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In the face of the sheer statistics of the current and likely future impact of neurodegenerative diseases it is hard not to be down-hearted. It has been estimated that by the year 2030, no fewer than 76 million people worldwide will suffer from dementia of one form or another, with most cases being caused by Alzheimer’s disease (AD). Apart from the devastating effects of AD on the patients themselves and their families, the likely increase in the economic impact of Alzheimer’s disease on already creaking health systems is staggering, all the more since Alzheimer’s patients frequently have debilitating and synergistically costly co-morbidities.

Against this sombre background, it is encouraging to see definitive signs of progress on the Alzheimer’s research front. As Jagust points out in his recent paper (Jagust W. Tau and β-Amyloid: The Malignant Duo. JAMA Neurol. 2016 Jul 25. doi: 10.1001/jamaneurol.2016.2481) over the past decade there has been an astonishing change in the way that research on AD is conducted. Although the importance of the pathologic aggregated proteins—β-amyloid and tau—has long been suspected, understanding their links to symptoms required long-term clinical observation paired with postmortem examination of the brain. However as these observations are now being complemented with imaging of brain structure and function, molecular genetics, and animal models, the amyloid hypothesis of AD has now clearly emerged.

The recent addition of tau positron emission tomography (PET) imaging has made it possible to examine the interactions between β-amyloid and tau, which will be crucial to understanding the etiology of AD and its eventual treatment.

As always however, it is necessary to put these results into a broader context. Important as imaging studies are in the context of basic research, the holy grail of studies into Alzheimer’s disease is ideally to allow the identification of suspicious brain pathologies at a pre-symptomatic stage early enough for appropriate therapeutic interventions to be initiated. It is here in the so far fruitless quest for effective drugs, that the picture darkens again. Despite years of intensive and hugely costly research into the development of possible pharmaceutical agents for AD, progress on therapies is extremely limited (Although the current approach based on possible inhibitors of β-site amyloid precursor protein cleaving enzyme 1, BACE1, looks promising). The absence of any significant progress regarding therapeutic approaches to AD does not however mean that the positive developments in imaging are worthless. In fact it looks as though they will inevitably be playing an important role in the future.
**COVER STORY**

MRI shows brains of overweight people look ‘ten years older’ than lean counterparts at middle-age

From middle-age, the brains of obese individuals display differences in white matter similar to those in lean individuals ten years their senior, according to new research led by the University of Cambridge.

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- Ultralow-dose CT can substitute for standard dose CT in some COPD patients.
- Concerns raised over unnecessary imaging in surveillance of thyroid cancer.
- PET/MRI better than mpMRI for accuracy of targeted prostate biopsies.
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**COMING IN THE OCTOBER ISSUE:**

Breast Imaging special
Ultralow-dose CT can substitute for standard dose CT in some COPD patients

A recently published study from Japan reports the results of a retrospective analysis of the CT data of 50 emphysema patients and found that ultralow-dose CT (ULDCT) can substitute for standard-dose CT (SD CT) in disease quantification if both iterative reconstruction (IR) and filtered back projection are used (Nishio M et al. AJR Emphysema Quantification Using Ultralow-Dose CT With Iterative Reconstruction and Filtered Back Projection Am J Roentgenol. 2016 Jun;206 (6):1184-92.).

"Although further studies are needed to validate the usefulness of emphysema quantification with ULDCT, we expect that it will be able to be reliably performed with ULDCT both without and with IR to stratify lung cancer risk and reduce the radiation dose associated with CT screening for lung cancer," said lead author Dr Mizuho Nishio, of the Advanced Biomedical Imaging Research Center, Kobe University Graduate School of Medicine, Kobe, Hyogo, Japan.

The introduction of MDCT has greatly increased the total number of CT examinations, accordingly raising concerns about radiation exposure and the associated cancer risk. The current principle of clinical CT practice is to use a radiation dose as low as reasonably achievable (ALARA) while maintaining acceptable diagnostic accuracy. "However, given the trade-off between image quality and radiation dose in CT, excessive dose reduction can interfere with the interpretation and analysis of CT images," Nishio said.

Since the early 1970s, filtered back projection has been used for CT image reconstruction. It is increasingly being replaced, however, by iterative reconstruction (IR), which is becoming widely used to decrease the radiation dose in CT. Many studies have shown that substantial dose savings can be achieved in CT when IR is used.

CT is widely performed in patients with chronic obstructive pulmonary disease (COPD), and the technique allows quantitative evaluation to assess the progression of COPD and to monitor therapeutic effects.

Concerns raised over unnecessary imaging in surveillance of thyroid cancer

A marked rise in use of imaging tests in the surveillance of thyroid cancer has been associated with increased treatment for recurrence, but no clear improvement in survival from the disease, finds a recently published study (Banerjee M et al. Use of imaging tests after primary treatment of thyroid cancer in the United States: population based retrospective cohort study evaluating death and recurrence. BMJ. 2016 Jul 20; 354: i3839). The findings highlight the importance of curtailing unnecessary imaging and tailoring imaging after treatment to patient risk, say the researchers.

Over the past two decades, the incidence of thyroid cancer has risen, most of which can be explained by diagnoses of small, low risk cancers. During this same period, the use of imaging after initial treatment has also increased — most likely due to growing concern about the risk of recurrence.

But the relation between imaging, treatment for recurrence, and disease-specific survival remains unknown.

So a team of US researchers from the University of Michigan, Ann Arbor, MI, USA used a US national cancer database to identify over 28,000 patients diagnosed with thyroid cancer between 1998 and 2011. The team monitored the use of imaging (neck ultrasounds, radioiodine scans and PET scans), additional treatment for recurrence, and deaths due to thyroid cancer until 2013. The use of neck ultrasounds, radioiodine scans, and PET scans were associated with additional treatment for recurrence, such as surgery, radioactive iodine treatment or radiation therapy. Only the use of radioiodine scans was associated with improved survival from thyroid cancer. This was an observational study, so no firm conclusions can be drawn about cause and effect and the authors point to several limitations in the design of their study. However, the authors do say that it is not clear if the benefits of greater imaging outweigh the financial costs, heightened patient anxiety, and risk of patient harm from the treatment for recurrence.

