicians, administrative staff and nurses, all of whom play a vital role and without whose contribution the department just simply couldn’t run. Of course the bigger the department the bigger the potential for operational problems, but in this respect we are extremely fortunate in that without exception the staff are all highly motivated and cooperate efficiently to get the job done.

This isn’t just a question of luck. We have put in place several systems to ensure the optimal running of the department and also the maintenance of quality, which is vital in radiology. Thus we are ISO 9001 certified for the overall quality procedures for the department. The great advantage of ISO quality systems is that they provide a structured approach and allow quantification of the quality process. The down side is that quite some resources are needed to keep the system going. The people in the department also needed time and persistence to evolve to a culture of quality monitoring and continuous improvement. But I can say that, after 4 years of quality management, radiology UZG has now fully adopted this culture.

For radiology-related quality assurance we use the Total Quality Monitoring, TQM, from the Belgian-based company Qaelum. Their TQM is a range of advanced software solutions and services designed specifically to ensure patient safety and improve efficiency in medical imaging environments. The TQM system deals with all quality issues including monitoring radiation dose. Currently the question of radiation dose, especially with CT, is a hot topic but it is always necessary to put the issue into the appropriate context. Of course it is necessary to monitor compliance with protocols as far as expected radiation dose is concerned. Radiation dose can be high for a number of valid reasons like a patient being obese or a retake because of movement. The Qaelum system also allows to check for protocol violations. However many cases of so-called protocol violations are simply due to non-sinister issues such as the patient having the image taken in a different position as originally foreseen. What is important is to make sure that the reasons for a higher than expected radiation dose of protocol violations are documented in the RIS/PACS system and this is made easy with the TQM system.

Q. Which brings us on to your new PACS system.

Well just as I said earlier that the practice of modern medicine is inconceivable without radiology, so it is inconceivable to have a modern radiology department without an
efficient PACS system. We of course carried out an extensive evaluation of the various systems available. Given the central role and importance of PACS this evaluation was not just carried out by our internal IT specialists — in addition we deliberately got our radiologists involved in the evaluation/selection process. After all, they are the final end-users of the system.

In the end we plumped for the IMPAX system from Agfa. There were several criteria involved in the choice, not just the basic issue of the cost and efficiency of connecting images and information to ensure improved diagnostic confidence.

The new IMPAX system had many features that were interesting such as extended desktops, offering advanced image processing in a multi-modality environment. There were many features which interested us, and one of the most important issue to us was the excellent work flow management embedded in the IMPAX system. This allows for easy balancing of the radiological work between several radiologists and residents. We are also quite happy with ClinApps, a series of tools to manipulate images, do comparisons, measure lesions automatically etc. The speed of retrieval of the images could be better though, but that is not in the hands of Agfa. At UZG there is a policy of installing software solutions on existing IT hardware as opposed to acquiring dedicated hardware. In the beginning, non optimal database operations caused quite some delays in image retrieval. Fortunately our IT specialists collaborated with Agfa to greatly improve the speed so that now the waiting times have become acceptable. Further improvements are expected soon with the acquisition of faster storage solutions.

We are happy with the system, even though officially the installation isn't yet complete since we are still migrating our archived images of 10 years (this totals some 77 TB) over to the new system. Legally we have to keep all our images for a period of thirty years, so you can imagine how big our archives will become.

One consequence of having an efficient PACS system covering the whole department and, via teleradiology, even outside the hospital, is that now we can have our radiologists dispersed over several reading stations. A disadvantage is that we could miss out on the personal interaction that was easy when we were all reading images together because there was only a hard copy on film. This aspect is easily compensated for by organizing frequent multidisciplinary meetings and working with a work place strategy to promote interaction.

**Q. What about the research or non-routine work you mentioned earlier?**

Yes we have an active research program and are proud to have a respectable list of research publications, the majority being in the field of MRI examinations of the brain. Being a neuroradiologist by training and interest, I am very happy that we have close cooperation with the Institute of Neuroscience based here in Ghent and which provides a platform for neurosciences in the whole of Flanders, Belgium. The Institute for Neuroscience focuses on two main research themes, namely cognitive and emotional control and neuromodulation.

In practice these themes are organized in two administrative divisions, namely the Multidisciplinary Research Platform (MRP) Neuroscience of Ghent University and the Neuromodulation Research Theme of Ghent University Hospital. Where radiology comes in is in the fact that we have created an MR-imaging platform for supporting existing and future research groups in performing integrated neuroscience research.

This platform is called the Ghent Institute for Functional and Metabolic Imaging, or GIfMI.

We are extremely privileged in that we received a € 2.7 million grant from the Flanders government for the purchase of a 3 Tesla MRI system which is devoted purely to research purposes. The majority of such research is in the field of neuroscience, and we have close collaboration with the Institute of Neuroscience also based here in Ghent.

Apart from the intrinsic interest of research in such a fascinating field as neuroscience, the motivation is that ultimately the findings of our research projects will result in practical benefits to our patients and that what may currently be considered experimental innovative approaches will one day be part of the routine service offered to all patients who require them.

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Mr Simon Holt is a consultant surgical oncologist based at the Peony Breast Care Unit, Prince Philip Hospital, Llanelli, Wales. He also works at Bronglais Hospital, Aberystwyth and the Breast Test Wales Screening Unit, Swansea, Wales. He leads a dedicated team in the Peony Unit with particular support from Dr Ali Moalla, consultant radiologist and Helen Williams, senior research radiographer.

Mr Holt and Dr Moalla are long-standing champions of Digital Breast Tomosynthesis (DBT) and when the Peony Unit opened in August 2010 they chose Hologic Selenia Dimensions mammography equipment. The department is one of the first in UK, and the first in Wales, using C-View software, which creates 2D images from tomosynthesis data.

This enables symptomatic patients to benefit from 3D and synthetic 2D images without doubling dose levels. The synthetic C View 2D images are similar to standard 2D images, which helps when comparing priors and assists in identifying areas for scrutiny on the DBT. The literature supports their view that combination 2D and DBT leads to a higher detection rate and greater diagnostic certainty, particularly true in symptomatic women, many of whom are younger and therefore have denser breasts. 2D and 3D views can be displayed simultaneously, which greatly simplifies and reduces reading times for the DBT. This potentially addresses a barrier to the introduction of DBT, for example in screening; they believe that having directly comparable 2D and 3D images to view simultaneously could provide the solution.

Acquiring C-View takes 4 seconds, 60% less than performing a 2D+3D combination, important for the patients who have less time in breast compression as well as receiving much lower radiation dose.

“DBT images are diagnostically superior to 2D images. As C-View 2D images retain much of the information from the 3D dataset, they potentially deliver superior diagnostic information over standard 2D images. Our initial impression after 2000 examinations is that this could be the case. Microcalcifications are highlighted and radial enhancement algorithms can pick out spiculations from individual cuts of the DBT and retain them for presentation in synthetic images. The introduction of synthetic 2D has simplified reading of DBTs and our radiologists are delighted” said Mr Holt.

He also believes there is great benefit in tomosynthesis guided wire localization. “Initially we were faced with the problem of how to biopsy lesions only seen on the 3D images and developed a technique of DBT guided wire placement using a gridded plate. This proved so simple, accurate and quick that we now perform all our wire placements this way. The procedure can be completed in under 4 minutes using only 2 exposures,” he added.”

Following the delivery of the Hologic Affirm™ Tomo synthesis Breast Biopsy Guidance System all X-ray guided biopsies are performed using tomosynthesis. Most are performed using the Eviva vacuum assisted system which has the advantages of simplicity, speed and image resolution over the prone table method used previously in the department.

So far Mr Holt and Dr Moalla’s team have done 30 cases and have been delighted with the results. Hologic sales specialist Louise Wilcox has been available to assist if needed, but so far the staff have found the system intuitive and easy to manage. Mr Holt is looking forward to a time when it may be possible to excise small cancers under local anaesthetic using the system in the Breast Unit without the need for restricted and expensive operating theatre time. Paula Scully, regional manager Imaging UK & Ireland commented, “We are delighted with the feedback we have received from Mr Holt and his colleagues on the C-View installation and in particular now they have commenced Tomo Biopsy work; it is by listening to leading clinicians that we learn about the need for product enhancements and where our solutions can bring improvements for staff and patients alike as is the case at Llanelli”.

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Modern medical imaging in a brand-new modern hospital

One of the biggest private clinics in the Basque country in Spain, the brand new IMQ Zorrotzaurre Hospital in Bilbao, is a benchmark hospital in terms of innovation and medical technology. The clinic has recently installed some new diagnostic MRI equipment. We wanted to find out more about the clinic in general and the equipment in particular so we spoke to Dr G. Solís, head of the Department of Diagnostic Radiology.

Q. Let’s start at the beginning. Please tell us about your hospital.

As you can see from the picture, our hospital, the IMQ Zorrotzaurre Hospital is a strikingly modern building designed by the famous architects Carlos Ferrater and Alfonso Casares. The building is polyhedral in shape, with the geometry changing from one floor to another, resulting in an overall spectacular structure which in practice means that all the patients’ rooms are arranged to take advantage of the best possible views. And since the hospital is located in the Zorrotzaurre area of Bilbao, the views are splendid. This is a famous part of the town, opposite the Euskalduna Palace and on the Zorrotzaurre peninsula on the banks of the river Nervión, which runs through Bilbao.

But of course although much appreciated, great location and striking architecture do not alone make a good hospital. What matters is the services the hospital can provide to its patients.

Our hospital is a private 171-bed hospital with only single rooms and no fewer than 15 suites designed for the maximum comfort of patients and their families. Overall the hospital covers more than 40,000 m² and has intelligent operating theatres, with minimally invasive Da Vinci robotic capacity, cardiovascular surgery, a hemodynamic suite. For radiotherapy and radiosurgery we have the latest generation of linear accelerators (in 2014 we inaugurated a new state-of-the-art TRUEBEAM accelerator). The hospital provides 24 hours emergency service; we have an adult ICU and a neonatal intermediate care unit, as well as maternity services and surgical and oncology day-hospitals.

We serve an area with a population of over 330 000 inhabitants and interact closely with the public health services of the area.

Every year we have more than 22 000 admissions with a total of more than 58 000 hospital-days of patient care: There are more than 81 000 emergency out-patient visits for adult, pediatrics or obstetrics cases.

Q. Very impressive but what about the radiology services to support all this? What personnel and equipment do you have to provide the service expected of you?

The Department of Diagnostic Radiology was formed three years ago. We are fortunate in having state-of-the-art technology in all the imaging modalities. We are totally committed to providing excellence in clinical imaging and make a point of not being a isolated service
unit but instead we are integrated fully with the medical and surgical functions available at IMQ Zorrotzaurre. The aim of our radiology department is quite simply to provide the highest quality diagnostic and treatment imaging services in a caring, safe and efficient environment.

To do this we have a team of 16 radiologists and 42 radiographers and technologists together with 20 support staff. Altogether we carry out 120 000 examinations each year. We use modern systems and protocols from the major manufacturers of imaging equipment. We have dedicated workstations for image processing, a digital environment for processing and viewing images as well as integrating multiple modalities. Data and images are stored in electronic medical records.

In addition to trying to provide a full range of general diagnostic imaging and therapeutic services, we have a strong commitment to the development of subspecialty expertise for example in oncology imaging. As I have said, in general we are very well equipped. As far as specific imaging equipment is concerned in addition to basic CR and DR radiology systems and ultrasound scanners, we have two Magnetic Resonance Imaging systems, two CT Scanners, plus a modern tomosynthesis mammography unit and an interventional ultrasound system.

We also have a vascular/interventional radiology system while in nuclear medicine we have a PET/CT scanner.

Q. In addition, you have recently acquired an Oasis MRI system. Since when has it been up and running? How have you found it?

When the new clinic opened in May 2012, we in fact carried out all our MRI examinations using a new 1.2 Tesla open architecture system from Hitachi. (Later on we complemented this with a closed magnet MRI system, a 1.5 T Avanto Siemens machine which we recovered from the old clinic).

Since 2012, we have carried out more than 12 000 examinations in the open vertical-field magnet.

This open-bore equipment is able to do all kinds of MRI examinations, even cardiac exams, and we have found no significant difference in the amount of time that such examinations take compared to similar examinations in the closed magnet system.

The Oasis system is highly appreciated by our patients and has made scheduling of our MRI cases much more flexible. We are able to handle many claustrophobic patients without any need for anesthesia and in some cases, with no sedation at all.

We are really impressed with the fast gradients, the multi-channel RF coils and the patient comfort. Being able to have the region of interest in the center of the magnet means that scan times are decreased. We get better quality images and there is no need to rescan patients because of movement, size or other considerations.

The image quality is better than we expected. In particular its specialized capabilities in musculoskeletal imaging are driving referrals to the Department.

Q. So how do you see the future?

Simple. For the future our priority is to develop into a University Hospital where we can combine research and educational programs together with excellence in clinical imaging to provide outstanding patient care. With our current imaging systems we are already well placed to achieve this aim.
Satellite Symposia at ECR

Three lunch time symposia sponsored by Bracco Imaging at the upcoming ECR meeting look set to attract the crowds. To whet the appetite, here’s an aperitif of what will be presented.

Evolving needs in CT Imaging: a Patient-centred approach
Thursday March 5 12.30 - 13.30. Room E1 (level 0)
• Advanced CT Technology: How to Minimize Patient Dose
  Dr Mathias Meyer, of the Institute of Clinical Radiology and Nuclear Medicine, University Medical Center Mannheim, Germany will describe how the concept of personalized medicine is evolving and is starting to replace standardized CT protocols in Radiology. Given the fact that the patient collective varies widely from young children to the elderly with acute and chronic diseases, individualized and more customized CT protocols are mandatory.
• Tailoring CT Scans to Individual Patients: Design and Validation
  Dr Angelo Vanzulli of the Department of Radiology, Ospedale Niguarda Cà Granda Milan, Italy will emphasise how the proper use of iodinated contrast agents in MDCT is essential to achieve high contrast resolution and correct diagnosis while minimizing patient and risk. He will give examples of the implementation of tailored protocols
• Standardization of scanning protocols and patient diversity: oil and water?
  Presentation given by Dr Mathias Prokop Professor of Radiology at Radboud University Nijmegen, The Netherlands

Imaging in Oncology: what can MRI do today and tomorrow?
Friday March 5 12.30 - 13.30. Room E1 (level 0)
• The role of MRI in the diagnosis and early detection of pancreatic cancer: current and future perspectives.
  Dr Riccardo Manfredi, of the Department of Radiology, University of Verona, Verona, Italy will describe how MRI of the pancreas is assuming an important role in the identification and characterization of pancreatic ductal adenocarcinoma. Although CT is still considered to be the reference method in pre-operative staging of pancreatic cancers, MRI provides non-invasive images of the pancreatic ducts and parenchyma, allowing better evaluation of the relationship between the mass and the bile and/or the pancreatic ducts which can be helpful in pre-therapeutic planning
• The evolving role of MRI in prostate cancer management
  Dr Aytekin Oto, Professor of Radiology and Surgery, University of Chicago, USA will show how MRI is not a rookie in the field of prostate imaging. It has been more than three decades since the first prostate MRI was performed. Despite its limitations, it is currently the best imaging modality for prostate examinations. However, promising early results from single center cohorts have not been reproduced in multi-institutional trials and this has been one of the major obstacles limiting the widespread use of MRI for the detection and diagnosis of prostate cancer.

Contrast-Enhanced Ultrasound in the imaging of patients at risk of developing Malignant Lesions
Saturday March 7 12.30 - 13.30. Room M (level1)
• The role of CEUS in the detection and diagnosis of liver metastases
  Dr M Beermann of the Södersjukhuset (South General Hospital) Stockholm Sweden will describe how, for patients with malignant disease at risk of developing liver metastases, preoperative imaging as well as surveillance of the liver is very important as the presence of metastases affects treatment. Although imaging can be done with different techniques, contrast enhanced ultrasound (CEUS) plays an important role.
  • Surveillance of patients with liver cirrhosis: is there still a role for CEUS?
    Prof Vito Cantisani of the Department of Radiology, Oncology and Anatomo-Pathology, “Sapienza” University of Rome, Italy will describe how hepatocellular carcinoma (HCC) is the most common primary liver tumour, and is ranked in the top 10 human cancers worldwide. He will show how the role of CEUS in HCC management will be re-considered as technology continues to evolve and as its use spreads not just among experts operators but also among everyday ultrasound personnel involved in HCC surveillance.
  • Quantification on DCEUS: New trends and developments
    F Tranquart, of Geneva Research Center, Bracco Suisse SA, Switzerland will show how CEUS is now an established valuable tool in many clinical applications, and how quantification relies on the analysis of ultrasound contrast agent kinetics obtained from dynamic CEUS recordings after bolus injection or during constant infusion. At Bracco, they have developed a software solution, named VueBox, which is independent of the ultrasound platform used, allowing meaningful comparisons between examinations.
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In this article, we present a summary of our recent study in which we investigated, using a well established training evaluation system, the outcomes of the incorporation of e-learning in radiology at the undergraduate level. Our data show that there is an increasing use of highly interactive self-directed e-learning courses. In the majority of cases a positive response is reported as far as student satisfaction and outcome are concerned. The e-learning initiatives included interactive games, audience response systems and a wide range of customized tools designed to address individual learner needs.