"In light of the growing incidence of low-risk thyroid cancer and the paradoxical rise in imaging after primary treatment, this study provides the foundation needed to reassess thyroid cancer surveillance patterns and to curb unnecessary imaging," the authors conclude.

http://tinyurl.com/Banerjee-et-al-paper
PET/MRI better than mpMRI for accuracy of targeted prostate biopsies

A recent study from a US group of researchers (Piert M et al. 18F-Choline PET/MRI: The Additional Value of PET for MRI-Guided Transrectal Prostate Biopsies. J Nucl Med. 2016 Jul; 57(7): 1065-70) reports that the addition of F-18-choline PET molecular imaging improves the identification of significant prostate cancer compared to multi-parametric prostate magnetic resonance imaging (mpMRI) alone for targeted transrectal prostate biopsies. MRI-guided biopsies already outperform standard, non-targeted biopsies. The addition of PET promises to improve targeted biopsies even further.

The figure shows a Gleason 3+4 prostate cancer (arrows) as identified on T2-weighted (panel A) and diffusion-weighted (panel B) MRI. F-18-choline PET (panel C), as well as PET/MRI (Panel D). Credit: University of Michigan

Approximately 14 percent of men in the Western world will be diagnosed with prostate cancer at some point during their lifetime. Dr M Piert of the University of Michigan points out, “Our positive results suggest that in the future, PET/MRI may become a one-stop imaging test for men with suspected but undetected prostate cancer or for patients undergoing surveillance for known low-risk prostate cancer”. He went on to explain that “Since prostate cancer is often multi-focal and presents with multiple lesions of varying risk, it is important to identify the lesions that harbor the greatest malignant potential. Accurate identification of clinically significant cancer and avoidance of clinically insignificant cancer is the centre-piece of modern prostate cancer diagnosis”.

As part of an ongoing prospective clinical trial, the researchers studied 36 men with rising PSA levels to assess the value of fusion 18F-choline PET/MRI for image-guided prostate biopsies to detect significant prostate cancer, compared to standard non-targeted, systematic 12-core biopsies. The biopsy procedures were performed after registration of real-time transrectal ultrasound (TRUS) and included image-guided cores plus standard cores. Histological results were determined from standard and targeted biopsy cores, as well as prostatectomy specimens.

Fifteen subjects were ultimately identified with significant prostate cancer (Gleason >3+4), of which targeted biopsy identified 12, while standard biopsy identified only five. [See Figure]. A total of 52 lesions were identified by mpMRI (19 low, 18 intermediate, and 15 high risk), and mpMRI-assigned risk was a strong predictor of final pathology (Using the mean 18F-choline target-to-background ratio, the addition of 18F-choline to mpMRI significantly improved the prediction of Gleason > 3+4 cancers over mpMRI alone).

The study concluded that fusion PET/MRI-TRUS image registration for targeted prostate biopsies is clinically feasible and accurate, and the addition of 18F-choline PET to mpMRI improves identification of significant prostate cancer.

Piert noted “the use of advanced imaging to inform placement of biopsy needles promises to greatly minimize the uncertainty associated with prostate cancer care. Imaging may one day be performed prior to biopsy and, if negative, no biopsy would be needed. To reach that future state, advanced imaging will need to have a superior negative predictive value that may not be obtainable with multi-parametric MRI alone”. He adds, “Although we used 18F-choline PET in this trial, it is likely that other radiotracers, which are more specific for prostate cancer — for example, those that target PSMA — may hold even greater promise”.

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

Gd deposition now found in pediatric brains

In the growing controversy regarding the implications of the recent findings of gadolinium (Gd) deposition in the brains of patients who had previously received Gadolinium Based Contrast Agents in MRI examinations, so far all the observations have been made in adults.

Now, a recent study shows that such Gd deposition can be found in pediatric patients who have had prior GBCA (Roberts DR, et al. Pediatric Patients Demonstrate Progressive T1-Weighted Hyperintensity in the Dentate Nucleus following Multiple Doses of Gadolinium-Based Contrast Agent. AJNR Am J Neuroradiol. 2016 Jul 28.). The researchers, from South Carolina, USA and Xinjiang, China investigated the relationship between the number of prior gadolinium-based contrast agent doses and increasing T1 signal in the dentate nucleus on unenhanced T1-weighted MR imaging in pediatric cases. They hypothesized that despite differences in pediatric physiology and the lower gadolinium-based contrast agent doses that pediatric patients are typically administered based on weighted-adjusted dosing, the pediatric brain might nevertheless also demonstrate...
AUG/SEPT 2016

**IMAGING NEWS**

**Trans-cranial ultrasound headset could facilitate recognition of sports-related concussion**

Mapping blood flow in the brain of athletes using an advanced form of ultrasound may make it easier to more accurately recognize concussions, according to a study released today that was presented at the recent American Academy of Neurology’s Annual Meeting in Vancouver, Canada. There is increasing concern about the cases of concussion among athletes in contact sports such as American football, rugby, football, basketball, hockey, water polo and lacrosse. 

There is growing evidence that concussions can change the blood flow in the brain,” said study author Dr Robert Hamilton, co-founder of Neural Analytics in Los Angeles, CA, USA. “While such changes can be detected with MRI, we believe there may be a less expensive and portable way to measure these changes using a transcranial Doppler (TCD) device.” TCD uses ultrasound to map blood flow activity in the brain. Traditionally, the technique has measured variables such as the speed and variability (pulse) of blood flowing through the arteries. But those measurements haven’t been enough to accurately detect concussion.

For the study, Dr Hamilton’s group used an advanced version of TCD ultrasound to get a more complete picture of just how the blood moves through the middle cerebral artery.

The researchers compared a group of American 66 high school athletes in contact sports who had been recently diagnosed with a concussion against a control group of 169 high school student athletes from both contact and non-contact sports. The non-contact sports included cheerleading, cross country, cycling, tennis and track events. Both the control and concussion groups were approximately 30 percent female.

Each of the concussed athletes had their brain blood flow measured using the advanced ultrasound headset within an average of six days after the injury. They were also given a general concussion evaluation and had their blood pressure checked.

The study found that the advanced version of TCD ultrasound was able to differentiate between healthy and concussed athletes 83 percent of the time. This is in contrast to traditional TCD ultrasound measurements such as change in cerebral blood flow reactivity which differentiated between concussed and non-concussed 60 percent of the time, average blood flow speed which differentiated 55 percent of the time and blood flow resistance which differentiated 53 percent of the time.

“This research suggests that this advanced form of ultrasound may provide a more accurate diagnosis of concussion,” said Hamilton. “While more research is needed, the hope is such a tool could one day be used on the sidelines of sports pitches to help determine more quickly whether an athlete needs further testing.”

“This important work provides insight into a tool that may yet prove useful in the recognition and management of concussion,” said Dr Jeffrey Kutcher, of the Sports Neurology Clinic in Brighton, MI, USA. “The potential of having an accessible technology that detects a physiological change following brain trauma is very exciting. However, what these detected blood flow changes mean to a patient’s clinical care is still unclear. This is an important area of research. Testing of the TCD technique on the sideline of the sports pitch at the time of injury will be an important next step to determine its ultimate utility,”

http://tinyurl.com/AAN-presentation

**dose-dependent increasing T1 signal in the dentate nucleus.**

Over 20 years at the researchers’ institution (the Medical University of South Carolina, US), 280 patients had received at least 5 gadolinium-based contrast agent doses, with one patient receiving 38 doses. The team found that in pediatric patients, the number of prior gadolinium-based contrast agent doses was significantly correlated with progressive T1-weighted dentate hyperintensity. The authors point out that so far potential clinical sequelae of gadolinium retention in the developing brain are unknown, but advise that GBCA-based pediatric MRI exams be approached cautiously e.g. through the use of the more stable macrocyclic GBCAs which in both human and animal studies have been shown to be associated with lower levels of gadolinium deposition. The authors stress that it is important that their findings should not result in any patient being deprived of a well-indicated contrasted MR examination.

http://tinyurl.com/Roberts-et-al
CT – communicating the radiation risk appropriately

Despite evidence that low doses of ionizing radiation associated with imaging are not dangerous, the medical community is frequently faced with the challenge of communicating the risk to the public and managing the dose.

In a recent paper, Dr. C McCollough, Professor of Medical Physics and Biomedical Engineering at the Mayo Clinic, Rochester, MN, USA., analyzed the discrepancy between the public’s perception of radiation risk and the actual risk from low doses of ionizing radiation. *(McCollough CH The Role of the Medical Physicist in Managing Radiation Dose and Communicating Risk in CT. AJR Am J Roentgenol. 2016 Jun;206(6):1241-4)*

The paper reviewed the resources in the medical physics community that exist to manage dose levels in CT and suggested approaches for presenting radiation risk and benefit information that support the ALARA (as low as reasonably achievable) principle and acknowledge the overall low or nonexistent risk of CT.

“When asked by a patient or a patient’s family about the risk of radiation, it is incumbent on each of us to remember the tenet of justification first and foremost,” McCollough said. “If the examination is needed, the benefit will outweigh any small or potentially nonexistent risk. The next responsibility is to image the patient with care by adjusting the delivered dose to the patient size and to the diagnostic task.”

“There have been too many polarizing articles on the topic of radiation dose in CT. These articles serve only to perpetuate the discussion, leaving patients and their families with the impression that this issue is a deeply concerning one” McCollough said.

The correct approach to the discussion of radiation dose and communicating the risk is one that includes the five elements that neither brush aside the potential for risk nor propagate the alarmist message that CT is dangerous. These elements, contained in the American Association of Physicists in Medicine’s Position Statement on Radiation Risks from Medical Imaging Procedures, are: shown above.

http://tinyurl.com/McCollough-paper

Optimizing ASL to identify signs of dementia and Alzheimer’s disease

While dynamic susceptibility contrast (DSC MRI), CT perfusion imaging, SPECT, and PET are well-established methods for investigating blood flow in neurological diseases, arterial spin labeling MRI (ASL-MRI) has emerged as a versatile complement that warrants regular consideration in the clinical setting. ASL generates an image by magnetically “labeling” water molecules as an endogenous tracer as they travel to an organ of interest. ASL does not require a gadolinium-based tracer.

A “COST” (European Co-operation of Science and Technology) network of over 200 scientists, clinicians and industry partners have optimized ASL as a cost-effective diagnostic tool for measuring the tell-tale signs of dementia and Alzheimer’s disease. The network set a reference for the best possible way of measuring blood flow, allowing all researchers using ASL in neurodegeneration to compare the network’s results.

MRI systems can show anatomical changes in the brain, such as the loss of dying neurones due to Alzheimer’s disease. The technique of Arterial Spin Labelling (ASL) provides a non-invasive way to measure blood flow to the brain, thus allowing assessment of whether brain cells are being nourished with the oxygen and glucose they need to survive.

The aim of the new collaborative network was to provide researchers and clinicians with a reliable and comparable way to measure the tell-tale signs of dementia. “After 15 years of development of ASL around the world, there were a plethora of methodologies and techniques,” said Prof X. Golay of University College London. “It was a nightmare for anyone who wanted to work in this field because they did not know where to start or how to achieve the best results.”

Members of the “COST” action joined forces to find the best possible method to measure perfusion. The resulting paper has become a reference for scientists in the field *(Grade M et al. A neuroradiologist’s guide to arterial spin labeling MRI in clinical practice. Neuroradiology. 2015; 57(12): 1181).*

“It has really changed the field,” says Professor Golay. “This allows all of us using ASL in neurodegeneration to compare our results and it has even been taken up by the three main vendors of MRI machines – GE, Siemens, and Philips.”

http://tinyurl.com/Grade-et-al-paper
Ultrasound-guided RF ablation reduces volume of benign thyroid nodules

Two studies presented at the recent European Congress of Radiology showed the potential role of ultrasound-guided radiofrequency ablation in the treatment of thyroid nodules.