Radiology education is a mandatory component in the medical curriculum and is introduced in some form or another in almost every medical undergraduate year. In most European countries, the year in which most radiology is taught to undergraduate medical students is during their fourth year of medical training [2]. A lesser amount of radiology content is taught in the third and fifth year and only a relatively minor amount of initial radiology training is given in the first year of the medical course. The importance of radiology in medicine and of radiology training has been highlighted in recent surveys [3-5]. Training in radiology is of course essential for doctors who plan to specialize in radiology and for future radiographers but it is also important to teach radiology to all junior doctors. This is simply because of the central role of radiology in modern medicine which means that even junior doctors must have a deep enough experience of radiology so as to ensure they don’t miss any critical features in the radiological images they will inevitably meet in their clinical practices.

Because of the importance of radiology in medicine, modern technologies for teaching the subject are increasingly gaining prominence in radiology education. In our study [1] we found that the incorporation of advanced technological methods such as e-learning procedures in the radiology educational system led to an improvement in the skills and knowledge of medical students.

In our study which evaluated the learning outcomes in undergraduate radiology education, four databases were searched, namely (1) PubMed Central, (2) MEDLINE, (3) Embase and (4) Eric between the years January 2003 to December 2013 to identify reports on the use of e-Learning in undergraduate radiology education. We found 130 papers in total and extracted 30 studies which met our criteria of radiology education at the undergraduate level. These thirty studies were then categorized according to study design in medical research. A total of 13 papers involved experimental studies, 11 were observational and 6 studies were simply reports.

The training evaluation model used to evaluate the learning outcomes presented in the experimental and observational studies was the well-established Kirkpatrick's four level learning model [6]. The six descriptive reports did not report any level of learning outcome.

Out of the remaining twenty four studies, 19 satisfied the learner satisfaction level and 15 studies satisfied the learning outcome level but no study reported satisfaction of practical change level and health outcome level. The reason for the absence of outcome measures with respect to performance improvement in clinical practice and patient healthcare is believed to be due to the difficulty in measuring these levels in medical education as retrospective assessments of e-learning interventions may not be able to assess these measures [7]. A change in education environment may not have a sudden impact on change in practice or health outcome [8] but clinical competencies and performances are highly affected by learning environments [9]. The evaluation of published literature helped us in identification of those precious learning environments that ultimately aid in change in practice or health outcomes.

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The selected studies were categorized into radiology subfields along with the identification of the year in which the related e-learning intervention was offered. The studies were broadly divided into three main categories: (1) Interventional, (2) Diagnostic and (3) Medical Radiation. The most prevalent category found in the radiology undergraduate education was diagnostic radiology (n=26) which was further subdivided into 6 more categories as shown in Figure 1. The data extraction showed that the focus of the e-learning initiatives within diagnostic radiology was to improve the interpretational skills of radiology in students along with the learning of imaging techniques, radiation protection and safety related issues. The coverage of reported studies related to diagnostic radiology is spread across all years of education (1-5 years). There were three reported studies related to radiation protection that covered radiology education in 2nd, 4th and 5th years. We found only one study covering interventional radiology which was given in the 4th year of education.

**E-LEARNING INITIATIVES**

The studies that satisfied the learner satisfaction level were categorized according to the reported e-learning interventions (web-based, blended, online, computer-based and audience response system based learning). The most prevalent intervention found in the undergraduate education...
radiology education was web-based learning interventions followed by blended learning environments and computer-based learning. The ease of access and presentation of ideas using a wide range of multimedia objects is the prime reason for designing web-based learning interventions. The selected studies in this group reported on use of various web-based tools, web modules integrated into Learning Management Systems (LMS), web tutorials (both interactive and non-interactive) and use of web-based customized Picture Archiving and Communication Systems (PACS). In [10] 75% of students showed satisfaction with the use of web-based video tutorials in understanding the concepts of interventional radiology procedures while 87% of the students rated Dynamic Quiz Bank [11] as a useful tool in radiology education. A Radiation Protection (RP) web-based module was rated good by 81% of the students but the preference in this case was given to clinical attachments and educational material as compared to e-learning tool [7].

Blended learning involves the blending of traditional classroom based teaching with other form of e-learning interventions. The use of blended learning in undergraduate radiology education [12] may be underestimated because of the difficulty in evaluating blending learning outcomes [13]. The studies that used the blended learning environments incorporated the use of the CaseTrain tool [14] with classroom learning for the nuclear medicine discipline, the use of video sequences for solving oral radiological cases on discussion forums [13] and the use of learning management system k-MED for nuclear medicine and radiotherapy education. All these blended learning environments were rated highly effective for undergraduate radiology education. A special form of computer supported collaborative learning has been observed in solving and discussing radiological cases [15] in which student's response was neutral.

Computer-based learning has been used in radiology education for a very long time and can potentially produce significant results if used appropriately. The digital hot seat method [16] for solving radiological cases and the Virtual Learning Object VLO [17] for Cephalometric Radiography (CEPH learning) were rated as being good by 100% and 83% of the students respectively. As far as regular online learning systems are concerned they were also found to be beneficial [18] in limited situations where only basic radiology topics are to be covered. The usefulness of virtual lectures through EMERAM (Aplicación Multimedia para la Enseñanza de Radiología a Alumnos de Medicina) was high for learning general radiology [19]. The use of Audience Response System (ARS), i2vote, for radiology education was reported in [20], and was rated 4.2 on a five point Likert-scale in terms of its usability by students. The use of ARS may be low in radiology because of its intense imaging nature. Overall, all the e-learning interventions used in radiology education at undergraduate level received positive response from students. Figure 2 summarizes the count of all e-Learning initiatives found in the thirty studies.

**LEARNING OUTCOMES**

Table 1 summarizes the significance of the interventions in radiology education according to the outcomes achieved [1]. A total of 15 studies satisfied the Kirkpatrick's learning outcome. The most effective e-learning intervention in enhancing knowledge and skills in radiology education at undergraduate level was blended learning as all four blended learning related studies [8, 14, 21, 22] showed significant learning outcomes. These four blended learning related studies reported improvement in knowledge and skills in nuclear medicine, oral radiology, diagnosing imaging procedures (CT, MRI, ultrasound, neuroradiology, etc.) and case-based radiology in undergraduate students. The second most effective e-learning intervention found in enhancing the learning outcomes of radiology education was online/virtual learning environments [19, 23]. It is noteworthy that online learning showed significant learning outcomes when only basic radiology topics were involved. On the other hand, web-based learning was found to be significant in only 60% of the time in enhancing the learning outcomes in undergraduate radiology education. The web-based video tutorial for MR arthrography [10], Online Electronic Information Skills (OEIS) intervention in the area of radiography [24], and Radiation Protection (PR) module in delivering radiation protection...
Radiology education includes the new aspects arising in the field of radiology education. The reported computer-based learning studies were found to be the least effective in improving learning outcomes in radiology education with only 25% of the significant results [1].

**DISCUSSION AND CONCLUSION**

Kirkpatrick’s learning model was applied to evaluate the learning outcomes in undergraduate radiology education. From the analysis, we found that blended learning was the most significant e-Learning intervention in radiology education. The results of the study show that the use of virtual lectures for undergraduate radiology education was found to be the most significant learning intervention, but in the case of the basics of radiology education. Audience response system was used in thoracic radiology learning and it was found that knowledge retention can be improved through use of i2vote audience response system [1].

New aspects arising in the field of radiology education include the increase in the use of blended learning environments (including commercial and non-commercial learning management systems, PACs and case-based learning management systems), emergence of audience response systems (even though the radiology is of an intense imaging nature). Other aspects whose use is on the increase include development of customized tools (LVO, EMERAM, k-MED, RP module, video tools etc); the emergence of highly interactive educational games (Breast Cancer Detective), the use of video lectures in interventional radiology; the replacement of problem-based learning with case-based learning [25]; the development of customized PACs and the replacement of traditional classroom-based lectures with virtual/online lectures [1].

**REFERENCES**


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US health care system moves towards more value-based purchasing

In late January 2015, the United States Department of Health and Human Services (HHS) announced their intentions to help drive the U.S. health care system towards greater value-based purchasing – rather than continuing to reward volume regardless of quality of care delivered. HHS has set a goal to have 30 percent of Medicare payments in value-based alternative payment models by the end of 2016, and tying 50 percent of payments to the models by the end of 2018. This will be achieved through investment in alternative payment models such as Accountable Care Organizations (ACOs), advanced primary care medical home models, new models of bundling payments for episodes of care, and integrated care demonstrations for beneficiaries that are Medicare-Medicaid enrollees. Overall, HHS seeks to have 85 percent of Medicare fee-for-service payments in value-based purchasing by 2016 and 90 percent by 2018.

Q. When the Department of Health and Human Services (HHS) says they want 85 percent of Medicare fee for service payments in value-based purchasing by 2016, what does that really mean for U.S. providers?

Medicare already has programs such as the hospital value-based purchasing program where a small percentage of all hospitals’ inpatient Medicare revenue is pooled and then hospitals “win” a portion back based on their value index or score from various quality measures and the costs per beneficiary to provide the care. There are also programs where hospitals will not be paid for complications or conditions, many related to patient safety and that are acquired during a hospital stay. There is also a companion to this program where hospitals with the highest numbers of these conditions lose 1 percent of all their Medicare dollars. Then there are the hospital quality measure reporting programs that began all of this, which still impact a hospital’s annual Medicare payment update.

While some of these programs currently have the percentages at risk in the law, some also have the flexibility to both increase the percentages at risk and also increase the number and type of measures being reported in each program. So, expanding these programs to cover more Medicare revenue could be done through the annual Medicare rulemaking process. The Proposed FY 2016 Medicare Rule for the Inpatient Prospective Payment System will be released in late April 2015 and it will have a 60-day comment period for its proposals.

Q. Can similar initiatives be duplicated in other countries?

Given the universal nature of the various coding systems used to report quality measures and conditions, and the U.S. system finally implementing ICD-10 in October 2015, plus the ability to duplicate the cost per beneficiary measures, I think it would be quite easy for the various European healthcare systems to implement the value-based purchasing program, hospital acquired conditions, and re-admission programs in their payment structures.

Q. Where does the use of ultrasound fit into these value-based payment structures?

One of the main patient safety measures across the value-based purchasing, hospital quality reporting, and the hospitals acquired conditions reduction program is a composite measure called PSI-90 Patient Safety for Selected Indicators. PSI-90 contains several conditions such as a hospital’s iatrogenic pneumothorax rate and its rate of accidental puncture. Here’s where ultrasound comes in: using ultrasound to guide a catheter or needle procedure, a hospital can bring its rate of complications associated with thoracentesis or paracentesis down to zero. Preventing these complications will help their score on value-based purchasing and on both of the hospital acquired condition programs. It will also improve their cost per beneficiary as well.
Q. Can you talk more about the specific ways ultrasound fits in with those patient safety and quality reporting programs?

Regarding central venous access, the use of ultrasound has been found to reduce the number of placement attempts by 54% versus the landmark method [1]. Use of ultrasound has also been found to reduce the rate of pneumothorax to zero [2]. With the charge for a complication of a pneumothorax at an excess of $17,312 and an additional 4.38 days in the hospital [3], ultrasound guided placements are responsible practice. [Figure 1]

Another prominent quality measure in all of these value-based programs is the rate of blood stream infections in a hospital. Ultrasound guidance of catheterization of the internal jugular vein reduces the rate of catheter-related blood stream infections by more than one-third (35%) [1]. The Centers for Disease Control and Prevention estimate that the marginal costs to the healthcare system of a single catheter-related blood stream infection is $25,000; attributable mortality is estimated at 12% [2].

There really is no reason to put anything in the body—catheters, taps, needles, etc.—blind when ultrasound can be used to visualize the anatomy and guide the placement of the item. Adding this guidance helps avoid dangerous complications that could cost the hospital money, regardless of what country that hospital is in, and that could potentially cost patients more co-pay or cost-sharing because the complication increased their stay and the overall cost of their care.

Q. What about these larger, structural reforms for increased value such as Accountable Care Organizations and Bundled Payments; how do they impact imaging?

With both of these types of alternative payment models, the “value” comes from moving the risk for the amount and cost of the case over to the provider and in some respects the patient. For Accountable Care Organizations to be successful, they have to be able to manage the cost of care for a beneficiary against a benchmark for the care that was provided to a similar type of patient in a previous year. To be rewarded or share in some type of saving, the providers have to become aware of the costs and then how to manage the costs out of the system. Bundled payments are similar. The provider has to understand the cost of the various options for care that will ensure that the patient gets high quality care, and then make a choice with the patient that fits the amount of money available. The appropriate use of imaging, ordering the right scan at the right time for the right condition, will help to manage the overall costs per case.

Q. Can you give a specific example of this type of decision-making?

A case in point is the diagnosis of shoulder pain in the Medicare population. Currently, only about 4 percent of these cases are diagnosed using ultrasound versus MRI, yet the scientific literature and the American College of Radiology’s appropriate use criteria both support the routine use of ultrasound to diagnosis this condition. In their November 2012 review of the Medicare claims data, KNG Health Consulting, LLC found that ultrasound was an underutilized diagnostic tool in extremity imaging. The study reported that increasing the use of ultrasound in the Medicare population by just 2 percent while decreasing the use of MRI by the same amount would have saved the Medicare program $34 million in spending in 2011, and patient co-pays would have also been positively impacted.

A pilot program at Greenville Health System under the direction of Dr. Mike Kissenberth demonstrates the cost savings and better clinical pathway:

“The shoulder pathway uses best practice at the point of care to initiate an immediate treatment plan and limit specialized care unless warranted. When the patient’s history and physical examination suggest imaging is needed to confirm a rotator cuff tear, physicians use ultrasound at the point of care to provide real time diagnosis for the patient as opposed to waiting for an MRI. MRI and ultrasound are clinically equivalent for the diagnosis of rotator cuff tear with significant cost savings and convenience to clinicians and patients. Recent reports suggest every 1 percent conversion of MRIs to ultrasound can equate to $1 million in cost savings for the Medicare program and its patients. Not only does this clinically integrated pathway decrease costs by using ultrasound, it also provides the patient with a clear diagnosis at the point of care. This is in contrast to use of an MRI, which would result in a delay in diagnosis and return appointments for a clear prognosis and treatment plan.”

Protocols such as this, where ultrasound is used appropriately as the “first” diagnostic test, can lead to savings for both the patient and the healthcare system.

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Clinical Audit in a Pediatric Radiology Department

The establishment of Diagnostic Reference Levels (DRLs) is a first step in clinical auditing of radiology departments. Comparison of local and European DRLs can prompt re-evaluation/optimization of procedures.

This article describes a practical example of such a clinical audit in a Portuguese pediatric radiology department.

The worldwide use of ionizing radiation for medical use has increased considerably over the last few years [1]. Recent studies indicate that the dose a patient receives can vary considerably from one healthcare unit to another, even for the same type of examination, suggesting that there is a considerable margin for optimization and dose reduction [2–4]. This is all the more important in pediatrics, given that children are ten times more vulnerable to the effects of radiation than adults. Dose reduction should be a matter of concern in all radiology but especially in pediatrics [5].

Dose values should be reviewed periodically to ensure adequate radiological protection according to clinical audit Directive 97/43 EURATOM [6].

PEDIATRIC CLINICAL AUDIT

A clinical audit is defined as a process based on a structured review of radiological practices, procedures and results carried out in order to promote standards of good medical radiological practices [7]. The overall aim is the improvement of the quality and outcome of patient care. The audit process is established to ensure that all facilities and professionals are in accordance with European Directives. Guidelines for the carrying out of a clinical audit are given in the Radiation Protection report no.159 [6].

Conducting clinical audits of the ionizing radiation used for medical purposes is mandatory in the EU, although the audit frequency and detailed methods may differ from Member State to Member State. The quantification of dose is done by the establishment of local Diagnostic Reference Levels (DRLs). Establishment of DRLs is a basic step in the audit process. The first directive of the Patient Radiation Protection document, 84/466 EURATOM, states that quality criteria must be tailored to pediatric patients, because of their higher radiosensitivity and life expectancy [8]. Female children are more radiosensitive compared with males of the same age [9]. The justification of making the radiological examination in the first place, the use of standardised techniques and procedures as well as the optimization of the protective measures are all important factors to ensure the optimization of dose with the overall objective of micronizing the potential risks without any loss in diagnostic accuracy. Therefore, it is always essential to balance the benefits of a procedure against the possibility of inducing damage or harming the patient, although this can be difficult to quantify [10]. Exposure in pediatric imaging depends on several factors such as age, gender, body mass index, antero-posterior and lateral diameters, the cooperation of the children themselves, as well as the technology and equipment being used and the selection of the exposure parameters.

This pioneer study in Portugal aimed to promote a radiological clinical audit and demonstrate that optimization and radiological protection assume a major role in pediatrics.

METHODOLOGY

The study took place at the Pediatric Hospital of Coimbra, Portugal. The frequency of radiological examinations and local DRLs were analyzed and compared with recommendations and international literature.

A retrospective data analysis of dose reports and Digital Imaging and Communication in Medicine (DICOM) headers available in Picture Archiving and Communication System (PACS) was performed for the two most common procedures per modality (radiography, Computed Tomography (CT) and fluoroscopy).

Children who had radiological examinations in 2012 were categorized according to age into several groups, namely 0, 5, 10 and 15 year old (+/- 1 month). For each age group and procedure ten dose files were collected as well as information on the patient gender, age and type of radiological examination. Exposure parameters were collected as well as the appropriate dose descriptors for the modality used. These were the Dose Area Product (DAP) expressed in Gy.cm² for radiography and fluoroscopy. For CT, the CT Dose Volume Index (CTDvol) expressed in mGy and Dose Length Product (DLP) expressed in mGy.cm were also used.
The carrying out of clinical audits is imperative to ensure both the safety of patients and diagnostic accuracy. The establishment of DRLs is the first step in an audit and is the best way to guarantee self-assessment and continuous improvement of radiology practices. The results of our audit highlighted the need for optimization of procedures and also to alert radiographers and radiologists and encourage them to participate in experimental and clinical studies in order to promote dose reduction in their pediatric patients.