The six-month results from the first study presented in the ECR’s symposium on “Ablation outside the Liver” found that ultrasound-guided radiofrequency ablation of benign thyroid nodules results in 74% volume reduction. Dr CG Monaco and colleagues from Milan, Italy set out to estimate the effectiveness of ultrasound-guided radiofrequency ablation to treat benign thyroid nodules. They treated nearly 30 patients with a biopsy-proven benign thyroid nodule causing compression and/or esthetic dissatisfaction. The results of the study showed that the treatment is feasible, safe and effective; the investigators also noted that contrast-enhanced ultrasound (CEUS) is useful to check the effectiveness of the procedure, both immediately and during the follow-up period. CEUS was performed to determine the avascular portion of the tumor and the need for immediate re-intervention. Follow-up included ultrasound and CEUS at one and six months. The investigators also measured volume and calculated percent variations and compared them to pre-treatment values. The median pre-treatment volume was 20 mL with the avascular portion being 13 mL. At one-month follow-up, the median nodule volume had reduced to 9 mL—a reduction of 60% with the avascular part being reduced to a median of 5 mL, a reduction of 59%. At six-months, the nodule volume reduced to 4 mL, i.e. a reduction of 74% and the avascular part reduced to 2 mL, a reduction of 84%. All patients reported relief of initial symptoms at one and six months.

Another study presented at the same session was a single-centre experience from Pisa, Italy. The investigators used radiofrequency ablation as an alternative local treatment for hyperfunctional solid thyroid nodules. Rosa Cervelli and colleagues set out to validate the efficacy and safety of radiofrequency ablation for treating autonomously functioning thyroid nodules.

The authors concluded that radiofrequency ablation was efficacious and safe in treating autonomously functioning thyroid nodules. “Radiofrequency ablation can be considered a suitable treatment instead of conventional therapy (surgery or radioiodine therapy), especially for patients with pre-toxic benign nodules. In fact, this technique only affects pathological areas and preserves all the remaining thyroid gland,” they wrote.

They treated 15 nodules in 13 patients (11 females; 59±11 years) with toxic and pre-toxic autonomously functioning thyroid nodules, who refused or were not suitable for surgery or radioiodine therapy in a single session of radiofrequency ablation. The Pisa group performed ablation in real-time with ultrasound guidance and local pericapsular anaesthesia, using an 18-gauge, internally cooled electrode. Evaluations of nodule volume, thyroid function, ultrasound, contrast enhancement US (CEUS) and scintigraphic were made before therapy and at six months follow-up.

Cervelli and colleagues used radiofrequency power ranged between 35 and 45W. The mean application time was 9.34 ± 5.09 minutes, depending on nodule size. The mean pre-treatment nodule volume was 13.5 ± 13.3 mL. The nodule size decreased in all cases (3.9 ± 3.1 mL at six-month follow-up) with a mean volume reduction rate of 74.2%, six months after treatment. “Significant improvement of thyroid function was observed at last follow-up. As for scintigraphy, all hot nodules became cold or normal when scanned,” Cervelli said.

Statistics used in fMRI analysis shown to be erroneous

A recently published paper shows that common statistical methods used to analyze brain activity through images taken with MRI scanners cannot be trusted (Eklund A, et al. Cluster failure: Since its beginning more than 20 years ago, functional magnetic resonance imaging (fMRI) has become a popular tool for understanding the human brain, with many papers published on the topic. Despite fMRI’s popularity for this application, the statistical methods used have rarely been validated using real data.)
Predicting advanced prostate cancer outcomes with PET/CT

A recent pilot study found that sodium fluoride (Na-18F) positron emission tomography/computed tomography (NaF-PET/CT) accurately detects bone metastases in patients with advanced prostate cancer, and follow-up scans over time correlate clearly with clinical outcomes and patient survival. (Apolo AB et al Prospective Study Evaluating Na18F PET/CT in Predicting Clinical Outcomes and Survival in Advanced Prostate Cancer. J Nucl Med. 2016; 57(6): 886-92)

Dr A Apolo, head of the Bladder Cancer Section at the NCI in Bethesda, Md., said, “This is the first report of follow-up NaF scans of prostate cancer patients over a one-year period correlated with survival. The findings in this study provide support for the use of NaF-PET/CT in clinical practice in patients with advanced prostate cancer.”

Sixty prostate cancer patients, including 30 with, and 30 without known bone metastases as determined by conventional imaging, underwent NaF-PET/CT at baseline, 6, and 12 months. Positive lesions were verified on follow-up scans. Changes in standardized uptake values (SUV) and lesion number were correlated with prostate-specific antigen (PSA) change, clinical impression, and overall survival. Also, greater change in SUV at 6 and 12 months correlated with greater change in PSA.

In an exploratory analysis, paired Tc-99m-MDP bone scans (TcBS) were available in 35 patients at baseline, 19 patients at 6 months, and 14 patients at 12 months. Malignant lesions on NaF-PET/CT were classified on TcBS as malignant only 65 percent of the time; 25 percent were indeterminate; and 10 percent were negative. In addition, 65 percent of paired scans showed differences in the expected five percent of cases.

“Thanks to modern graphics cards, large calculations can be run. It would take 1,000 times longer to run the calculations using a normal computer, but thanks to the graphics cards the processing time can be reduced so that the method is usable in practice,” Dr Eklund says. He also analyzed the same data set with his more calculation-heavy method and obtained a considerably better correspondence, with differences in the expected five percent of cases.

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MRI shows brains of overweight people look ‘ten years older’ than lean counterparts at middle-age

From middle-age, the brains of obese individuals display differences in white matter similar to those in lean individuals ten years their senior, according to new research led by the University of Cambridge.

White matter is the tissue that connects areas of the brain and allows for information to be communicated between regions. Our brains naturally shrink with age, but scientists are increasingly recognising that obesity - already linked to conditions such as diabetes, cancer and heart disease - may also affect the onset and progression of brain ageing; however, direct studies to support this link are lacking.

In a cross-sectional study the researchers looked at the impact of obesity on brain structure across the adult lifespan to investigate whether obesity was associated with brain changes characteristic of ageing. The team studied data from 473 individuals between the ages of 20 and 87, recruited by the Cambridge Centre for Aging and Neuroscience and have just published their results. The researchers divided the data into two categories based on weight: lean and overweight. They found striking differences in the volume of white matter in the brains of overweight individuals compared with those of their leaner counterparts. Overweight individuals had a widespread reduction in white matter compared to lean people.

The team then calculated how white matter volume related to age across the two groups. They discovered that an overweight person at, say, 50 years old had a comparable white matter volume to a lean person aged 60 years, implying a difference in brain age of 10 years.

“... We’re living in an ageing population, with increasing levels of obesity, so it’s essential that we establish how these two factors might interact, since the consequences for health are potentially serious...”

Prof Paul Fletcher

Strikingly, however, the researchers only observed these differences from middle-age onwards, suggesting that our brains may be particularly vulnerable during this period of ageing.

“As our brains age, they naturally shrink in size, but it isn’t clear why people who are overweight have a greater reduction in the amount of white matter,” says first author Dr Lisa Ronan, “We can only speculate on whether obesity might in some way cause these changes or whether obesity is a consequence of brain changes.”

Senior author Professor Paul Fletcher, from the Department of Psychiatry, adds: “The fact that we only saw these differences from middle-age onwards raises the possibility that we may be particularly vulnerable at this age. It will also be important to find out whether these changes could be reversible with weight loss, which may well be the case.”

Despite the clear differences in the volume of white matter between lean and overweight individuals, the researchers found no connection between being overweight or obese and an individual’s cognitive abilities, as measured using a standard test similar to an IQ test.

REFERENCE
Improving the risk/benefit ratio of CT and MRI procedures

This article summarizes presentations given at the recent educational symposium jointly sponsored by Bracco and Bayer at ECR 2016. Prof. Christian Herold, chairman of the session, noted that this was a unique occasion in which a symposium was jointly sponsored by two industrial concerns and he welcomed this initiative as an opportunity for radiologists to focus exclusively on fundamental issues. The session comprised two presentations on the value of contrast enhancement in brain and abdominal imaging, followed by four presentations on the prevention and management of acute adverse reactions to contrast media.

CT and MR contrast in brain Imaging: how to improve lesion visualization and characterization?

Speaker: Prof. Paul M. Parizel

Prof. Parizel introduced his presentation with a Shakespearean question: to contrast or not to contrast? Of course, in an ideal world the answer would always be to give contrast to get the benefit of improved image quality, but in the real world there are other aspects such as safety, time and cost to be considered.

To evaluate such an advantage/disadvantage balance it is necessary to understand the basic mechanism of how enhancement occurs.

Lesion visualization

Unlike other organs, the brain is special because of the existence of the blood-brain barrier (BBB) which prevents normal brain parenchyma from enhancing. Enhancement in the brain occurs because of 1) accumulation of contrast material in the intravascular compartment (blood vessels), and 2) leakage of contrast material into the extravascular compartment (interstitial spaces). Intravascular enhancement can signify an increase in the number of blood vessels (e.g. neovascularity in a tumor), vasodilatation, and shortened transit time or shunting (e.g. arteriovenous malformation). Extravascular enhancement is observed in tissues which are not protected by the blood brain barrier (e.g. pituitary gland, pineal gland, choroid plexus), in extra-axial tumors (e.g. meningioma, pituitary adenoma) and in intra-axial lesions with breakdown of the blood brain barrier (e.g. high grade gliomas, inflammatory lesions such as active multiple sclerosis plaques, and various other conditions). Enhancement of intra-axial lesions due to a breakdown of the blood brain barrier is time-dependent, with the greatest degree of enhancement seen 5 to 9 minutes after injection. Therefore, care should be taken to avoid acquiring images too quickly after contrast agent injection. Ideally, T1-weighted sequences should be acquired after several minutes for optimal enhancement. But instead of idly waiting, we recommend to fill this time by first performing a T2 FLAIR sequence after contrast injection, then followed by one or more T1-weighted sequences.

Lesion characterisation.

For lesion characterization, Prof. Parizel focused on two techniques, namely perfusion imaging and angiography.

Perfusion imaging. To understand perfusion imaging, the principles behind the distribution of contrast media in a typical voxel should be appreciated at the cellular level. If there is damage to the blood barrier, contrast molecules which are initially circulating in the blood vessels, will leak out through the vessel wall into the interstitial spaces between cells. There are many variables governing such an apparently simple process, e.g. the concentration of the contrast molecules in the vessel, the blood flow, the surface area of the capillary walls, the density of the capillary bed, the size of the fenestrations between the endothelial...
cells, the volume of the interstitial spaces, the size of the cells, the intratumoral pressure, etc. One of the earliest applications of perfusion imaging was in the detection of stroke.

For example in contrast-based CT perfusion imaging of acute stroke, the calculation of parametric maps can give information on reduction in cerebral blood flow, in cerebral blood volume and in mean transit time.

In MR there are two types of perfusion imaging, namely Dynamic Susceptibility Contrast (DSC) perfusion and Dynamic Contrast Enhanced (DCE) perfusion. Since the introduction of gadolinium-based contrast agents, DSC, or T2* perfusion has been used. Several parametric maps can be extracted, among which cerebral blood volume (CBV) is probably the most important for tumor evaluation. Dynamic T1 imaging perfusion, or DCE has a slightly longer acquisition time scale than T2* but also generates a number of parameters, including k trans, which is an indicator of both capillary permeability and cerebral blood flow.

In short, both CT and MR perfusion imaging have opened up new areas of application and have deepened our understanding of stroke and brain tumor physiology.

**CT and MR Angiography.**

One example of the use of CT angiography is in evaluation of arteriovenous malformations (AVMs) where the use of contrast agents can provide information on arterial inflow to, and venous outflow from, the lesion. Such information can then be used to create a model to assist interventionists in deciding how to treat the patient. Contrast-enhanced CT angiography is also widely used to detect cerebral aneurysms and other vascular abnormalities.

In MR angiography, although no contrast medium is required for Time of Flight MR angiography, contrast is of course necessary for time-resolved contrast-enhanced MRA, which in addition to providing time-resolved, dynamic images also permits greater volume coverage.

To summarize, contrast-enhanced CT and MR angiography are robust techniques which have become part of routine brain imaging protocols.

**Take home messages**

- I.V. contrast media improve detection and characterization of intracranial lesions
- The dynamic use of contrast agents in perfusion or angiography has opened up new areas of applications.
- The potential benefits must always be balanced against possible safety concerns, time, and cost.

**Contrast enhancement in abdominal imaging**

**Speaker: Prof Luis Marti-Bonmati.**

The objectives of Prof. Bonmati’s presentation were to highlight the importance of contrast enhancement for indications in which high diagnostic confidence is needed.