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RESULTS

The most common procedures were selected and local DRLs were established for these procedures in the following age groups:

- 0 year: chest radiography, head CT and micturating cystourethrography (MCU);
- 5 years: chest radiography, pelvis radiography, head CT and chest CT;
- 10 years: chest radiography, pelvis radiography and head CT;
- 15 years: chest radiography, head CT and chest CT.

The results showed a large variation and inconsistency in the selection of exposure parameters according to patient age.

Table 1 shows the comparison of the locally established DRLs with other European pediatric studies.

It can be seen that the majority of the local DRLs for chest and pelvis radiography and the MCU examination are similar to other European studies. The locally established DRLs for chest CT were in general much lower than those in other European studies whereas, for head CT, the local DRLs were in general much higher than the other European DRLs.

A multidisciplinary team was assembled to analyze the results of these dose values and the underlying practices. In particular the dose values for CT suggested that there was a high potential for optimization of procedures and suggested the need to revise protocols. The adjustment of the exposure parameters, as a function of age categorisation, could have a great impact on dose value with minimal impact on image noise.

Our pediatric hospital participated in a collaboration for the calculation of Portuguese national CT DRLs [15] and decided to participate in experimental tests for CT optimization [16]. The results of these studies prompted an upgrade of the CT software to include a combination of tube current and tube voltage modulation. This enabled a mean dose reduction of 43% for head CT examinations [17].

CONCLUSION

This study was carried out in 2012 according to the recommendations and guidelines of Radiation Protection report no.159, which describes how to implement a structured audit in a Radiology Department in compliance with the most recent guidelines from International Atomic Energy Agency (IAEA) [1].
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The metamorphosis of radiology

One of nature's most amazing transformations begins with the hatching of a very hungry caterpillar. That raven- ous creature devours food; grows bigger; molts several times over; then – suddenly – stops eating; hangs upside down; spins a cocoon; and…changes.

Modern imaging is like that. It began in the 70s with CT. Ultrasound turned digital and MRI commercial ten years later. Hybridization took hold in the 2000s with PET/CT, then SPECT/CT, most recently with PET/MR. Sites multiplied into the tens of thousands for the myriad scanners. Annual scans numbered into the hundreds of millions. Then, suddenly, exponential growth leveled off. Reimbursement cuts destroyed the fee-for-service model. Calls arose for radiology to transform itself, to become more efficient…more effective…more a part of the rest of medicine, to put the patient first.

Inside the cocoon, the caterpillar releases enzymes that dissolve most but not all of its tissues. Imaginal disks for each part of the adult remain intact, organizing cells, shaping parts. These disks have been there since the hatching. Waiting. Radiology may now be undergoing a kind of metamorphosis, retooling the protein-rich goop of its various modalities around imaginal disks of its own.

In what may be a glimpse of metamorphic processes now underway, the vendors of medical imaging systems point today at the improved efficiency and patient centric- ity of new machines, some displayed at RSNA 2014, due to repeat at ECR 2015.

Siemens Artis with PURE boasts newfound efficiency in interventional angiography. Its 3D Wizard simplifies 3D imaging. QuickZoom allows one-click focus and zoom at tabletop. DynaCT SMART removes metal artifacts; Dyna4D displays flow in three dimensions.

Philips Veradius mobile C-arm simplifies its interventional use. A finger on the touch screen chooses the exam type, adjusts dose settings, collimates. Color coding on the C-arm speeds positioning.

The company's IntellSpace Portal 7.0 increases efficiency through advanced analytics, visualization and data sharing across multiple systems and scan types. The updated portal connects radiology and referring physicians across clinical domains, integrating modalities and information systems.

Patient safety assumes rock star status, as low-dose CT systems proliferate. Reconstruction schemes, designed originally to improve image quality, are repurposed to cut patient radiation; imaging chains do more with less voltage, producing less radiation. Machines take on an air of intelligence. Siemens' Somatom Force supports dual-source, dual-energy CT at voltages from 70 to 150 kV in 10kV steps. Its built-in CARE kV chooses the voltage automatically, considering patient body habitus and exam type to optimize dose. Meanwhile the imaging chains, mounted on a high-performance gantry, enable a 50 cm field of view and scan speeds close to 40 cm per second.

Complementing this in the Siemens portfolio is the single-source dual energy scanner Somatom Definition Edge. Designed for routine clinical routine, its TwinBeam Dual Energy X-ray tube enables simultaneous imaging at two different energy levels, a first for a single-source CT.

Toshiba Medical makes CT upgrades a snap, as its Aquilion ONE CT family allows field upgrades from 320 slices (Aquilion ONE 320) to 640 (Aquilion ONE 640) to the super premium VISION Edition with ultra-high speed rotation.

PATIENT COMFORT IN MR

MR gravitates toward patient comfort with open MRs in the 90s, followed by ultrashort, wide bore magnets. But it’s 21st century technology that allows patient concerns to...
really shape MR. *Philips*’ newest MRI, Ingenia 1.5T S, automates patient set up to reduce exam time, while enhancing patient comfort through visual and audio distractions. The hope is that faster exams and reduced patient anxiety translate into less patient movement, resulting in fewer motion artefacts, and ultimately higher quality scan results. Patients can personalize their experience. They select a visual theme that fills the room with colorful video image, the air with relaxing audio.

Designed to one-up their wide-bore competitors are Hitachi’s Oval scanners. Apertures gape 74 cm at their widest points, offering additional room at the shoulders. Available worldwide on the 1.5T Echelon Oval, this added room enhances access to the patient as well as patient access to the magnet.

*GE*’s SilentScan addresses one of the biggest challenges to patient comfort during MRI – damping the often bizarre noises that emanate from gradient coils as the scanners march through their various protocols. SilentScan reduces this noise with Silenz, a 3D acquisition and reconstruction technique, that combines with improved gradient and RF system electronics. With SilentScan, acoustic noise drops from as high as 110 decibels to just three dBA above ambient for most head exams.

Two years ago, when launched, SilentScan worked only on head scans. Today the technology, integrated into GE’s new SIGNA Pioneer 3T, is enabled for musculoskeletal and spine imaging, as well as neuro, which has been expanded to include Diffusion Weighted Imaging.

Most remarkably, the company’s latest 3T scanner captures quantitative T1, T2, STIR, T1 FLAIR, T2 FLAIR and proton density-weighted images all in a single scan, and in as little as one-third the time of a conventional scan. GE is framing the time savings possible through MAGnetic (resonance) image Compilation (MAGIC) as enough to allow the scanning of an additional patient per hour, a welcome improvement in productivity at a time when all modalities are being pressured to deliver more with less.

**THE ALLURE OF EFFICIENCY**

Efficiency and patient safety are suddenly in vogue, a fact that will be very apparent at ECR 2015 along with the transformation of medical imaging.

Low-dose CT is dropping exams typically heavy on radiation exposure into the millisievert range. At ECR 2015, attendees of a scientific session on virtual colonoscopy (SS 701b - Colonic imaging, March 5, 14:00 to 15:30 in Room MB 2) will hear that advanced iterative reconstruction can decrease the patient radiation exposure to less than 1 mSv. Researchers from Charles University in Prague and St. Anne’s University Hospital in Brno, Czech Republic will report that a hybrid iterative reconstruction technique exposed 58 patients to an average 0.41 mSv during supine and 0.42 mSv during prone acquisitions.

For routine applications, *Siemens* Definition Force allowed scans at 80 kV for abdominal perfusion imaging, even in large patients. The reduction in energy cut patient dose by more than 50%, yet increased the contrast-to-noise ratio and scan range, according to Siemens researchers due to present their findings during an ECR session entitled “Advances in CT imaging” (March 4, 10:30 to 12:00 in Room F2).

The benefits of dual-energy scanning will be confirmed in research presented by two other groups. At ECR 2015, American researchers from the Medical University of South Carolina in Charleston, SC, will report during the “Optimisation of patient dose in CT session” (March 6 session from 10:30 to 12:00 in Room N) that dose reduction of 32.7% can be achieved using a “3rd generation dual-source dual-energy CT scanner.” At a later presentation in the same session, researchers from University Hospital Heidelberg in Heidelberg, Germany will conclude that dual-energy iodine maps from a single acquisition might replace abdominal CT-perfusion measurements – and that doing so can lead to “large reductions in patient dose.”

**DECT CLINICAL BENEFITS**

The benefits of dual-energy CT go beyond patient safety. On March 4, German researchers participating in a scientific session on thoracic oncology (March 4, 10:30 to 12:00 in Room F1) will present data showing DECT at 60 keV significantly improves lesion enhancement, contrast-to-noise ratio, subjective overall image quality, and tumor delineation of lung cancer.

Four days later, in a scientific session addressing urinary stones, ureters and bladder pathology (March 8 from 14:00 - 15:30 in Room G), a research team from Bolzano Central Hospital in Bolzano, Italy, will report that DECT more reliably than conventional single-energy CT distinguishes uric acid from non-uric acid renal stones. Similar results will be reported by a research team from the University of Rouen in France. Their data, showing the ability of DECT to accurately differentiate uric acid and non-uric acid stones, will be presented at the same scientific session immediately after the Italian group.

DECT also offers advantages in the assessment of cardiovascular disease. Researchers at Hospital POVISA in Vigo, Spain, will report as part of a scientific session on myocardial perfusion imaging (March 6, 10:30 to 12:00 in Room N) that dual-energy CT with iodine quantification can distinguish between normal myocardial tissue and pathologic myocardium.
The improved image quality possible with DECT can better detect brain infarcts, according to research performed at Khoo Teck Puat Hospital in Singapore. Researchers from the Singapore hospital will report March 7 during a scientific session on ischemic stroke (10:30 to 12:00 in Room E2) that DECT may even be able to assess the age of a cerebral infarction.

And dual-energy CT shows promise in the early detection of re-thrombosis following endovascular therapy, according to data to be presented at a scientific session on neuro interventions (March 5, 10:30 to 12:00 in Room D2). A research team at Innsbruck Medical University in Innsbruck, Austria examined the utility of DECT in differentiating residual clots and intra-arterial contrast staining following endovascular stroke therapy, finding that DECT not only had value in spotting re-thrombosis following stroke therapy, but might detect intracranial thrombo-embolic complications after cardiac endovascular therapies – and rule out suspected intracranial thrombosis after prior intravenous contrast application. They concluded that using DECT for such applications "could lead to faster clinical decisions and avoid further time-consuming diagnostic studies."

**HYBRID SCANNING**

The first commercial PET/CT scanners appeared in early 2001. Within five years, PET-only scanners were all but impossible to buy, as hybrids had replaced them as the go-to scanners for positron imaging. In 2010 the first commercial PET/MR scanners were unveiled, followed at RSNA 2014 by GE's SIGNA PET/MR, the first to fully integrate a time-of-flight PET scanner with a 3T MR scanner.

Clinical experience with PET/MR over the past several years has demonstrated that the hybrid is comparable to PET/CT, or even superior, when used to assess tumor extent and infiltration, and metastatic spread. So too have early studies shown its potential in the visualization of cardiovascular and neurodegenerative diseases. Yet its future is far from certain, as PET/MR faces major technological challenges.

In the E3 session “MR/PET - the future of hybrid imaging?” (March 6, 16:00 to 17:30 in Room K), Lale Umutlu from University Hospital in Essen, Germany, will argue the advantages of using MRI in place of CT together with PET, noting particularly the significant reduction in ionizing radiation possible with PET/MR in comparison to full-dose PET/CT. This is particularly relevant in pediatric diagnostics as well as therapy monitoring under systemic or radiation therapy.

Major hurdles, however, threaten to sidetrack this modality. Alberto Cuocolo, Carmela Nappi and Roberta Assante from the University Federico II in Naples, Italy, will describe the formidable challenges, such as the inevitable cardiac and respiratory motions and partial volume effect that erode MR image resolution. Particularly problematic, according to the Italian radiologists, is correcting PET data. Eliminating CT reduces the total radiation dose associated with PET/CT studies. But the lack of an electron density map, possible with the CT component of PET/CT, compromises PET data attenuation correction, they will explain.

**TRANSFORMATION**

In a symbiotic ballet, the practice of medical imaging and the industry that serves the imaging community are changing each other. The digital revolution, begun by CT and carried on by all other imaging modalities, has virtually replaced x-ray film as a medium in the healthcare of developed nations.

In turn, film companies have become providers of information technologies, as well as radiography, and recently in some instances ultrasound. Kodak has morphed into Carestream Health with its cross-discipline IT platforms, mobile and stationary radiography products. Later this year, the company will launch a family of ultrasound systems.

Like Carestream, FUJIFILM Medical Systems has evolved its line of radiography products from computed to digital flat panels. And, through its purchase of SonoSite, the company has moved into diagnostic ultrasound. Agfa, like FUJIFILM and Carestream, offer enterprise-wide IT solutions, as well as CR and DR products.

In the decades ahead, with the continued evolution of corporate strategies and the portfolios they breed, the industrial landscape of medical imaging will become unrecognizable from what it was in the mid 20th century. One-time film companies will embrace CT, the world’s third largest imaging equipment market, just as they have x-ray and ultrasound. (Carestream is already conducting pilot R&D of a CT product.) Meanwhile the vendors of multi-modality imaging portfolios will expand their IT offerings throughout the enterprise.

Driving this change, then as now, will be the imaging community. Changing its practices to reflect new demands. Foreshadowing change. Becoming change. Transforming into something new.
A holistic approach to radiation safety

Each year approximately 3.6 billion X-ray examinations are performed worldwide [1] leading to earlier and more accurate diagnosis of medical diseases. However, considerable concern has been voiced regarding the impact on both patients and medical staff [2]. Regulatory bodies have therefore emphasised the importance of ensuring the proper performance of X-ray equipment and of keeping the dose to medical staff and patients as low as reasonably achievable. A holistic approach is required to ensure overall radiation safety.

CENTRAL ASPECTS OF RADIATION SAFETY

One central aspect of radiation safety is the regular quality assurance and servicing of diagnostic X-ray equipment [3]. Only when equipment complies with legal regulations, can it be assumed that it emits only the selected dose during diagnostic X-ray applications. To ensure accurate results, the measurement devices used for the quality assurance of diagnostic X-ray equipment need themselves to be precise and easy to handle. Safety awareness among medical staff working with the equipment who are exposed to scattered radiation represents another important aspect affecting radiation safety. As empirical studies indicate a causal relationship between X-ray dose exposure in interventional radiology and an increased risk of severe diseases such as brain tumours [4] and cataracts [5], wearing the legally-required badge might not be enough. In order to avoid unnecessary radiation exposure, medical staff should be able to monitor their exposure to scattered radiation during interventional procedures in real-time. In this regard, ICRP [6] recommends a second dosimeter worn outside the lead apron to better monitor personal dose exposure.

A third central aspect of radiation safety concerns the dose to the patient. When it comes to best practices in radiation safety for patients, some basic guidelines are widely referenced [7]: medical imaging examinations should only be performed if medically justified and if so, patients should receive an optimal X-ray dose which is as low as reasonably achievable (ALARA) while maintaining sufficient image quality to meet the diagnostic need. Comprehensive systems for patient dose management have been identified as valuable means of supporting these guidelines [8].

A HOLISTIC APPROACH TO RADIATION SAFETY

We at Unfors RaySafe believe that only a holistic approach to radiation safety can effectively reduce unnecessary radiation exposure to patients and medical staff. Our measurement devices combine technological precision with user friendliness. From close partnerships with X-ray manufactures and medical physicist communities we know that our devices help ensure the performance of X-ray equipment in an accurate, yet comfortable way. With regard to occupational dose, our real-time dose monitoring system enables medical staff to monitor their exposure to scattered radiation during interventional procedures in real-time. Studies indicate that the use of this real-time monitoring system raises awareness and compliance among medical staff and encourages an increased use of radiation protection utilities [9]. Overall, a dose reduction for medical staff of up to 45% has been observed [10]. In addition, our comprehensive patient dose-tracking software helps justify, optimise and control the dose to patients. By providing role-based support in the form of valuable exam and dose information to different individuals in the medical imaging workflow, our software solution helps healthcare institutions reduce patient dose, improve process quality and increase productivity in the imaging workflow while reducing cost.

CONCLUSION

The available data suggest that a holistic approach is required to ensure overall radiation safety. At Unfors RaySafe we continue to pursue our mission to help people avoid unnecessary radiation exposure. Our RaySafe range targets central aspects of radiation safety and help not only to ensure the performance of diagnostic X-ray equipment but also to optimise the dose to medical staff and patients.

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Unfors RaySafe is a Swedish medical engineering company that offers solutions for quality assurance of diagnostic X-ray equipment, for real-time dose monitoring and for patient dose tracking.

www.raysafe.com
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April 15 – 17, 2015, Bruges, Belgium

Workshop organisers
Philippe Lefere, Stefaan Gryspeerdt

16th Liver Imaging Workshop
April 24 – 25, 2015, Novi Sad, Serbia

Workshop organiser
Sanja Stojanovic

4th Pancreas Workshop
May 7 – 8, 2015, Athens, Greece

Workshop organiser
Charina Triantopoulou
Control of Patient Exposure using true anatomy measurements

More and more attention is being focussed on the need to avoid unnecessarily high levels of ionizing radiation in digital X-ray imaging. Modern digital imaging equipment incorporate automatic image brightness correction systems, so monitoring of potential over-exposure depends on the use of equipment safety features, such as the Exposure Index (EI).

However the accuracy of the EI can itself be affected if the anatomy of the body zone being imaged is not taken into account. To overcome this, a new software system has been developed to calculate a "true" EI value.

This article describes the general background to the issue of radiation overexposure and summarizes the principles behind the new software.

MINIMIZING RADIATION EXPOSURE FOR SAFER IMAGING IN THE PRE-DIGITAL WORLD

In the early days of X-ray imaging, when photo-sensitive film-screen radiology was the standard technology, the relation between the blackening of the photographic film and the radiation to which the detector (i.e. the film) had been exposed was clear and evident. Every X-ray technologist could adjust the dose by varying the mAs setting to achieve the desired, appropriate blackening of the film. In this way radiation exposure could be made more precise and was specific for each image. Thus, traditional screen-film systems use overall film density as an indicator of exposure. Direct feedback to the technologist regarding exposure was obtained simply from the appearance of the processed film image.

The optimization of the setting of the technical parameters (kVp and mAs) that affect radiation exposure is based upon the patient size, the body part and the radiographic speed of the screen film combination being used. In situations where automatic exposure control is not used (for instance, in the majority of small pediatric patients), the use of fixed exposure parameters requires the technologist to use experience and appropriate judgment to set up the radiographic techniques.

Since the mid-1990s, there has been a steady replacement of analog screen-film detectors by digital radiology detectors. This has been accompanied by an expectation that overall lower doses could be attained thanks to consistent image quality and a minimal need for retakes. Modern computed radiography (CR) and direct radiography (DR) devices have not only wide exposure latitude/dynamic ranges, but also capabilities for image post-processing that provide consistent image appearance even with underexposed and overexposed images. Thus, it is no longer possible to determine the correct settings of dose parameters and patient exposure simply from the image appearance, as used to be done with the density on a film image.

In digital systems, underexposed images have lower levels of X-rays being absorbed by the digital detector. Such images can be recognized by their "noisy" appearance. However this is not the case with overexposed images which can easily go unnoticed, resulting in unnecessary radiation exposure for the patient.

MAINTAINING QUALITY AND CONSISTENCY

In today's digital X-ray world, modern systems use automatic image processing, so the relationship between detector exposure and image brightness is not always obvious. The old method of visual control for detecting excessively high dosage is no longer available. Over-exposures will not be detected from different levels of brightness on the screen since the brightness is corrected automatically.

Exposure index (EI) is the measure of the amount of exposure received by the X-Ray detector and is an indication of image quality. EI in digital radiography can be considered as analogous to film speed and blackening in film-screen systems where the accuracy of the exposure was obvious based on the appearance of the image. Modern equipment manufacturers provide a recommended EI range for optimal image quality.
It is clear however that any errors introduced in the actual calculation of the EI will result in inaccuracy. This could be the case if the software used to calculate the EI fails to appropriately take the true anatomy of the patient into account.

**CALCULATION OF TRUE ANATOMY-BASED - EXPOSURE INDEX**

The Exposure Index module from the Swedish company ContextVision enables automatic monitoring of the digital X-ray system to continue to deliver correct exposure to the patient, and is adjusted for each anatomy and projection.

The “true EI” is still calculated according to the latest regulations for dose monitoring recommended by the International Electrotechnical Commission Standard. However in addition, it is based on an accurate measurement carried out only on the relevant image region.

The module automatically segments the true anatomy in the actual image. From this it calculates the average pixel value. The module then delivers a binary image mask (ROI mask) of the segmentation and mean pixel value of the ROI/true anatomy. This functionality also allows the ROI mask to be modified by a self-developed user interface so that the average pixel value will then be based on a corrected ROI mask.

The EI allows the operator to judge whether an image has been taken using a detector exposure level suitable for the intended level of image quality. [Figure 2, 3]

The explicit EI is equipment-specific and provided by the equipment manufacturer. EI is derived from the mean detector entrance exposure which is derived from the mean pixel value of the image.

The Exposure Index, EI is calculated by the equipment manufacturer, according to the standard issued by the International Electrotechnical Commission (IEC) [Reference 1] using the formula

\[
EI = c_0 \cdot g(V),
\]

where \( c_0 \) is a constant and \( g(V) \) is an equipment-specific inverse calibration function defined in the IEC standard.

**REGULATORY REQUIREMENTS FOR EXPOSURE INDEX**

Recognizing that the use of EI brings additional quality assurance to digital X-ray examinations and results in increased safety for the operator and lower exposure for the patient, Germany became, in 2012, the first country to introduce regulatory requirements for the use of EI. The new German regulations make it mandatory for all manufacturers to supply Exposure Index values for all digital X-ray units sold in the country.

It looks likely that the German regulatory action will be followed in other countries in the coming years.

**REFERENCES**


   The IEC 62494-1 standard specifies definitions and requirements for the exposure index of images acquired with digital X-ray imaging systems. IEC 62494-1:2008 is applicable to digital X-ray imaging systems used in general radiography for producing projection X-ray images for general applications, such as, but not exclusively: computed radiography (CR) systems based on stimulable phosphors; flat-panel detector based systems; charge-coupled device (CCD) based systems. Accessible at http://webstore.iec.ch/

**FURTHER INFORMATION**

A poster “Control of patient exposure with true anatomy measurements” will be presented in the Eurosafe Imaging session of the upcoming ECR meeting in Vienna, March 4th - 8th.
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Renewal of radiological equipment

In autumn 2014, a seminal paper was published by the ESR Working group on Economics [1] highlighting the fact that the rapid technological development over the last few decades has created new medical imaging modalities and methods, but that the speed of this progress has inevitably resulted in accelerated technical and functional obsolescence of the same medical imaging equipment, consequent-ly creating a need for renewal.

Not only has older equipment a high risk of failures and breakdowns, which might cause delays in diagnosis and treatment of the patient, but this creates safety problems both for patients and medical staff. The ESR encourages each healthcare authority to formulate a 5-year plan for the upgrade of medical imaging equipment.

In the current period of austerity and budget cuts, the challenge is huge but the costs of not renewing old equipment are high. This article summarizes the main points of the ESR paper.

Medical imaging has a crucial role in modern healthcare systems. It is almost impossible to appropriately diagnose and treat most health conditions without the use of state-of-art imaging equipment. Besides providing fast and accurate diagnosis, advances in radiology equipment offer new and previously non-existing options for treatment guidance with quite low morbidity, resulting in the improvement of health outcomes and quality of life for the patients. The European Society of Radiology is actively promoting the use of up-to-date equipment, especially in the context of the EuroSafe Imaging Campaign, as the use of up-to-date equipment will improve quality and safety in medical imaging. Every healthcare institution or authority should have a plan for medical imaging equipment upgrade or renewal. This plan should look forward a minimum of 5 years, with annual updates.

EVOLUTION IN MEDICAL IMAGING

Imaging equipment is high-tech material requiring advanced electronic and mechanical engineering, together with a functional design. This is a very active research sector. Decade by decade progress in technology offers considerable improvement in terms of quality and security, both for diagnostic and therapeutic imaging.

Increase in spatial and temporal resolution, combined with a better lesion characterisation, leads to identification and diagnosis of smaller lesions, with considerable impact on patient care, e.g. in cancer. Innovation in imaging technologies results in a better imaging quality while also improving security. Cardiac CT imaging is a typical example of the evolution towards lower radiation exposure levels while improving lesion conspicuity; the newest technology offers 10–30% the radiation exposure levels of systems 5 years ago. Based on this, newer technology, even though it is being used more, will lead to a reduced overall medical radiation exposure of the community.

Besides providing fast and accurate diagnosis, advances in radiology equipment offer new and previously non-existing options for treatment guidance with quite low morbidity, resulting in improvement in health outcomes and quality of life for patients.

EQUIPMENT LIFE CYCLES

Radiological equipment has a definite life cycle span, resulting in unavoidable breakdown and decrease or loss of image quality, which renders equipment useless after a certain time period. The state of the equipment is also affected by its utilisation and maintenance. The Canadian Association of Radiologists endorses general rules regarding the life cycle of various types of equipment based on their utilisation, which is categorised into three categories (high, mid and low) on the basis of number of exams per year, as shown in Table 1. In this, an “examination” is defined as technical investigation using a medical imaging modality to study a body structure, system or anatomical area that yields one or more views for diagnostic and/or therapeutic purposes. The figures for cardiac suite and angiographic procedures do not specify the ratio of diagnostic versus interventional procedures. As older equipment has a high risk of failure and breakdown, this may lead to crucial delays in the diagnosis and treatment of the patient. Moreover, older equipment might cause safety problems both for the patient and for the medical staff. Operating costs of older equipment will be high when compared with new equipment and sometimes maintenance will be impossible if no spare parts are available. Technical or functional obsolescence might deteriorate the functionality of radiology equipment.
It is known that equipment up to 5 years old reflects the current state of technology and offers opportunities for economically reasonable upgrade measures. Equipment which is between 6 and 10 years old is still fit to use if properly maintained, but already requires replacement strategies to be developed. Equipment older than 10 years is no longer state-of-the art and replacement is essential. It is recommended that at least 60% of the installed equipment in radiology departments should be up to 5 years old. Up to 30% should be 6–10 years old, whereas not more than 10% of equipment should be older than 10 years.

The age profile of radiology equipment hardware is not the only factor presenting the state-of-art status. Technological advances render some equipment obsolete, or require software and hardware upgrades to keep the existing equipment in the state-of-art status or simply in a satisfactory status for a certain period of time. But after a certain age, upgrade and even repair become no longer possible. Therefore equipment becomes progressively under-used and discarded, serving at best as a source for spare parts. Another limit of old equipment is its inability to be included in an up-to-date communicating environment which requires a high performance electronic infrastructure. Examples are telemaintenance, teleradiology, patient identity propagation and connection with the electronic patient record.

**ECONOMIC CONSIDERATIONS**

Modern healthcare is very competitive, and patients and healthcare authorities are demanding the best for the patient in most European countries. This can only be achieved by the use of state-of-art imaging technologies. However, imaging equipment is very expensive to install and maintain. The constrained healthcare budgets create dilemma in almost all countries. Practice in Europe is very diverse regarding the renewal of radiology equipment, as the consequence of considerable differences among healthcare systems in different states, percentage of GDP allocated for healthcare in specific countries, reimbursement policies in specific countries, regions and institutions, and many other factors, such as access rationalisation and equipment use optimisation.

In some countries (especially those with National Health Service types of centralised healthcare and universal coverage of population), austerity and efficiency policies are severely restricting the available finances for capital equipment. Also, the low or decreasing reimbursement for imaging procedures due to economic difficulties and spending policies results in longer periods of use of specific radiology equipment as it becomes harder or impossible for specific departments to obtain new equipment from the responsible health authorities, or as the cycle of return on investment is extended. This severely affects the whole health sector, both private and public, including academic departments, particularly in those countries—within the EU or outside of it—that are/were severely affected by the economic crisis. The fact that older equipment is used eventually results in higher costs due to the delay in diagnosis and treatment, and increasing maintenance costs.

However, specific data about these economic figures are lacking, but undoubtedly many departments have a considerable proportion of equipment in use that is in need of immediate replacement.

Local decisions rely on combination of multiple criteria: age, breakdowns and availability rate, operational costs, repair possibilities, medical benefit of the technology, functionality as regards the clinical requirements, image quality, safety (radiation), risk of claims, regulatory obligations, equipment efficiency (ergonomics, patient throughput), strategic factors such as attractiveness for the employees and patients. Experts (radiologists and biomedical engineers) should develop controls on image quality and ring alarm bells when appropriate care of patients is no longer offered. In parallel, users should prospectively gather precise data on equipment malfunction (number of hours of partial or total failure) and try to estimate its consequences (appointment delays, under-employment of human resources).

**GENERAL INCENTIVE MEASURES**

Health policies in some countries have set up different incentives leading to equipment quality improvement and transparency towards both requesters and patients. Examples of such measures are:

- Regulatory obligation of specific mentions in the medical report about the type and age of the equipment used, the radiation dose for tech-

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**Table 1.** Medical imaging equipment life expectancy guidance (utilisation and age-related) adapted from [1]. In the above table, HIGH utilisation means 24 h/day 5 days/week or 750 8-h shifts/year; MID means 16 h/day 5 days/week or 500 8-h shifts/year and LOW means 8 h/day 5 days/week or 250 8-h shifts/year.
BARTHOLOMEW, STELLA

Technologies using X-rays, all these data being indirect information to assess the quality of the examination
• Regulatory obligations to measure and optimise the radiation dose
• Quality control of the equipment (security, image, radiation)
• Reimbursement models on fees for exam, taking into account the level of performance of the equipment, its age and possible upgrade.

However, specific regulations in different European countries vary or sometimes do not exist at all.

**RECOMMENDATIONS**

Every healthcare institution or authority should have a plan for medical imaging equipment upgrade or renewal. This plan should look forward a minimum of 5 years with annual updating. Studies have shown that the lifetime of medical equipment will be prolonged by up to 50% if it is not utilised often compared with institutions with high utilisation rates of the equipment. Also, if maintenance is ignored, equipment lifetime will be shortened by up to 50%. Another consideration will be the changes in medical practice which will affect the need for some types of imaging.

Within an environment where decisions are mainly driven by financial considerations, business models should include the global cost for running equipment and not purely the acquisition cost. Decisions should intelligently take into consideration not only immediate results but also the cost of poor quality, errors and diagnostic delays.

The ESR strongly promotes the use of up-to-date equipment also in the context of the EuroSafe Imaging Campaign, as the use of up-to-date equipment will improve quality and safety in medical imaging. The ESR’s general position is that equipment which is up to 5 years old has state-of-the-art technology. Properly maintained equipment which is between 6 and 10 years old is still suitable for use. However, a replacement strategy has to be developed. If equipment is older than 10 years, it is not accepted as state-of-the-art equipment and replacement is essential.

**REFERENCE**


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**FIGURE 1.** A graphical representation of the problem of Europe’s aging medical imaging equipment. The diagram was produced by GE Healthcare (www.gehealthcare.com) and presented here with permission. A sister division of GE Healthcare, namely GE Capital has also produced country-specific reports (www.gecapital.com)
Making personalized breast care a reality

As one of the most prominent radiologists specializing in mammography in Spain, Dr Rafael Salvador’s goal is the establishment of advanced diagnosis for his patients. In the private clinic of which he is Director, they provide women with a low dose mammogram of outstanding image quality which can also help to objectively quantify breast density. This paves the way to the establishment of more precise risk assessment and personalized care. Dr Salvador uses MicroDose mammography SI’s unique Spectral Breast Density Measurement application to support personalized breast cancer care.

This article summarizes his experience with and opinion of the MicroDose SI system.

EXCELLENT IMAGE QUALITY WITH LOW DOSE

Dr Salvador has been familiar with MicroDose SI since its conception. He has carried out extensive research on the system, as well as on other full-field digital mammography (FFDM) systems.

“I knew that photon counting was an advanced scanning technology for Mammography and that behind it there was a well-established yet innovative company like Philips. Therefore it finally had all the conditions that I consider necessary: a financially stable and reliable company; a technology that, for me, is one of the best; and also what I’m offering to all the patients: superb technology with low radiation which is in alignment with the ALARA (as low as reasonably achievable) principle.”

According to Dr Salvador “MicroDose SI has surpassed even my original high expectations, on two very important criteria. Firstly, the outstanding diagnostic quality of the images and secondly, what is critically important: low dose. We’ve noticed a dose reduction much more significant than what we had originally planned.”

Several studies have shown that MicroDose Mammography can provide outstanding image quality at 18% to 50% lower dose than used on other digital mammography systems, with an average dose reduction of 40%[1], [2], [3], [4].

A recent study comparing MicroDose Mammography with other FFDM systems shows that the Mean Glandular Dose of the MicroDose system was significantly lower than that of the subgroup of conventional DR systems (0.60 vs. 1.67 mGy), even though the mean compression thickness was higher (61 mm vs. 59.4 mm). The Philips MicroDose photon-counting system enabled a higher overall cancer detection rate for subsequent screening compared with the statewide rate (0.76% vs 0.59%, P<0.05) at a higher recall rate (5.4% vs 3.3%, P<0.05)[5].

Dr Salvador stresses the importance of low dose, clearly stipulating, “The radiation dose to which I expose...”
my patients is crucial. In mammography the important point is the detection of cancer in preclinical stages, which involves the radiation of healthy women – therefore, the less radiation, the better”. He continues by saying “patients want zero dose. However that does not yet exist; what does exist, and what we can offer is a dose that is almost negligible. Patients frequently tell us that they are worried in case the radiation can “provokes” something they don’t already have. They know that radiation is involved but trust that the end justifies the means. They are reassured when we can tell them that with the MicroDose SI, radiation dose is very low”.

MicroDose SI features industry-leading 50 μm spatial resolution, which offers exceptional image quality. Dr. Salvador explains, “...this equipment is unique, as the examination is done with a scanning motion and the detector counts directly each photons using only one conversion step. Typically, in the handling of images, quality may be compromised with each conversion step in the processing of the image. As this system is direct digital, it is really efficient”. This outstanding image quality facilitates fast and confident diagnosis. Dr Salvador stresses the importance of this as better patient care can be achieved, “advanced diagnosis is our goal– this is a philosophy we endorse, and will practice in everything we do, every day. If we can diagnose breast cancer before the tumor becomes untreatable, we will have fulfilled our mission”.