**Contrast Media optimization in MDCT**

- *Arterial enhancement* is affected by several factors, including iodine delivery rate, injection duration and body weight and the saline chaser. In abdominal applications, it is important to adjust every acquisition to the time of arrival of the bolus. Given the variability of patients’ characteristics, the use of fixed delays is no longer acceptable, so bolus tracking is preferred. Bolus tracking is easy to use in practice and simply involves the setting of a threshold contrast value of the arrival of the contrast medium and an appropriate diagnostic delay which can vary according to the application. For early arterial phase studies, such as CT angiography, a short diagnostic delay is used, but liver lesions will not be seen. If the diagnostic delay is lengthened then not only is there vascular enhancement but also some peripheral vessels and hypervascular lesions will be enhanced in the late arterial phase. With an intermediate diagnostic delay, good angiographic images can be obtained together with definition of intra-tumoral vessels.

- *Parenchymal enhancement.* This is independent of the iodine flux but is directly proportional to the total iodine dose which should be chosen as a function of body weight. Usually a dose of 600 mg iodine/Kg body weight is adequate. However since fat is an extremely hypovascular tissue, even better consistency of enhancement can be achieved if lean body weight (LBW) is used for the calculation of dose (800 mg iodine/Kg LBW is adequate). Regarding flow rates, monophasic (i.e. constant) injection rates produce higher enhancement of parenchymal structures than multiphasic injections.

**Hepatobiliary exams. using CM. Typical Images, from left to right: arterial; portal; equilibrium and at 20 min.**

**Contrast Media optimization in MR**

In MR, the use of contrast media (CM) improves lesion detection as well as characterization and classification. In practice, several factors should be considered, including CM dose and concentration and its preferential distribution and elimination. In this it is important to consider both the number of contrast molecules present and their relaxivity. Similar to the situation in CT, in MR analysis of the abdomen there are vascular-perfusion effects, a vessel wall effect and also an interstitial effect.

**Hepatobiliary CM.**

The use of MR contrast agents will result in some hepatobiliary uptake, which varies depending on the agent used (hepatocyte uptake is ~ 5% for MultiHance and 50% for Primovist). This can be very useful for differential diagnosis. For example focal nodular hyperplasias (FNH) usually show hepatocellular uptake of these agents, whereas adenomas do not. Likewise, dysplastic nodules and well-differentiated hepatocellular carcinomas (HCC) typically enhance on hepatobiliary phase images while moderate and undifferentiated HCCs do not.

Since these CM are excreted in part with the bile, chloioangiographic images enable evaluation of the functional capacity of...
the liver to eliminate CM. Extravasation of CM can be easily delimited and the presence of free intraperitoneal bile and bile leaks can be clearly identified with these CM.

**Prevention and management of acute adverse reactions to Contrast Media**

**The size of the problem in 2016**

**Speaker: Prof. F Stacul**

In his presentation, Prof. Stacul dealt with acute adverse reactions to Contrast Media (CM), defined as those which occur within 1h after CM injection. These can be classified as dose-dependent reactions or dose-independent hypersensitivity; the latter category being further sub-divided into allergic or non-allergic hypersensitivity.

It has been reported that the incidence of mild allergy-like acute reactions to non-ionic iodine-based CM can be up to 3% of patients, with moderate reactions occurring in 0.5% of patients and severe reactions occurring in 0.04% of patients. As for Gadolinium-based CM, the incidence is even lower, with severe life-threatening reactions being exceedingly rare. Although there are some relatively old published papers on the incidence and management of serious adverse events, a more up-to-date assessment of the issue can be obtained from the post-marketing surveillance records of the companies producing contrast media. Bracco kindly gave Dr Stacul access to their database, which showed that in two months time (Dec 2015 - Jan 2016) there were 373 reports of serious adverse events worldwide. In 61% of these cases, treatment was administered directly, the remainder of the cases receiving delayed care, which basically meant that the radiology personnel simply waited for the arrival of an emergency team. However, analysis of the reports in the data base showed that correct or appropriate treatment was administered in only 73% of cases. Selection of only European cases from the database showed that the situation in Europe from the point of view of whether the appropriate treatment had been given was if anything even worse than this.

**How to prevent adverse reactions to Contrast Media**

**Speaker: Prof. A.J van der Molen**

In general, the benefit of contrast enhanced CT or MRI is much, much bigger than the associated risk but nevertheless risk/benefit assessment should be carried out. This means that the basic rationale for taking the CT or MRI in the first place should be known and if necessary discussed with the referring physician. Risk factors should be known and in the case of CT, the CM injection protocols should be adapted as a function of lean body weight and tube kVP.

In addition to knowing the patient and the risk, it is necessary to be aware of the characteristics of possible adverse reactions, e.g. immediate reactions occur usually within 15-30 min and are more frequent with patients between 20 and 50 years of age. Reactions to CM are less frequent if the CM is pre-warmed. Patients on β blockers may have more severe reactions and treatment for adverse reactions may be complicated.

Radiologists should be able to talk the same language as other medical colleagues such as allergy specialists, who in particular talk about “hypersensitivity” to a drug and only use the term allergy if it has been analyzed, characterized and documented as such. The term anaphylaxis should be reserved for severe life-threatening reactions. **Hypersensitivity** reactions are generally seen in the skin or mucosa; a few cases involve respiratory symptoms e.g. bronchospasms, laryngeal edema or pulmonary edema. Even fewer examples of CM-associated hypersensitivity reactions are cardiovascular in nature.

The risk factors are well known, e.g. patients with previous history, those with asthma or those with multiple systemic allergies requiring treatment.

**Prevalence.** This may in fact be lower than generally assumed. A recent survey carried out a few years ago in the Mayo clinic analyzed the reaction reports of more than 300,000 injections of low osmolality CM and found that the total frequency of reactions was 0.153%, with there
being only 13 severe reactions. The most frequent reactions were hives and nausea and the vast majority of the reported reactions were able to be easily treated within the radiology department.

Despite the fact that such figures show the extreme rarity of severe reactions to CM, it is nevertheless prudent that the radiologist be prepared to treat it. The Dutch guidelines for such treatment can be recalled in the form of the mnemonic CASH (Clemastine, Adrenaline, Salbutamol and Hydrocortisone) of which the most important by far is adrenaline, which should be given intramuscularly and at the correct dose. (There are several published reports that the administration by radiologists of adrenaline to treat CM reactions is frequently incorrect).