Based on his experience, Dr. Salvador recommends MicroDose SI to other colleagues, and emphasizes that “in 39 years I have worked with a multitude of mammography systems – different technologies, from various vendors but in my opinion MicroDose SI achieves superb performance”.

A SYSTEM THAT HELPS THE CLINICAL CENTER

Being a private clinic, one of the biggest challenges for the Imagine clinic is to manage and maintain costs – Imagine is a small clinic, offering women an exceptional, personalized service for the care of their health and wellbeing. However, this comes with a cost. Dr. Salvador emphasizes efforts undertaken to “maintain the level of patient care and quality service every day”, something that they can achieve by renewing and incorporating technology to suit their needs, and ensuring that professionals and technicians are well trained and equipped with profound knowledge of these new techniques.

"Since the installation of the MicroDose SI, we have noticed a substantial increase of women to the center - even women who had gone to another facility closer to their homes came back - something positive for a small, private center, such as ours” explains Dr Salvador. Conclusively, staff at Imagine consider MicroDose SI to be a breakthrough technology.

Alberto Chacon, who is Coordinator of Technicians in the Imagine Center adds “It’s a very simple system to work with every day, it has no complication. The team from Philips explained the system to us in just two days, and within a week we had already resolved issues that can be expected in learning a new technology, and had the confidence to work with the system without any problem... The system provides exceptional image quality without the need for manual adjustments”.

REFERENCES
4. White paper, Comparison of Dose Levels in a National Mammography Screening Program, Philips Healthcare
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Prostatic Artery Embolization (PAE): a novel treatment option for patients suffering from Benign Prostatic Hyperplasia (BPH)

The minimally invasive catheterization technique known as prostatic artery embolization (PAE) is showing promise as an outpatient treatment for patients suffering from the increasingly prevalent condition of prostate hyperplasia. Pioneered by a Brazilian radiologist Prof C Carnevale, the procedure began U.S. Food and Drug Administration - approved trials last year in twelve medical centers in the USA and Europe.

Benign Prostatic Hyperplasia is a common condition usually affecting men over 50. Caused by normal aging processes and influenced by hormones, the prostate grows and may cause symptoms of the urinary tract such as frequency, urgency, nocturia (wake up during sleep), as well as burning or pain while voiding.

The prostate is a small gland (25-30 grams) surrounding the urethra. As a natural process it starts growing in men at the age of around 25. This non-cancerous growth of the prostate volume causes a gradually increasing compression of the urethra as well as a constriction of the bladder outlet resulting in intermittence of urinary stream and finally permanent storage of urine in the bladder due to incomplete voiding. For men suffering from these symptoms, the quality of life drops remarkably.

Mild symptoms of BPH are treated via drug therapy, which reduces the size and increases the softness of the glandular tissue and hence relieves the compression of the urethra. The common treatment of advanced BPH with prostate volumes smaller than 100 grams is the less-invasive surgical method known as TURP (trans-urethral resection of the prostate). For even bigger prostates with a volume of more than 100 grams, usually an open prostatectomy (complete removal of the prostate in open surgery) is performed. Although these surgical procedures have been carried out for more than 20 years with very good results, invasive treatment techniques carry an increased risk of infection, and may cause impotence and transient or even permanent urinary incontinence. In addition, patients undergoing TURP often complain about retrograde ejaculation as a displeasing consequence of TURP treatment.

In the last two or three years, experts in Interventional Radiology have developed a new – minimally invasive – treatment method for BPH, called Prostatic Artery Embolization (PAE). Through a small incision in the groin, a catheter is inserted into the femoral artery and pushed forward toward the arteries feeding the prostate. With the catheter being positioned precisely, small particles or microspheres are inserted into the prostatic arteries until the particles occlude the vessels. As a consequence, the supply of blood and hence of oxygen and nutrition to the prostate is blocked which finally causes a shrinkage in prostate volume. The entire procedure takes 1.5 – 2 h, and it can be repeated several times for the same patient over the years. PAE can also be applied to convert an open surgery candidate (prostate bigger than 100 grams) to less-invasive surgery such as TURP.

PAE is less stressful for the patient's body compared to surgical procedures since the patient is not required to receive general anesthesia. PAE can even be performed as outpatient procedure. PAE is very well suited for patients who do not qualify for surgery, are afraid of surgery or deny surgical treatment. In this way, it offers an effective treatment to a wider range of men suffering from lower urinary tract symptoms. More than 1,000 patients have been treated so far and experience shows that PAE is safe, effective and associated with very low side effects. Patients undergoing PAE do not suffer from impotence, urinary incontinence or retrograde ejaculation after treatment, as seen with some patients after surgical treatment.

In an aging population with an increasing number of men suffering from BPH, the financial impact on health-care and society is huge. Safe and cost-effective treatment methods are in great demand. According to a study published in 2005, 4.4 millions BPH patients consult their urologist per year in the US alone, more than 117,000 emergency room visits, 105,000 hospitalizations, and 20-40 Million hours of lost productivity accrue from BPH per year in the US with a yearly impact of $3.9 billion.
Case study

Benign Prostatic Hyperplasia

PATIENT HISTORY
A 66-year-old male with benign prostatic hyperplasia (BPH).

The patient had received drug treatment (alpha blockers and 5 alpha reductase inhibitors) for one year. His symptoms worsened gradually to the point where the patient needed invasive treatment due to major dysuria.

The patient rejected transurethral resection of the prostate (TURP) because he was afraid of potential side effects such as urinary incontinence or impact on his sexual life.

The patient was referred to interventional radiology for prostatic artery embolization after multidisciplinary discussion.

DIAGNOSIS
Prostate volume: 60g,
Prostate specific Antigen (PSA): 0.85;
International Prostate Symptom Score (IPSS): 13;
Quality of Life (QoL): 4;
Flow Max 5ml/s

TREATMENT
Bilateral prostatic artery embolization using 300 – 500 μm Embospheres (Merit Medical).
A homogeneous solution of 2 mL spheres combined with 10 mL contrast agent and 10 mL saline. Fathom .014” steerable microwire (Boston Scientific) and 2 Fr Progreat Microcatheter (Terumo).

Assessment of prostate in preinterventional MRI for identification of central gland and transitional/ peripheral zone before intervention.
Foley catheter filled with contrast medium and saline placed and used as basic landmark in 2D imaging.
syno DynaCT imaging when catheter in left/right iliac artery for assessment of 3D vessel tree and identification of prostatic arteries using access path planning software syno Embolization Guidance [Fig. 1A, 1B], syno DynaCT with reduced dose (5s syno DynaCT Body CARE protocol, 248 projections) with hand injection of diluted contrast agent via catheter in right prostatic artery to exclude non-target embolization.
This CBCT was acquired with the angiography system on the left side of the table to reach pelvic area also in taller patients.
Successful superselective embolization with very slow injection into right and left prostatic artery until stasis was reached.

COMMENTS
The procedure requires a thorough understanding of the vascular anatomy and use of CBCT technology to exclude non-target embolization. It was possible to show that a 5s syno DynaCT Body CARE run provides sufficient image quality to confirm safe catheter position, while saving about 37 % dose compared with a regular 6s syno DynaCT Body.
Injection of diluted contrast is mandatory to obtain optimal syno DynaCT imaging.

With cranial/caudal collimation during syno DynaCT acquisitions, dose can be reduced while image quality improves even further due to less scatter radiation. syno Embolization Guidance for faster navigation to the target vessel saves contrast media, shortens fluoroscopy time, and enables dose reduction [Fig. 2].

Acknowledgement

The case study above was kindly supplied by Dr M Sapoval, Head of Department of the Vascular and Oncological Interventional Radiology at the Hopital Européen Georges Pompidou, Paris, France.

The imaging studies on the case study presented above were carried out by Dr Sapoval using a syno Dyna CT system from Siemens. Further information on PAe is available from Siemens (Axiom Innovations November 2014 (www.siemens.com/angiography)
UKRC 2015 PROGRAMME

The UKRC programme once again brings together an impressive and diverse range of high-profile speakers, keynote and ‘state of the art’ lectures from the UK, Europe, North America and the Far East. The 3 day event offers 8 specialist streams; eminent lectures from SCOR, IPEM and BIR; interactive voting; OsiriX workstations and FRCSR VIVA tutorials, along with exciting new features for 2015.

Along with interactive and informative sessions in a range of presentation styles, this event is less than 2 months post a UK general election, therefore our plenary sessions will also address the key controversial questions and provide a glimpse of the future and ideas on evolving practice.

The exhibition complements the main programme, bringing the top companies in the industry to showcase the latest developments and technical updates; a full programme of satellite sessions; CPD NOW education on the stands; poster displays, ePoster consoles and much more, making this the largest clinical imaging exhibition in the UK.

Inspiring keynote and ‘state of the art’ lectures:

• Internationally renowned speaker Prof Sir Muir Gray who will deliver the opening plenary lecture on ‘From quality to value - population and personalised imaging’.

• Join the Question Time debate! - ‘Is outsourcing the silent killer of the NHS?’ Discussing by a top panel, including Dr Clive Peedell and Pam Black, taking questions from the audience

• Prof David Townsend who will deliver a plenary session on cutting edge imaging titled ‘PET/CT where did it come from and where might it be going?’

• One of the inventors of the CT scanner Prof Willi Kalender from the University of Erlangen, Germany who will discuss the ‘CT: even faster, even more resolution’.

HIGHLIGHTS

EXCITING NEW FEATURES FOR 2015

In addition to the streams, interactive workshops and plenary sessions, we aim to evolve the programme based on your feedback – we are delighted to include these new elements into the programme and exhibition.

Drop-in programme - ‘Know your Rs from your elbow’! Informal drop in sessions covering the basic terminology of PACS, RIS & VNAs for radiologists.

A giant PACS touchscreen tablet
A giant touchscreen MDT table to look at use for anatomical teaching, hands-on PACS review and demonstrations in MDT meetings, pre-operative planning, medical education and presenting clinical case studies.

A directory of exhibitors by product and/or service to help you identify organisations you wish to engage with, along with a discussion zone for procurement managers and exhibitors to meet.

For all programme updates, view the live interactive programme planner at www.ukrc.org.uk
Impact of anatomical noise on nodule conspicuity: a comparative study between digital radiography, dual-energy imaging, and digital tomosynthesis

In this article, we present an overview that compares the relative impact of anatomical noise reduction in dual-energy x-ray imaging (DE) and digital tomosynthesis (DT) on lung nodule conspicuity. Both technologies have been available for a few decades, but with digital detectors becoming faster, cheaper, and ubiquitous, these advanced imaging applications have become increasingly promising for clinical use. Below is an introduction to the assessment of anatomical noise using an anthropomorphic chest phantom imaged across three modalities: digital radiography (DR), DE, and DT. The results are further used to provide some insight on how to optimize acquisition parameters by increasing image quality while minimizing patient dose.

BACKGROUND ANATOMICAL NOISE

Depending on the imaging task at hand, a given anatomical structure can be either a structure of interest or constitute a confounding background of the image. For example, if a radiologist is searching for a nodule, the overlapping ribs, the lungs, and vessels are background structures that may confound the detection of the nodule. Anatomical variations in the image not associated with the structures of interest can be labeled as background anatomical noise.

Studies investigating the relative influence of quantum noise (random fluctuation in the image observed as mottle) and background anatomical noise in the chest have demonstrated that anatomical noise can far outweigh the impact of quantum noise. [1] In medical imaging, there are broadly speaking two approaches to reducing background anatomical noise: Tissue discrimination via the enhancement of tissue such as contrast injection or via tissue removal such as dual-energy imaging [2,3] (see Fig 1) or Spatial discrimination by the separation of overlapping structures such as in CT [4] and digital tomosynthesis [5] (see Fig 2).

QUANTIFYING BACKGROUND ANATOMICAL NOISE

The noise power spectrum (NPS) is a metric widely used by scientists to quantify image noise by measuring the noise contribution across a range of spatial frequencies. For example, noise on the scale of small features will have a NPS greater at higher frequencies while noise on the scale of larger features will have a NPS greater at lower frequencies. The generalized NPS (GNPS), which includes the...
background anatomical noise, provides a useful metric for quantifying and comparing anatomical noise across various medical images. Background anatomical noise tends to exhibit low-spatial frequencies while quantum noise exhibits higher spatial frequencies. See the following references for more details on quantum and anatomical noise assessment. [6] [7]

**DEFINING A METRIC FOR NODULE CONSPICUITY**

The noise power spectrum can be combined with a mathematical form of an idealized task function that describes the spatial frequencies of interest associated with a given imaging task. For example, this can be the 2D signal of a nodule used for the modeling of a detection task. The ratio of the feature’s signal and image noise provides a spatial-frequency dependent signal-to-noise ratio figure of merit. The resultant function can be mathematically integrated to yield the detectability index $d'$. This scalar metric has been shown to provide a meaningful surrogate for estimation of nodule conspicuity. [7] [8] In this work, $d'$ is defined as follows: in Equation 1

$$d' = \sqrt{\int \frac{\text{Task}_{\text{image}}^2(u,v)}{\text{GNPS}(u,v)} \, dudv}$$

where $\text{Task}_{\text{image}}$ denotes the image task function and $\text{GNPS}$ denotes the generalized noise-power spectrum which describes anatomical noise and quantum noise in the image. The $u$ and $v$ variable denote the vertical and horizontal spatial frequencies in a 2D image.

**EVALUATION OF NODULE CONSPICUITY USING AN ANTHROPOMORPHIC CHEST PHANTOM**

An anthropomorphic chest phantom (LUNGMAN, Kyoto Kagaku, Japan) with a spherical nodule feature (0.5 cm, 100 HU) was imaged using DR, DE, and DT with the same in-room system. The x-ray room employed a 43x43cm flat-panel detector. An image of the phantom is shown in Figure 3 with the simulated nodule.

A standard chest DR provided a performance reference level. The PA image was acquired using automatic exposure control (AEC) to achieve a 400-speed equivalent image.

The DE images were acquired with fixed and differential filtration to evaluate the impact of using a different x-ray filter on dose efficiency. Differential filtration implies that the filter is changed between the low- and high-energy images thus improving the separation of the two x-ray spectrum yielding higher contrast and lower noise in the resultant DE image. [9]

The nominal “100 %” dose level for the DT images were acquired at approximately 8 times the exposure of the PA with a total of 60 projection images. Tomosynthesis images were also acquired at two other dose levels: 30% and 50% of the nominal dose. The three dose levels are denoted DT30%, DT50%, DT100%. The images were reconstructed using a standard filtered back projection algorithm.

The image task function was computed from a region extracted around the nodule. This provided a method for evaluating the node's contrast and shape across DR, DE, and DT acquisitions. The Fourier transform of the nodule's signal yielded the task function. Figure 4(a) illustrates the nodule used for the computation of the task function [Fig. 4(b)] for the DE image. The nodule detection task function was found to weigh mostly lower frequencies due to its larger size (compared the pixel area).

The image noise (GNPS) was estimated via Fourier spectrum
The noise results were combined with the nodule’s signal (TaskImage) - see Eq 1 - to generate the detectability index (d’). The detectability index was further normalized by entrance surface exposure (ESE), denoted $d’_{\text{norm}}$, to provide a dose-efficiency metric to compare across acquisition protocols and modalities.

**RESULTS: COMPARISON OF X-RAY MODALITIES**

Figure 5 contains images used for the evaluation of nodule conspicuity across DR, DE, and DT and for different acquisition settings. The impact of tissue and spatial discrimination on the reduction of overlying lying structures is appreciable, where nodule conspicuity is improved in both DE and DT compared to DR.

Figure 6(a) plots the detectability index values for DE fixed and differential filtration. The results in each case were normalized such that $d’=1$ for DR. This provides a relative metric to compare with the standard of care used in x-ray room. The values for $d’$ are 1.2 and 1.3 for fixed and differential filtration, respectively. Therefore the overall performance between the two approaches is similar and indicates improved conspicuity compared to DR. When the results are further normalized by dose [Fig 6(b)] the values for $d’_{\text{norm}}$ are 0.7 and 1.1 for fixed and differential filtration, respectively. This indicates that fixed filtration is significantly less dose efficient than differential filtration. Furthermore, a $d’_{\text{norm}}$ value of less than 1 for fixed filtration indicates that it is less dose efficient than DR for the modeled nodule detection task – even if it has improved conspicuity.

Figure 7(a) plots the detectability index values for tomosynthesis at three dose levels. The results for $d’$ are 11.8, 14.6, and 18.1 for DT30%, DT50%, DT100%, respectively, where...
d’=1 for DR. This indicates a substantial improvement in nodule conspicuity for DT compared to DR. For dose normalized d’, we measured values of 7.8, 7.7, and 5.9, for DT30%, DT50%, DT100%, respectively - see Fig 7(b). From these results we observe that DT becomes anatomical noise limited as opposed to quantum noise limited – meaning that after a certain dose level, (i.e., DT50%) the most important limiting factor to conspicuity is anatomical noise not quantum noise. This is indicated by the drop in dose efficiency at DT100% compared to DT30% and DT50% and suggests an ideal operating point for DT acquisitions.

CONCLUSIONS
The study provides a useful method for the comparison of imaging performance across x-ray modalities and settings. Both DE and DT can provide improved nodule conspicuity via reduced anatomical clutter and better use of the x-ray information compared to DR - exemplified by a d’norm value greater than 1. For DE imaging, the results indicate that differential filtration provides significant dose efficiency compared to fixed filtration. For DT imaging, the method provides a framework for identifying which dose level yields the most dose efficiency for a given task. The results indicated that DT can become anatomical noise limited as the dose is increased beyond a certain dose level. Further work will look at the impact of other factors such as patient size, pixel binning of the detector, and the use of an anti-scatter grid.

REFERENCES.
Imaging Decision Support in the Emergency Department: what do providers want and will they use it?

Although computerized decision support for imaging is often recommended for optimizing computed tomography (CT) use, no studies have evaluated emergency physicians’ (EPs’) preferences regarding computerized decision support in the emergency department (ED). This article summarizes an investigation to determine if EPs view overutilization as a problem, if they want decision support, and if so, the kinds of support they prefer. The results of the study showed that emergency physicians view overutilization of CT scans as a problem with potential for improvement in the ED and would like to have more information to discuss risks with their patients. EPs are interested in all types of imaging decision support proposed to help optimize imaging ordering in the ED and to reduce radiation to their patients.

CT has been a transformative tool in medicine, perhaps nowhere more so than in the emergency department (ED). However, increases in CT utilization over the past decade have raised concerns about both costs and associated increased risks of cancer from radiation. Though the estimated risks of cancer from low-dose ionizing radiation remain somewhat controversial, concern about overuse is less so. It is not uncommon for patients to undergo repeat or multiple CT imaging both in the ED as well as in other settings, some of which may be avoidable. Data suggest that in the United States, while the overall rate of CT imaging plateaued between 2008 and 2010, this trend did not hold not true for imaging in the ED [1-3], where it is estimated that one in seven patients undergoes CT scanning, accounting for 25% of CT scans performed in the US [4]. This reflects in part larger trends as to where Americans get their acute care: ED visits increased nearly 30% between 1996 and 2007 to 117 million annual visits, and EDs now account for nearly 30% of all acute care visits and 50% of hospital admissions in US hospitals [5-7]. This nevertheless presents an opportunity for improvement in optimizing imaging utilization that deserves input from those making imaging decisions.

“...Though the estimated risks of cancer from low-dose ionizing radiation remain somewhat controversial, concern about overuse is less so...”

Although technological solutions to reduce radiation dose-per-study have made significant progress, perhaps the biggest opportunity for reductions in utilization and associated radiation lies at the point of imaging order entry. Various approaches have been proposed to help improve utilization and/or cumulative radiation, including preauthorization requirements, use of clinical decision rules (CDRs), consensus-derived evidence-based rankings of the appropriateness of different imaging studies for a given indication, such as American College of Radiology’s (ACR) Appropriateness Criteria (AC) [8]. Other approaches include patient and provider education campaigns with tracking of patients’ cumulative radiation doses [9,10] and "soft stops" such as peer-to-peer consultation [11,12]. As more clinicians use electronic medical records, increasingly these approaches are provided as computerized decision support (CDS) within electronic order entry systems.

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These efforts have had varying levels of success [13-18] and the development of a useful tool does not guarantee its adoption and spread. For example, one study found that up to one third of all chest CTs performed for suspected pulmonary embolus could have been avoided with the appropriate use of D-dimer testing for low or intermediate risk patients [13]. Several studies have explored problems with the adoption of the Ottawa ankle rules [19-21] Indeed, how to improve the dissemination & implementation of evidence-based imaging guidelines and decision support is the focus of an upcoming consensus conference at a meeting of the Society for Academic Emergency Medicine in May 2015.

NEED FOR THE OPINION OF THE CLINICIAN TO BE HEARD
What has been missing in the evaluation of various attempts to provide decision support to date is the voice of the clinician: whether providers on the front line want Clinical Decision Rules (CDRs) for CT order entry, what kinds of information if any they want, and what they would do with this information. Specifically, we also wanted to learn whether providing other kinds of information for decision-making that cut across indications might be perceived as valuable to clinicians. CDRs for imaging in the ED are frequently focused on determining whether any imaging is indicated, whereas guidelines such as the ACR-AC are directed at determining what imaging study is the most appropriate, given that imaging is indicated. Though CDRs can have great utility, because they are necessarily directed at discrete clinical scenarios (e.g. “rule-out pulmonary embolus”) and are time-consuming and expensive to derive and validate, relatively few robust CDRs have been developed and tested in a rigorous fashion. Though the ACR-AC can be very helpful, the studies these guidelines rank for a given indication often include choices that are either not available in many EDs, particularly at nights or on weekends, or that simply are not commonly in contention or consideration for use in the ED setting.

“...one study found that up to one third of all chest CTs performed for suspected pulmonary embolus could have been avoided with the appropriate use of D-dimer testing...”

We sought to determine whether EPs would be interested in receiving information such as the effective dose of a study being ordered, patients’ prior CT count, cumulative radiation, associated lifetime attributable risk of cancer, recommendations for alternate studies and presence of features placing a patient at increased risk from radiation or increased risk of repeat/multiple imaging prior to ordering a CT.

STUDY DESIGN
To this end, we conducted a study of emergency physicians to evaluate their attitudes, and preferences and knowledge related to CT utilization, radiation risks, and interest in decision support, including information they think might be useful in decision-making. We emailed EPs in the St. Louis, Missouri metropolitan area working in academic, community and hybrid clinical settings to participate in an anonymous web-based questionnaire using standard survey methodology. The overall response rate was 63% (155/235). To make the results digestible, we conducted principal components analysis, which is a data reduction technique to identify themes in survey data.

RESULTS:
Five main themes emerged:
1) respondents felt overutilization of CT is a problem in the ED with a significant opportunity for improvement;
2) a patient’s cumulative CT study count affects decisions of whether and what type of imaging study to order only some of the time;
3) knowledge that a patient has had prior CT imaging for the same indication makes EPs less likely to order a CT;
4) concerns about malpractice, patients’ satisfaction or insistence on CT imaging affect CT ordering decisions.
5) EPs want decision support before ordering CTs.

Greater interest in decision support was associated with lower knowledge scores, feeling that CT study count more frequently affects the decision to order a CT, particularly for the same indication, and that overuse of CT is a problem, though this model only accounted for 31% of the variance of interest in decision support.

Because most patients do not have high CT study counts, it makes sense that most EPs responded that cumulative CT study count only affects the decision to order a CT some of the time. Providers wanted all forms of decision support offered, including information on effective dose of studies being ordered and patients’ cumulative exposures. However, they feel inadequately familiar with this information to make use of it clinically, which is understandable, since how best to do so remains unclear. EPs indicated that if provided with patients’ cumulative radiation exposures from CT and estimates of LAR of cancer, 87% of them would use this information to discuss imaging options with their patients, which is recommended but in practice only infrequently done [22-25].

Performance on knowledge questions, which were primarily drawn from prior studies, was poor. Only 18%
to 39% correctly responded to each of the three multiple-choice items about effective radiation doses of chest radiograph and single-pass abdominopelvic CT, as well as estimated increased risk of cancer from a 10-mSv exposure based on the BEIR VII unadjusted risk model. This is consistent with findings of prior studies across specialties, which demonstrate poor knowledge as relates to estimated effective doses and equivalencies [22,26-29]. The finding that a lower total knowledge score was independently associated with increased interest in decision support may reflect appropriate self-awareness of the need for assistance in decisions to use CT imaging in the ED.

Availability of alternate imaging options, such as magnetic resonance imaging and ultrasound, especially during evenings, nights, and weekends, was strongly felt to be a barrier affecting the decision to order a CT. EPs agreed that concerns about malpractice, patient satisfaction, patient insistence on CT, and pressure from other physicians were important factors in imaging decisions. These are increasingly important considerations given the noted trends for physicians to refer patients for evaluations in the ED and the increasing focus on patient satisfaction in evaluating physician performance. Though recent data argue against tort reform impacting CT imaging rates, the costs of defensive medicine are high, the specter of malpractice looms large, and true safe harbor legislation for use of CDRs, for example, remains to be tested [30-33].

CONCLUSION
In summary, EPs recognize CT overuse as a problem and are interested in reducing utilization and radiation exposure in the ED. Although EPs feel that imaging history affects decision-making only some of the time, when they know that a patient had a history of CTs for the same complaint, they report being less likely to order a CT for that patient. Despite feeling unsure about how to use effective dose information clinically, EPs wanted this information in addition to all other forms of decision support offered in the questionnaire and indicated that if provided with this information they would use it in discussions of risk with their patients. Interventions to increase the availability of imaging alternatives to CT, and to address outside pressures to perform CT scans, might also affect utilization of CT in the ED. Future efforts should focus on whether providing decision support and interventions on other modifiable factors affects CT decision-making and utilization in the ED.

REFERENCES
10. Image Wisely: Radiation Safety in Adult Medical Imaging.
As recent evolutions in medical imaging have produced more complex exams, it has become necessary to develop more advanced, multi-functional display technologies. Until recently, display technology advancement has not kept pace with the demands of modern imaging. Complex multi-headed workstations still occupy a large physical footprint in today’s typical radiology rooms, where workstations can have a mis-matched array of displays with varying resolutions, color appearance, or indeed no color monitors at all.

One of the real disadvantages of these large display configurations is the resulting ergonomic strain experienced by a radiologist due to the need to frequently move his head to view all of the images in a single study. In addition, each time he refocuses on a particular region of interest or significantly increases his dwell time on a large display, he loses productivity. The fundamental reason for this is that the human eye reaches its optimal viewing performance in a relatively small field of vision, resulting in more efficient (and thus more productive) reading. Therefore, if display performance could be optimized for the field of vision, one could theoretically maximize productivity while minimizing occupational stress.

**CONCLUSION**

The 24-page White Paper describes in full the extent and shape of the field of vision and also describes the factors affecting image quality in the field of vision.

The quality of images in the radiologist's field of vision is an important criterion in the selection of a medical display to optimize performance, diagnostic accuracy and radiologists' comfort during image reading sessions. By designing the ideal display form factor as well as enhancing display parameters, such as local contrast, color, luminance, and viewing angle, Barco has created a diagnostic imaging solution that optimizes the reading experience. The result: enhanced productivity and less occupational stress and strain for the clinician.

The field of vision has an extent of +/- 30 degrees; within this range, shapes and colors can be readily observed. The most comfortable portion of this area is limited to near eye-level and below, suggesting an ideal size for a medical display.

The Coronis Uniti has been designed to fill this field of vision, featuring vast real estate to prevent the need for auxiliary diagnostic displays. The fusion format eliminates distracting bezels and allows the valuable space in the middle of the field of vision to be used for image data. Studies show that a bezel-free widescreen display can increase radiologist productivity by enabling them to read faster, with less eye strain.

To optimize the field of vision, every aspect of the display image quality has been specifically designed for the task.

- Barco’s Optical Glass reduces blurriness.
- Local contrast has been dramatically improved, making the image contrast of real images up to 12 times higher than before.
- Reflections have been reduced by a factor of three, making the display more tolerant of ambient light.
- Spatial resolution matches that of a 5MP display, allowing optimum perception of fine details, not only for mammography but also for challenging radiology work.

- Calibrated color provides repeatable, evenly spread colors that are bright and vivid.
- Improved detectability of objects is achieved by the combination of stronger signal and lower noise, resulting in an improved contrast-to-noise ratio, thanks to two proprietary features: DuraLight Brilliance and Per Pixel Uniformity.

With the Coronis Uniti, radiologists can optimize their diagnostic image reading experience by utilizing a display that is tailored to their visual “sweet spot,” with features that are optimized to deliver the best image quality. Featuring the latest in imaging technology and ergonomic design, the Coronis Uniti is the ideal choice for managing the myriad of studies and images that make up the busy day of any radiologist.

The full white paper is available from Barco (www.Barco.com) Further information can be obtained from the author of the White Paper, Albert Xthona, Product Manager, Barco Healthcare. (albert.xthona@barco.com)
ESC CONGRESS
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Where cardiology comes together
Improving patient and staff safety and ensuring healthcare excellence are the primary goals of every quality assurance (QA) program for X-ray devices. However, advances in medical imaging technology and a growing, ageing population means that the number of scans performed is increasing. These factors ensure that whenever QA processes are discussed, efficiency is a key watch word from a cost and test time perspective.

A basic QA program to control diagnostic image quality consists of a series of routine, standardized tests to detect changes in x-ray equipment function, using original performance as the baseline. QA measurement efficiency is determined by two factors: appropriate processes to test, evaluate and record data; and equipment performance.

Whilst there are differences in hardware sold for X-ray QA programs in terms of accuracy, precision, sensitivity and range, these are not as great as they used to be, thanks to improvements in semiconductor technology. Many X-ray meters boast ‘one shot’ operation, requiring just one exposure to capture the relevant beam parameters. Similarly, all-in-one devices combining radiography, fluoroscopy, mammography, dental and CT capabilities are now commonplace. Arguably, selecting an all-in-one multimeter that is capable of one-shot measurement is a first step towards ensuring workflow efficiency.

Potentially the greatest workflow efficiency improvements can be realised by refining the measurement gathering process, and in this, access to the latest software is key. With appropriate set-up, contemporary test software can semi-automate test procedures by directing users through a prescribed set of test protocols. By applying an appropriate test workflow, errors can be minimised and ultimately, test time decreased.

Henrik Bertilsson is Medical Physicist for the Kronoberg region of Southern Sweden and the QA of X-ray equipment for two hospitals comes under his remit. Bertilsson explains: “I am currently responsible for more than 30 X-ray units, including 4 CT scanners, 3 interventional systems, 6 conventional radiographic systems, 4 mobile units, 9 surgical C-arms, 6 panoramic systems plus a CBCT for dental radiology. In addition, I am in charge of acceptance testing over a hundred intraoral units for dental applications throughout our region.”

As with any standard QA program, all imaging equipment in Kronoberg undergoes an initial acceptance test prior to routine service, plus a comprehensive annual check-up. This process examines all the usual performance parameters i.e. radiation dose and image quality, with a view to detecting performance deviations so that corrective action can be taken. The medical physicist checks all imaging equipment after service and operating staff calibrate CT equipment on a daily basis.

The Kronoberg hospitals uses RTI’s Piranha all-in-one X-ray meter, Cobia Smart for measuring different radiography and fluoroscopy parameters, and the firm’s Ocean diagnostic software. Says Bertilsson: “Ocean allows me to set up measurement templates for many different types of equipment. It is convenient as it collects all the data at once and performs automatic analysis.”

With time in the X-ray room often limited, speed is essential with these processes. RTI’s Ocean 2014 has a Quick Check mode that detects the instrument and detectors connected, allowing users to start measuring immediately. It displays all measured parameters on one screen and saves them in Ocean for later review, outside the X-ray room.

Whilst one shot measurement accelerates data gathering, Bertilsson confirms that the reporting capabilities of RTI’s Ocean deliver the greatest improvements to workflow, stating that ‘annual QA test time has been cut to between two to a maximum of four hours per unit on average, with it down to just one hour for some systems’. Other customers have reported cuts in more routine measurements from two hours to as low as 20 minutes, delivering real cost savings and greatly reduced downtime.

Crucially, a medical physicist’s time and expertise is best employed in many other ways than taking measurements and performing repetitive data entry. Contemporary test software in no way eliminates the need for highly skilled medical physicists in the X-ray QA process, but it can certainly optimise workflow and drive measureable efficiency improvements.
New hands on the wheel at Varian

In 2014 Sunny Sanyal joined Varian as corporate senior vice president and president of the Imaging Components division, which includes the X-Ray Products business. Varian’s Imaging Components business has a 50 plus year history of dedication to the imaging industry. We caught up with Sunny to talk to him more about the future, how he sees the business and what is his strategy going forward.

Q. So now that you have been on board almost a year with the Imaging Components division of Varian, how are things?

That’s an easy question to answer — being president of one division of Varian, namely Imaging Components, is extremely positive. Of course the division of which I am president is only one of several in Varian, which also includes an oncology/therapy division. So in a way you could say that in Varian we see two sides of the same problem. In the Imaging Components division, we supply X-Ray tubes and flat panel digital detectors to manufacturers of complete integrated X-Ray and CT systems. These end-products are used by radiologists all over the world for diagnostic imaging of all sorts of medical pathologies, including cancer. And while the advances in medical imaging and screening mean that more and more cancerous lesions are being detected early and can be easily removed and/or treated without the need for radiotherapy, there is still an increasing number of patients who need to undergo treatment with ionizing radiation. This is where our sister division, the Oncology division, comes in with a range of therapeutic products from radiosurgery through advanced radiotherapy systems to proton therapy and brachytherapy options.

Q. Let’s come back to the Imaging Components division. It’s not just medical imaging, is it?

No it’s not just medical imaging, although that is by far the biggest part of our division’s business. I am sure that many radiologists who daily use our X-ray tubes and detectors — even if they are unaware of that fact since our components are incorporated unseen in the interior of the systems they use — are even less aware that the same basic technology is also used in areas unconnected with medical imaging such as security scanning systems used in ports and other strategic areas. So Varian manufactures a line of industrial X-ray tubes for baggage screening applications and also supply cargo screening system manufacturers with products for high-energy X-ray imaging.

Q. Let’s go back to the Medical Imaging side of the Imaging Components division. Since basically your customers are the companies who produce complete X-ray or CT systems for end-use by radiologists, isn’t it difficult dealing with customers who themselves are competitors?

Again that’s an easy question to answer. This aspect is not at all a problem for us, probably because we have a long history going back for 30 years plus supplying OEMs (Other Equipment Manufacturers) with components for their end-products. Thus we have strictly professional dealings with our customers, covered by appropriate legal agreements such as Non-Disclosure Agreement (NDAs). However, in practice we view ourselves as being an extension of each of our customers’ R&D operations. So we bring products to market by engineering our X-ray tubes and flat panel detectors to suit our customers’ requirements.