**Prophylaxis.** In the absence of any solid evidence in favor of prophylaxis, this practice is increasingly being questioned. A recent study from the United States, where prophylaxis is much more common than in Europe, shows, in fact, that patients receiving prophylaxis had longer hospital stays and greater risks of hospital infections. Thus it seems that there is more harm from prophylaxis than benefit. In fact a study about to be published shows that the simple act of changing the brand of CM being used was more effective in reducing adverse reactions than prophylactic treatment.

**Personnel.** Given the very low frequency of severe reactions, it is all the more challenging to keep the radiology personnel suitably aware, trained and ready to react should a problem arise. Nevertheless, training activities such as lectures, role playing and simulations with multiple scenarios should be carried out. Training courses where the personnel have to sit a test at the end are more effective than courses without final assessment.

### What to do during and after a contrast-enhanced exam

**Speaker: Prof. F. Stacul**

To begin his second presentation of the session, Prof. Stacul recommended the latest guidelines on contrast media from the European Society of Urogenital Radiology (www.esur.org/guidelines) The guidelines describe the first line emergency drugs and equipment that should be present in the examination room and describe how immediate assessment of the patient should be carried out if acute reactions are encountered. The procedure involves stopping the imaging exam, assessing the patient, while simultaneously calling for help and taking action appropriate for the clinical condition of the patient.

Differential diagnosis, such as distinguishing between anaphylaxis and panic attacks or between allergy-like reactions and vasovagal attacks is important but can be difficult. The Guidelines describe the main simple measures to be taken to deal with several conditions, e.g. hypotension, bradycardia, bronchospasm, laryngeal edema or generalized anaphylactoid reaction.

The administration of adrenaline is frequently called for by the guidelines; in practice radiologists should only give this by the LM route. To avoid possible confusion, there should be only one concentration (1:1000) of adrenaline available in the radiology department. It is important to monitor the patients in order to detect any development to more serious conditions, with monitoring lasting for at least 30 minutes. For patients known to be at risk of hypersensitivity reactions, this monitoring process should be extended to 2 hours. Hypersensitivity reaction can be divided into allergic and non-allergic reactions; which can be distinguished by skin testing carried out at least four months after the adverse reaction occurred. If such tests confirm a true immunological reaction against a specific contrast agent, it should be contra-indicated for life.

The Guidelines also underline the importance of documenting those acute adverse reactions that required medical treatment so that appropriate precautions can be taken in the future. However, mild symptoms not requiring treatment should NOT be recorded since this may result in the unnecessary withholding of CM in the future.

**Conclusion.** Familiarity with the presentation and treatment of contrast media reactions must be part of the environment in which intravascular contrast media are administered. Additional efforts are required to ensure that this goal is achieved.

### Simulation Training for Enhanced Patient Safety (STEPS)

**Speaker: Prof. C. Herold**

To round off the session, the chairman Prof. Herold took the opportunity to describe a structured approach developed at his department at the Medical University of Vienna / Vienna General Hospital to improve the ability of radiology personnel to deal with any adverse reactions until the emergency team arrive. The STEPS (Simulation Training for Enhanced Patient Safety) program covers current developments in CM-related emergencies such as the use of adrenaline auto-injectors, training in basic life support and the use of simulations.

**High-Fidelity Simulation Training.** Since frequently it is not known right away what is the cause responsible for an emergency, High-Fidelity Simulation Training aims not only at managing CM-related emergencies but at mastering ALL emergency situations potentially occurring in the scanner. Clearly, differentiating between CM related emergencies and those of other causes is a core part of this process.

In practice the training model (which involves repetitive annual or bi-annual courses) involves a 3-step approach:

- **Formal lectures on CM-related emergencies**
- **Basic life support techniques**
- **High fidelity simulations of advanced life support techniques, carried out in the scanner facility itself.**
**In vivo demonstration of Significant Radiation Reduction in Interventional Fluoroscopy Using a Novel Eye - Controlled Movable Region of Interest**

While the positive clinical impact of interventional fluoroscopy in the management of many pathologies is undeniable, the increased radiation exposure associated with the procedure and to which both patients and medical staff are exposed is of growing concern.

This article describes a recently developed innovative technology that has the potential to reduce radiation levels associated with fluoroscopic procedures by as much as 75% without compromising either workflow or image quality.

**INTRODUCTION**

Fluoroscopically Guided Imaging (FGI) procedures should ideally maximize patient benefit via the images provided without exposing either patients or staff to non-justifiable risk [1]. Radiation load as described by the total Kerma Area Product (KAP) delivered during a procedure is one measure of risk. (KAP is closely related to the Dose-Area Product (DAP) and for all practical radiation protection purposes can be considered as being equivalent to DAP).

From the patients’ point of view, KAP provides an estimate of the nominal Effective Dose [2]; the intensity of scattered radiation to which medical staff members are exposed is proportional to KAP [3]. However, simply reducing KAP by reducing the dose-rate increases image noise and may thus interfere with the overall diagnostic accuracy and safety of the procedure. Reducing the field size limits anatomical coverage and may blind the operator to the occurrence of clinically important peripheral events.

**THE HUMAN EYE/VISUAL SYSTEM**

The human visual system enables simultaneous surveillance of a large field while being able to rapidly focus on a smaller and often moving target [4]. For most visual tasks such as reading, eye motion continuously moves the observer’s gaze to bring an ‘interesting’ event into foveal vision. While this is happening, peripheral vision provides continuous surveillance of the rest of the scene.

Applying this principle to fluoroscopy, overall KAP could be reduced without adversely affecting anatomical coverage and peripheral surveillance by providing different local dose-rates in the immediate CROI and the remainder of the field [5]. This is accomplished by reducing X-ray beam intensity outside of the CROI [6-8]. Digital post-processing provides relatively uniform brightness across the image. Figure 1 is a simulation of this process.

A recent publication reported the first, promising results obtained with such an approach, using an innovative gaze-controlled system produced by ControlRad Systems [9]. The system minimizes KAP while both supporting peripheral vision and simultaneously maintaining image quality in the CROI.