Of course, if they wanted to, our end-customers could become totally vertically integrated and produce everything by themselves. The reality of the end-market nowadays is that the priority of our customers is to bring products to market as soon as possible and not just make everything themselves. So they are happy to use our expertise and technology. And that’s not even mentioning the whole issue of providing the documentation necessary to comply with the myriad of regulatory authorities who ultimately control the market into which our customers sell.

Working at the same time with several customers who may themselves be competitors is quite common in the OEM business and involves certain codes of conduct. Thus if we work together with a customer to develop a specific X-ray tube for the customer’s specific purposes, then we respect that relationship — we will not run off to sell that product to another manufacturer. If an original customer is no longer interested in the product or is no longer purchasing it from us, then we are free to provide it to other manufacturers who may be interested...
mechanical, electrical and electronic engineers, software engineers, covering overlapping fields such as physicists,

Well we have more than 200 highly qualified scientists and

in it. As I said over the many years that we have been in the OEM business we have acquired a mutually acceptable way of dealing with our customers.

Q. So what sort of engineering capabilities do you have to support all these activities?

Well we have more than 200 highly qualified scientists and technicians, covering overlapping fields such as physicists, mechanical, electrical and electronic engineers, software engineers and all the other disciplines you could expect. The relationship we have with our customers could be characterized as a “push-pull” relationship. So we are not just contract engineers; we also develop our own technology. But since we have regular and close contacts with our customers to the extent that we know intimately their overall strategic directions, we can and will spontaneously propose possible technological solutions that could help them.

So to get back to the resources that we have, in terms of the number of people involved, in fact we have more people allocated to the development of X-ray tubes and detectors than our customers. Of course in absolute terms, the big players in medical imaging have in total many more R&D people than we have, but they are necessarily spread over all fields and not focussed on the tube and detector technologies as we are, which is why we can do business!

Incidentally you will notice that when I have been speaking of our products I have been mentioning in equal terms both X-ray tubes and flat panel detectors. It is true that simply because of our history, the name Varian is frequently more often associated with X-ray tubes than with detectors. The reality nowadays is that in terms of turnover our detector business is now equivalent to that of our tube business.

In addition, the growth rate of the detector business is significantly higher than that of X-ray tubes. There is still a huge installed base where radiology still depends on film or CR systems, so there is good growth potential as these systems convert to DR. And, by the way the split between film, CR and DR is not significantly different in different geographical areas.

Q. You talked about growth rates. Can you put a figure on these?

Overall as a division our growth rate is in the high single digit area, but as I said the flat panel detector business is growing faster than that of the tubes.

Q. Currently everybody seems to be talking about the issue of radiation dose and the need to reduce it. As manufacturers of X-ray tubes what is your take on this issue?

As you might expect, given the relationship we have with our OEM customers, we pay a lot of attention to their opinion, and on the issue of dose, let me tell you they take it very seriously indeed. So in the development programs, if a trade-off has to be made between one characteristic or another, it is nearly always the low-dose solution that is adopted. So, like our customers we take the issue of dose very seriously. And that’s where technology development can help. Features such as the ability to manipulate the focal spot and technologies such as energy pulsing, collimation, etc. mean that when you consider the tube and detector together there are all sorts of possibilities to ultimately lower dose.

Q. We have been talking about tubes and detectors, which are indispensable, but almost just as important nowadays is the data processing of the emergent signals.

Yes of course, software is needed but not just in postprocessing. Our opinion is that the image data processing function should be brought closer to the detector, and also be able to interact as a system with the tube. So, for example, if it is known what body organ is being imaged then suitable software could already interact before the image is acquired to optimize the detector and tube conditions. In fact the potential of software is the rationale behind our current plan for our proposed acquisition of the German-based company Mevis which has extremely interesting software platforms in this area. This acquisition is scheduled to complete in a few months.

Q. Out of all the technologies we have been talking about, what are your flagship products?

We don’t like to identify any flagship product as such since the important thing is that our OEM customers are happy with our product in the role it plays in their equipment. Having said that, we are particularly proud of our AEG (anode-end grounded) tubes. They have the characteristic of being able to produce high intensity output, at low heat emission and are themselves very lightweight. When you think of the gravity involved in modern CT systems, these are important features. As for the detectors we are also proud of our PAXSCAN series which incorporate the latest real-time flat-panel image receptor technology.
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How PACS technologies are transforming Middle East healthcare

As in other markets, PACS has significantly contributed to advances in Middle East healthcare delivery, leading to reduced costs, improved efficiency and better health outcome. Technologies such as zero footprint, mobile DICOM viewers, physicians and patients portals are being adopted by healthcare organizations across the Middle East and are revolutionizing the way in which images are archived, shared and delivered to caregivers and patients.

The Saudi German Hospitals Group (SGH) — the largest private healthcare organization in the Middle East has established a reputation across the region for its quality care, and for maintaining the highest standards in the healthcare industry. The group operates the hospitals with the support of several German Medical Schools and Universities and strives to elevate medical professionals with a single platform. SGH started looking at products to the management team and the hospitals staff. SGH started looking at vendors to demonstrate their products to the management team and the hospitals staff. SGH started looking at vendors to demonstrate their products to the management team and the hospitals staff. SGH started looking at vendors to demonstrate their products to the management team and the hospitals staff. SGH started looking at vendors to demonstrate their products to the management team and the hospitals staff. SGH started looking at vendors to demonstrate their products to the management team and the hospitals staff.

In 2010, faced with rapid growth and changing technology, the Saudi German Hospitals — the fastest growing healthcare group in the region, adding a new hospital and 500 employees each year — decided to replace its 11 year old PACS. The group invited several vendors to demonstrate their products to the management team and the hospitals staff. SGH started looking at the features and functionality the hospitals would need. They wanted a scalable solution to sustain their growth, innovative technologies, mobile imaging capability and solid after-sale support - a key component for avoiding future headaches. The team made reference calls to facilities who were already using vendors’ products to learn about their experiences. After a thorough evaluation process, the group selected PaxeraUltima.

This is the versatile multimodality medical viewer developed by Paxeramed Corp. It provided the SGH medical professionals with a single platform that offered “anywhere- anytime” access to pertinent and varied clinical data. The solution enabled access to relevant, prior exams that might have been carried out at any of the group sites. The true VNA solution made it possible for ubiquitous image access across the enterprise allowing transfer of data between disparate systems and benefited SGH users by having a single place to collect, store, share, and manage health data.

Advanced tools such as PaxeraPACS-Collaboration-Modules (PPCM) that include Instant Messaging, Peer Review, and Messaging Center allowed SGH specialists to group chat, share studies, consult with each other and offer real-time collaboration without leaving the unified PACS interface. The all-encompassing tools enhanced the workflow and helped SGH facilities to provide effective and efficient care.

By 2013 PaxeraUltima was implemented in four of the group’s hospitals (each with 300 to 400 beds) in Saudi Arabia. At every location the solution was up and running in few days and full training was provided to users.

For a number of years, the Jeddah hospital – the largest site in the group with more than 150K annual studies was relying on an expensive PACS workstation located in the radiology department for viewing studies images. Only images saved in standard DICOM format could be imported into the PACS. Staff were not able to view images in non-DICOM format, nor had the ability to access patients’ images from outside the facility.

In 2014, the group selected for its Jeddah hospital PaxeraUltima-360, a VNA solution that accommodates multiple data formats. The built-in Universal Viewer offered a powerful new way to access different file formats quickly regardless of the file or study size. Paxera Universal Viewer which is part of the VNA solution has helped the clinicians to make more informed decisions through multi-ology, multisite reading and enabled the group users to stay connected to the data and information they need from any browser or mobile device. During the recent Arab Health 2015 congress in Dubai, the group signed a contract to use Paxera solution at its latest hospital in Cairo hospital

“We chose PaxeraUltima-360 because we wanted a common patient-centric storage infrastructure that can handle multiple data formats and interoperates with the different RIS and EMR solutions. PaxeraUltima-360 allowed us to achieve the interoperability and cost-effective image-sharing approach needed to grow and connect our sites and clinics together” said Aladin ElSherif - SGH group head of radiology departments.

“There was no room for failure when upgrading the imaging solution in such a busy hospital and with the integration to RIS and EMR systems. A plan was proposed to deal with the large data amassed over 10 years of operation. In the final analysis, we were thrilled that Paxeramed completed the project on time and under budget” added Dr ElSherif.

The Jeddah hospital is a member of the Saudi German Hospitals Group (SGH), the largest and the fastest growing healthcare group in the region.
### MEDICAL DOCTORS (respond below)

1. What is your occupation? (check only one)
   - 50. Diagnostic Radiologist
   - 51. Other Physician (please specify)  

1a. What is your radiology sub-specialty? (check only one)
   - 52. General Radiology
   - 53. Nuclear Medicine
   - 54. Nuclear Radiology
   - 55. Vascular & Interventional
   - 56. Cardiologist
   - 57. Other (please specify)

1b. I am a Head of my department
   - 58. Yes
   - 59. No

Please continue with question #2 below

### NON-PHYSICIAN PROFESSIONALS (respond below)

(Non-physicians may qualify based on the criteria listed below)

1c. What is your occupation? (check only one)
   - 60. Radiology Administrator
   - 61. Radiology Business Manager
   - 62. PACS Administrator
   - 63. Chief Information Officer/IT Manager
   - 64. Chairman/Managing Director/Executive Director
   - 65. Chief Financial Officer/Other executive titles
   - 66. Medical Physicist
   - 67. Academic
   - 68. Chief Technologist/Senior Radiographer
   - 69. Manufacturer
   - 70. Business Consultant
   - 71. Distributor/Dealer
   - 72. Please specify

Please continue with question #2 below

### ALL RESPONDENTS reply to the questions below

2. In what type of facility do you work? (check only one)
   - 20. Private clinic
   - 21. Hospital (check number of beds):
     - a. More than 500 beds
     - b. 200-299 beds
     - c. 400-499 beds
     - e. 100-199 beds
     - c. 300-399 beds
     - f. 0-99 beds

3. With what technologies or disciplines do you work? (check all that apply)
   - 01. Diagnostic X-ray
   - 02. Nuclear Imaging
   - 03. Ultrasound
   - 04. CT
   - 05. PACS/Teleradiology
   - 06. PET
   - 07. Cardiac Imaging
   - 08. Bone Densitometry
   - 09. Interventional Radiology
   - 10. Mammography
   - 11. Bone Densitometry
   - 12. MRI
   - 13. CT
   - 14. CT
   - 15. Other

4. If you currently receive Diagnostic Imaging Europe, how many other people read your copy?
   - a. 0
   - b. 1
   - c. 2
   - d. 3
   - e. 4
   - f. 5
   - g. 6 or more

5. Please describe your involvement in the decision to purchase medical imaging equipment/products for your department. (check all that apply)
   - 33. Approve purchase of product
   - 34. Specify type of product to purchase
   - 35. Recommend purchase of product
   - 36. None of the above

---

**Signature:**

**Date:**

- **First Name:**
- **Last Name:**
- **Title:**
- **Hospital/Office Name:**
- **Address:**
- **City:**
- **Postal Code/Country:**
- **Business Phone:**
- **E-mail:**

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Wall-Mountable Medical CR Readers

The FireCR Flash Reader from 3DISC Imaging offers crystal-clear image quality, compact size, together with fast scanning speeds to meet every imaging need. The new reader is a compact and affordable Computed Radiography (CR) system and is designed to deliver the exceptional image quality required for diagnostic imaging, while offering aggressive pricing to make the readers affordable for all sizes of practices. As automated processes are key to efficient workflow, the FireCR Flash Reader combines an elegant design with a powerful yet easy-to-use system.

The FireCR Flash Readers offer increased productivity with a fast throughput of up to 70 plates/hour. The small size (~5” footprint) and light weight (only 19 Kg.) mean that the system can be placed on a counter or be wall-mounted—ideal for even the most space-challenged radiology department or practice.

With the QuantorMed+ Software, image acquisition, processing, and management have never been easier. The chronological and intuitive workflow helps in cropping, etching, enhancing, increasing brightness etc., on the images to enable a more precise diagnosis. The interface is DICOM compliant and compatible with HIS, RIS, PACS and local databases.

With the FireCR Flash, there is no need for customers to compromise on features and functionality. They can select a system that meets their exact current needs and budgets—and also have flexibility that lets them grow by scaling up as their imaging volume increases.

3DISC IMAGING
ALLERØD, DENMARK
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Safety of MR Imaging with MR-conditional cardiac devices

BIOTRONIK, the manufacturer of cardiovascular medical technology devices, have announced that the results of the ProMRI and ProMRI AFFIRM studies have just been published and validate the safety testing of the company’s ProMRI technology, consolidating the company’s reputation as a leading manufacturer of MRI-conditional cardiac devices. Historically, patients with cardiac devices have been contraindicated for MRIs, which are frequently necessary for soft tissue diagnostics and have the advantage of avoiding the radiation risks of computed tomography (CT) scans. ProMRI systems are approved as MR-conditional and enable access to this technology for the growing number of patients requiring an MRI. The results of the just-published prospective, multicenter studies provide yet more evidence regarding the clinical safety of the company’s ProMRI Evia/Entovis SR-T and DR-T pacemaker systems with Setrox/Safio S 53 cm/60 cm leads, when used in head and lower lumbar 1.5 T MRI scanning. These systems have already been approved for use in Europe based on comprehensive testing and computer simulations covering many thousands of possible imaging scenarios. The ProMRI (US) and ProMRI AFFIRM (Europe) studies were of identical design and enrolled 272 patients at 37 sites from October 2012 to November 2013. Device interrogation was performed at enrollment, pre- and post-MRI scan, and one- and three-months post-MRI. A total of 226 patients who completed the MRI and one-month post-MRI follow-up were included in the analysis.

The combined studies showed that there were no serious adverse device effects (SADE). The pacing threshold and sensing amplitude changes from immediately before the MRI to the one-month post-MRI visit were stable and unchanged. There was no evidence of adverse impact on either the patient or the pacemaker system caused by MRI scanning.

“The results of these studies are consistent with the extensive testing and simulation of these devices as part of the data collected to receive CE approval,” added Wolf Ruhnke, Vice President of BIOTRONIK. “With our investment in ProMRI technology and the body of evidence to prove its safety, physicians can confidently decide to perform any MRI scan needed on these patients. We believe that in the future, no cardiac device patient will be hindered from receiving this valuable diagnostic tool.”

BIOTRONIK
BERLIN, GERMANY
www.biotronik.com

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Bayer HealthCare are unveiling the MEDRAD MRXperion magnetic resonance (MR) Injection System at the recent ECR 2015 Meeting in Vienna. This latest injection system provides customers with tools to improve workflow efficiency in the magnetic resonance imaging (MRI) suite while accurately recording and reporting MR contrast-enhanced procedure data. The new system is the first MR power injector to combine both estimated glomerular filtration rate (eGFR) and weight-based dosing calculators at the point-of-care. MRXperion introduces snap-on/twist-off syringe design with syringe autoloading and priming functions for MR. MRXperion is the first MR power injector to be compatible with the latest version of Bayer’s Radimetrics Enterprise Platform. This platform combines contrast analytics and radiation dose management to offer enterprise-wide data capture, cumulative contrast dose tracking and PACS / RIS connectivity.

"Bayer was proud to have brought the first power injector to the radiology suite and now this next generation MR injector can help to set global standards for improved patient care and quality," said Christiane Pering, Chief Medical Officer and Head of Innovation within Bayer HealthCare’s Medical Care division. “MRXperion is the first MR injector to connect with the Radimetrics platform to build standard informatics and consistency across the MRI and CT suites, allowing radiology professionals to see patient histories across contrast analytics and radiation dose modalities and improve overall workplace efficiency.”

The MRXperion is the result of a rigorous development process, driven by a multi-disciplinary team, to deliver an injector that fulfills the company’s commitment to quality.

“It is important that organizations can accurately repeat specific contrast dose injection protocols and ensure enterprise-wide protocol compliance, allowing healthcare professionals to spend more time focused on patient care,” said Claus-Peter Reisinger, Bayer’s MR Business Segment Leader.

The new injector provides customers with tools to improve workflow efficiency through features such as: protocol management; snap-on/twist-off syringe design for easy syringe/tubing attachment and removal; auto plunger advance and retract when attaching and detaching syringes; automatic filling and priming; injection/post-injection reminders; on-board calculators for eGFR and weight-based dosing.

Bayer’s Radimetrics Enterprise Platform merges patient dose histories and current exam details across all enterprise sites, bringing analysis and quality solutions to the point of care. This platform provides both radiation dose management and contrast dose analytics management and rapid access to patient dose history.

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*For a limited time only.
Carestream has introduced enhancements to its digital breast tomosynthesis (DBT) module including a slidding tool, improved workflow capabilities and the display of DICOM-compliant 2D synthetic views (which are generated from the 3D dataset).

The new slidding tool combines slices of a DBT series, while allowing the user to choose different rendition modes and slab thicknesses. In scientific studies, radiologists have reported that this capability can help visualise calcifications and decrease reading time. The generation of 2D synthetic views is an alternative approach to acquiring conventional 2D mammography views, which can help reduce the radiation dosage to which a patient is exposed while allowing full advantage of the benefits of digital breast tomosynthesis.

One study that documents the effects of setting the slab thickness of volumes to 2 millimetres found that the visibility of micro-calculifications improved—and there was no significant effect on mass visibility. Radiologists were presented with 20 sets of images containing 16 tumour masses and 8 micro-calculifications clusters. They ranked 2 millimetre slabbed sets relative to standard 1 millimetre slices. The results indicate that it is possible to review DBT volumes with 2 millimetre slabs without compromising image quality.

In another study DBT slices were combined and merged into 2 millimetre slabs. Sets of slabs were created from 35 clinical DBT volumes with malignant or benign findings and from 50 DBT volumes drawn from screening sets without any prior review. There was no significant decrease in reading time on clinical cases, but data for screening images suggests that increasing slab thickness can reduce by 20 percent the time radiologists spend studying normal images.

The new DBT module adds advanced workflow capabilities and specialised tools that can optimise the reading of digital breast tomosynthesis exams at the same time as other procedures. Carestream's Vue Mammo workstation and PACS allows reading of traditional mammograms, breast ultrasound, breast MRI, DBT or general radiography exams from a single desktop.

Healthcare providers worldwide use Carestream's Vue PACS and mammography reading tools for the reading of routine screening mammograms as well as diagnostic mammmography exams.

As part of Carestream's "Knowing Matters" strategy, Carestream's Vue portfolio of healthcare IT solutions is designed to offer greater value and insight for clinicians, foster collaboration, control costs and streamline dataflow. The company's Vue solutions amplify the clinical, business and IT value of radiology services.

CARESTREAM RÖCHER, NY, USA
www.carestream.com

Entry level radiography system with high image quality

Shimadzu has released its RADspeed fit model which provides easy operability and extensive functionality, reducing exposure levels while supporting a wide range of general radiographic applications, such as chest, abdomen or extremities, and including emergency examinations. The system can be combined with either a digital or analog image processing system, making it ideal as an entry level digital radiography (DR) system equipped with a digital X-ray detector (FPD) or even complementing an existing CR or DR environment.

The ultra-compact new radiographic system provides outstanding technology with best-in-class features such as the highest image quality in its class. The large output X-ray high voltage generator capable of tube current levels of up to 630 mA (56 kW model) or 500 mA (32 kW model) provides shorter exposure times. It also minimizes blur in images even for larger patients, which contributes to improved diagnostic capabilities. The system's 220 kg patient weight limit is the highest in its class. The RADspeed fit provides a large examination range through a floating tabletop that can be slid either in a longitudinal or a lateral direction, and a support column and tube holder arm that can be moved longitudinally or laterally. This allows free positioning of the patients without having to actually move them. The system also features a mechanism that can rotate the X-ray tube by 180 degrees around the support column, which allows direct radiography of patients lying on a stretcher or sitting in a wheelchair placed next to the table, either on the far side or at 90 degrees to the side.

By pressing a single button, the "one-touch guide" displays the SID and cassette size required during radiography and whether or not a grid is needed. Optimal parameters can be specified from 432 radiography parameters registered in the system only by selecting the radiography technique, examination region, exposure direction, and body thickness.

The system includes a removable grid mechanism that allows the grid to be removed to reduce radiation dose levels for children. A function that measures the dose-area product is part of the standard configuration.

SHIMADZU KYOTO JAPAN
www.shimadzu.com

Software for X-ray QA Meters

Cobia Flex offers all possibilities to make X-ray Quality Control as quick and accurate as possible. With an internal detector, the system offers the possibility to connect different probes, ion chambers and has built-in mAs. The measured values can be read directly.
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www.escardio.org/EACVI
from Cobia Flex’s large and clear display or stored in the Cobia and read after all measurements have been taken. The system now has a practical log function that allows storage of all readings.

Users of Cobia systems can now use the Ocean 2014 diagnostic software for use with RTI instrument. The software displays all measurements and waveforms on an easy-to-read screen. It doesn’t matter if a full report is required or if it’s only needed to use the computer as a display. The software provides the possibility to use a tablet or a PC, saving data to a computer, printing reports, using analyses, etc.

In combination with the Ocean 2014 software and a PC or Tablet, the Cobia Flex is easier to use and save time and also makes it possible to perform remote X-ray QA measurements by simple connection via Bluetooth or a USB.

Minolta is a simple, trouble-free and financially intelligent solution featuring the durable AeroDR wireless flat panel detector. The new system meets all current imaging needs while allowing for future growth with all-in-one scalability and an array of workflow options. With AeroSync automatic X-ray detection or a simple hand switch connection, it easily integrates with most X-ray systems. Single click automatic image processing further enhances clinical confidence.

The ImagePilot Aero has the strongest, most resilient flat panel detector available today and can hold up to 300 kg distributed across the panel—for trouble free patient imaging. The 14” x 17” AeroDR wireless flat panel detector weighs just 2.6 Kg and has convenient grip strips that make it simple to maneuver between diverse exams—from bucky to table to wall stand. Greater uptime is assured with drop tolerant construction and a long life rapid charge power cell. With the ImagePilot Aero, imaging clinics can realize a better return on investment through improved patient care and reimbursable imaging capacity without replacing existing X-ray equipment.

Enterprise Imaging Radiology Suite

The Agfa HealthCare Enterprise Imaging Radiology Suite offers refined user experience and workflow by providing carefully designed desktops for specific roles: Diagnostic, Technologist, Clinician, Transcriptionist, Medical Secretary, and Administrator desktops. Each desktop is purposefully built with the specific functions required by each; everything is not just crammed into one GUI. In combination with the Agfa NX workstation, the Radiology Suite supports the industry leading MUSICA algorithms, resulting in excellent perceptibility, enhancing details. Multiscale window width and level can be used with non-Agfa Computed Radiography images. The Radiology Suite includes other important general radiology tools such as MIP/MPR/3D, reporting (text, dictation, speech), CT/ MR linking, cursor mode and more. The solution also includes modern tools for diagnostic mammography, angiography, and advanced ultrasound tools for OB/GYN, cardiology, vascular, and radiology. Detailed analysis of modern digital imaging workflows was carried out by watching users work and watching how and where they spend their time in practice. The results are new hanging protocols, which are designed to provide an automated and optimized image review workflow thereby reducing the extraneous work seen in most systems today. The Diagnostic desktop is completely 3D enabled to handle today’s volumetric studies. The 3D engine supports Maximum Intensity Projection (MIP; maximum intensity, minimum intensity and average intensity), Multi Planar Reconstruction, Curved Planar Reconstruction and Volumetric Reconstructions (VR). Users can work in a single application with familiar tools and workflow, which results in more automation and better usability. Further, it’s all hosted on the same hardware, reducing complexity and cost.

Many people criticize structured reports as being too time consuming, while others are concerned with the quality of information found in reports. Sectional reporting is an efficient and effective compromise between unstructured and structured reporting. Report sections are uniquely identifiable fragments of a report defined to serve a specific purpose in the clinical workflow or medical decision process. Sectional reporting increases the reporting consistency, predictability and complete-
ness (both in terms of content and timing) and, ultimately, decreases report turnaround time. The overall result is higher quality and consistency of reports for your referring clinicians. Distributing results is an important step in the overall workflow. With the Clinician Desktop it is possible to share many of the same imaging tools available in the Diagnostic Desktop, which is great for internal clinicians and specialists. The Radiology Suite also fully supports Agfa’s innovative XERO Viewer for EPR integrations, which doesn’t need any software whatsoever to be installed; all that is needed is a standard web browser and a modest internet connection. Results can also be distributed by printing, CD media, and DVD media, e-mail or fax.

AGFA
MORTSEL, BELGIUM
www.agfa.com

Eliminating obstacles for interventional radiologists

Large hospital equipment may be essential to clinicians’ work, but it can also be a space that limits efficiencies for clinicians. With space at a premium in the clinical environment, portable, accessible and adjustable technology is a growing commodity. To address this issue of rising demands on clinicians’ time and energy, GE Healthcare has introduced its latest solutions of systems with improved mobility and accessibility.

The Discovery IGS 740 is a rail-free, laser-guided premium interventional X-ray system that brings high-quality imaging and complete workspace freedom to interventional radiology procedures. Its mobile gantry platform provides outstanding imaging flexibility while keeping the ceiling unobstructed to freely position the monitors, radiation shields and lights during interventions. Several users testify to the advantages of the system.

“The IGS 740 system gives us the freedom we’ve been looking for to access patients during complex interventional procedures,” said Dr Robert Rhee, Chief of Vascular and Endovascular Surgery at Maimonides Medical Center in Brooklyn, N, USA. “The utilization is diverse and the predictability of movement gives our team the confidence we need to perform a wide range of procedures free of any interference you may get from fixed floor or ceiling structures.” The GE 41x41-cm detector offers one of the largest fields of view in the industry to image large anatomies at low dose in a single image. The wide bore C-arm makes it easier for clinicians to image the anatomy of interest and accommodate large patients. The dedicated arm-imaging positions facilitate arm fistulograms for hemodialysis patients, enabling full patient access from the left or right. The new system also meets the clinical needs in interventional oncology. By combining the large 41x41-cm detector and the wide-bore C-arm, physicians can easily perform off-centered liver 3D acquisitions to support chemoembolization or Y90 procedures.

GE HEALTHCARE
CHALFONT ST GILES, UK
www3.gehealthcare.com

Digital Radiography System

The DigiEye 760 (Plus Model) from Mindray is a fully digital flat panel ceiling suspended system incorporating the innovation and integration design aspects typical of Mindray’s R&D, not only in the design of the mechanical structure but also in the post-processing software. The system has flexible control modes and a user-friendly operation interface which is not just highly efficient but also appreciated by operators, with a combined result of improved examination speed and accuracy.

Patient positioning, registration and exposure processing are smooth and efficient and the system is of course totally compatible with all PACS/RIS/HIS with seamless support for storage online, browsing, query and output film by professional printer. With its combination of a high frequency generator, high-end tube, advanced flat panel detector and functional software support, the system provides high image quality with minimum exposure to radiation dose.

MINDRAY
SHENZHEN CHINA
www.mindray.com

MRI for enhanced patient comfort and efficient throughput

Philips’ new Ingenia 1.5T S MRI is the newest addition to the company’s Ingenia product line and is designed for “First Time Right” imaging and for faster workflow, while enhancing the patient’s experience during MRI examinations. Inconclusive image quality due to patient motion is a constant issue, making it difficult for clinicians to get accurate results in the first attempt. One repeat exam can throw off an entire day’s schedule by two to three hours, affecting throughput and patient satisfaction. Ingenia 1.5T S is designed for “First Time Right” imaging, addressing the issue in a holistic way.
“MRI scans can be very uncomfortable for patients, so Philips are designing solutions that can tackle the issue in two ways: reducing the patient’s anxiety, and generating higher quality results the first time around,” said Gene Saragnese, CEO of Philips Imaging Systems. “Our goal is to enhance the patient experience, while equipping clinicians with the best technology to improve diagnosis.”

Ingenia 1.5T S combines superb fat-free and motion-free imaging techniques, patient-centric workflow and a unique patient experience during the exam. The system is complemented with the patient in-bore solution, which offers a comforting, engaging visual distraction. It provides patients with the option to personalize their experience by selecting a visual theme to fill the room with colorful video images, which they can view during the examination. This is combined with soothing audio to create an immersive experience, allowing the patient to relax through the exam.

The system also includes Auto-Voice, to provide clear instructions and coach the patients, while scanner noise is reduced through ComforTone scan techniques. The system’s Premium IQ imaging, powered by dStream, allows for faster and more robust imaging, while the automated and intelligent iPatient platform provides quick patient setup, allowing clinicians to focus time on ensuring patient comfort.

PHILIPS EINDOVEN, THE NETHERLANDS
www.healthcare.philips.com

5MP Color LED display for Multi-Modality Imaging

The new 5MP Color LED display for multi-modality imaging from Double Black Imaging has been designed to meet the ever changing demands in the reading room allowing for multi-modality reads including, mammography.

The DBICX50-LED joins the company’s full line of LED Auto-calibrating with X-CAL Calibration software. The X-Series of LED backlit LCD line consists of a 2MP Monochrome and High-Bright Color, a 3MP Monochrome and High-Bright Color, 6MP High-Bright Color, a 5MP Monochrome and Color LCD and 10MP display for Mammography. There are higher brightness levels on each LCD, Digital uniformity Control, 14-Bit processing, a retractable front sensor for true DICOM calibration, a backlight sensor for luminance control and Display Port connectivity. DBI bundles these LCDs with a high speed graphic controller as well as X-CAL calibration software.

DOUBLEBLACK IMAGING WESTMINSTER, CO, USA
www.doubleblackimaging.com

X-Ray Generator Series

The newest X-Ray generator module from Spellman, the space saving uXHP, provides up to 80kV at 100 watts powered from a +24Vdc input, expanding both the output voltage and power level of Spellman’s recently released uX X-Ray generator series.

Spellman has utilized its innovative high voltage packaging techniques and encapsulation technology to produce an ultra-compact state-of-the-art high power X-Ray generator module. The 50/65kV uXHP measures 178 x 73 x 229mm while the 80kV version measures 178 x 78mm x 267mm.

Designed to power cathode grounded X-Ray tubes from all major X-Ray tube providers, the uXHP provides 50kV, 65kV or 80kV at 0-5mA, power limited to 100 watts. The uXHP has an adjustable ground isolated filament supply that provides excellent low current operation. The unit features local and remote emission control and is over-voltage and short-circuit protected. A dual high voltage monitor signal addresses applications where redundant high voltage monitoring is required.

The high stability (0.05% over 8 hours), very low ripple, and tightly regulated uXHP also has fully integrated digital control for output voltage, emission current, and filament current limit via Ethernet, RS232, or USB. Spellman’s proprietary GUI allows standard operation of the module, and simplifies OEM integration by allowing customized operation of functional parameters. The uXHP is suitable for many analytical and industrial inspection applications.

SPELLMAN HIGH VOLTAGE ELECTRONICS HAUPPAUGE, NY, USA
www.spellmanhv.com
Dual Energy in routine CT Imaging

With the new version of the Somatom Definition Edge, Siemens has created the basis for introducing dual energy procedures in clinical routine. The innovative X-ray tube concept in the new CT scanner enables simultaneous imaging at two different energy levels for the first time in single source computed tomography. Thanks to a novel user- and patient-friendly measurement method, information on tissue and other material can be obtained as well as traditional morphological data, even during examinations with high contrast media dynamics.

In dual energy imaging, the same region of the body is examined using two different energy levels. The two datasets offer more detailed information about tissue composition that goes beyond pure morphology. For instance, metal artefacts caused by implants such as artificial hips are reduced considerably, while tissue and bone structures can be displayed more clearly. However, in cases where data have been acquired using fast kV-switching or dual layer detector technology – dual energy imaging involved significant drawbacks. Single source dual energy images acquired with these methods were excluded for many important radiological use cases, because the tube does not emit the two energy spectra at the same time but only in succession through rapid switching or through spectra separation at the detector side after penetrating the patient. With kV-switching, the segmentation of the measuring points significantly impairs the image quality due to the limited data per energy level. At the same time, increased X-ray doses are inevitable because the dose cannot be modulated to reduce radiation.

Not so with the TwinBeam Dual Energy technology, in which the X-ray beam emitted is split into two different energy spectra before reaching the patient thanks to an innovative tube design. This means that the Somatom Definition Edge generates the dual energy images at the same time.

The benefits of the new procedure can be seen in cases of suspected pulmonary embolism. Due to the improved tissue differentiation and the precise representation of contrast media distribution, vascular occlusions can be quickly identified and their size determined. When examining lesions, for example in the liver, the detailed material information in the TwinBeam Dual Energy recordings clearly indicates their composition. This is based on the precise determination of contrast media uptake in the tumor, providing the physician with significantly more information to classify the tumor and decide on treatment. And during subsequent therapy control, it is easier to assess whether the treatment is working and the tumor is shrinking – or whether adjustments need to be made.

In addition to increasing the diagnostic strength of clinical images, TwinBeam technology also minimizes the X-ray dose required in a different way to other single source dual energy procedures. This now also includes Admire, the model-based iterative reconstruction procedure which was just recently released on the Somatom Force and whose scanner-specific algorithms can reduce X-ray doses further still – achieving excellent image resolution and extremely low image noise even at low doses.

Somatom Definition Edge can also simplify the radiology workflow considerably. Unlike other single-source dual energy imaging, the acquired dual energy datasets are intelligently pre-processed directly after the acquisition. Thus, they can now be made available directly at the CT workstation or can automatically be sent to the picture archiving and communication system (PACS) by the Somatom Definition Edge with the aid of the new Fast DE Results technology which allows reading the cases immediately. Single source dual energy will therefore become suitable for routine applications and integration into everyday clinical workflow. “We can make rapid decisions, because we can see the DE images straight away,” says Professor Michael Lell, senior radiologist at University Hospital Erlangen.

To further improve not only the quality of dual energy examinations, but also of conventional CT scans, Siemens is additionally introducing a new iterative algorithm — iMAR — for metal artifact reduction with the new Somatom Definition Edge: This allows respective artifacts – caused by implants, artificial joints or pacemakers – to be reduced significantly. Such artifacts may lead in the worst case to non-diagnostic images by concealing the relevant pathologies. Professor Lell provides one example: “Previously, a significant number of early stage cancers of the oral cavity and oropharynx could not be identified on CT images because amalgam fillings or metal crowns impaired the image quality,” he said. “A good way of correcting metal artifacts can therefore provide us with crucial advantages without increasing the radiation dose.” Even if a radiologist wishes to check whether bone fractures have healed and metal objects such as screws and plates can be removed, the iMAR algorithm can be used to clearly assess the anatomical details in the area of transition between bone and metal. With the aid of iMAR, streak artifacts can, according to initial scientific results be significantly reduced in clinical images.

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TECHnOLOGY UPDATE

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