The essential element of the new system is a unique...
real-time dynamic collimator that locates the CROI in response to the operator’s gaze by positioning, in real time, the unattenuated portion of the beam. Overall image brightness is then digitally equalized across the field. The positioning of the aperture anywhere in the field by the eye tracker is automatic and consequently does not affect procedure workflow. This technology is known as Eye Controlled Region-of-Interest (ECR); its operation is depicted in Figure 2.

The aperture provides an image quality bonus. Reduced radiation intensity in the volume of the field outside of the CROI cone reduces the level of scatter and therefore the amount of scattered radiation reaching the image receptor. This improves the signal-to-noise ratio in the CROI [Figure 3].

**MATERIALS AND METHODS**

An animal model was used to measure objectively the radiation reduction during fluoroscopically guided stent placements using the Eye Controlled Region of Interest (ECR) system. Kerma Area Product and Kerma Area Product Rate were used to characterize the animal irradiation. Air Kerma Rate and integrated Air Kerma measurements outside the primary field were used to characterize operator irradiation. A subjective evaluation of the effect of applying ECR as measured by the visibility of guide-wires and stents was obtained by interviewing the operators after they had performed the procedures.

**Technology**

A conventional C-arm fluoroscope with a 30 cm image intensifier and a unique collimator was added. In this collimator, a circular aperture in an attenuating plate projects an unattenuated field within a portion of the image intensifier’s active input area. This zone encompasses the operator’s foveal vision and is the CROI. When ECR is engaged, the operator’s gaze determines the location of the CROI within the imaged area (IA). When the attenuating plate is removed (i.e. ECR disengaged), the entire IA is uniformly irradiated. The eye tracker is calibrated to the operator prior to each procedure without radiation.

**Procedures**

Animal experiments were performed at the CRF Skirball Center for Innovation in Orangeburg, NY, USA. The study was approved by the Institutional Animal Care and Use Committee. The experimental animals were five male swine, of body weight ranging from 46 kg to 51 kg. Three pairs of stent placements were performed in each animal (two pairs of iliac and one pair of renal arteries). Each pair of stent placements involved one placement procedure carried out on
one side of the animal and in which the ECR was engaged and an equivalent procedure on the opposite side with the ECR disengaged. Half of the pairs of procedures were performed with ECR engaged, the other half disengaged. Three Board-certified interventional physicians performed the procedures. The same operator performed each pair of stent placements (ECR engaged/disengaged). The catheters, guide-wires, and stents were all standard equipment.

**Dosimetry Measurements**

External Air Kerma and Air Kerma Rate were measured using a dosimeter placed at a fixed position near the animal. Dose rates near the operator’s head were sampled using a survey meter. A KAP chamber was placed between the collimator and the animal.

Although formal evaluation of image quality was beyond the scope of these experiments, subjective opinions were solicited immediately after each experiment. In many instances, the operator stated that stent visibility was improved with ECR engaged. All three operators stated that the fluoroscopic images were acceptable, that stent visibility was improved, that stent placement had approximately the same difficulty with ECR engaged or disengaged, and that overall the practical experience of carrying out the procedures was equivalent.

**CONCLUSION**

This first in vivo evaluation of ECR demonstrated objectively that the eye-controlled technology can reduce KAP and operator irradiation by 75% without interfering with the performance of fluoroscopically guided interventional procedures. As expected from the literature, reduced scatter subjectively improved device visualization. These findings indicate the potential of the technology and the practicability of minimizing radiation dose in fluoroscopy.

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The potential of dose management software in computed tomography

INTRODUCTION

Over the last few decades, the level of radiation to which the public have been exposed through the use of medical imaging has grown by an estimated 600% [1–3]. A large part of this increase can in particular be attributed to the increasing number of computed tomography (CT) scans being carried out. Against this background and as a result of the growing awareness of the issue of radiation exposure, radiation monitoring and safety is nowadays becoming an ever more important part of quality assurance in radiology. Whereas in fluoroscopically guided intervention both patient and staff radiation protection need to be considered [4], keeping the patient’s radiation exposure as low as possible is the major issue in CT.

A basic requirement in all CT studies is that the three fundamental principles of the International Commission for Radiation Protection (ICRP, 2007), namely “justification, optimization, and limitation” should be respected. In an endeavor to underscore the importance of these three principles, several dose awareness campaigns such as Image Wisely [5], Image Gently [6] or EuroSafe [7] have recently been introduced worldwide.

The aim of the first of the ICRP principles, justification, is to limit the number of unnecessary examinations while still providing net patient benefit. For this, the diagnostic information that is likely to be obtained from the examination needs to be taken into consideration together with the associated radiation doses and risks to which the patient is exposed [8, 9]. This requires regular interdisciplinary communication and consultation between radiologists and referring physicians so that a joint decision on the most appropriate imaging solution for an individual patient can be taken.

Optimization means conforming to the ALARA principle (as low as reasonably achievable) so that when the need for a CT exam is agreed on, only the lowest possible amount of radiation is applied, namely the dose needed to provide adequate images, with a quality of image sufficient to answer the diagnostic question being posed. It is in this area that the implementation of technical innovations such as new reconstruction algorithms (e.g. iterative reconstruction), dose modulation, or ultra-low-dose protocols have resulted in significant improvement.

Finally, dose limitation means that certain dose levels must not be exceeded since otherwise an individual’s risk of suffering from stochastic dose sequelae such as radiation-induced cancer would be out of proportion to the benefit derived. To address the issue of dose limitation, it is recommended that guidelines such as the Dose Check Standard from the National Electrical Manufacturers Association (NEMA) be adhered to [10].

Dose Check Standard operates by issuing alerts in cases where the scanning parameters set by the CT technologists seem likely to result in a dose higher than predefined thresholds. Through these alerts, the CT technologists are prompted to review the parameters in order to prevent unnecessary high levels of radiation output. Another useful tool in dose limitation is the implementation of a dose management software, which provides dose data immediately after completion of the CT scan [11].

DOSE MANAGEMENT IN COMPUTED TOMOGRAPHY

Recently, several vendors have developed dose management software that can be connected to all imaging modalities using ionizing radiation. However, given that CT is much more standardized than, for instance fluoroscopically guided interventions, it is reasonable that the initial focus has been on first connecting CT scanners and on setting up the dose management software in the clinical CT workflow. Irrespective of the particular vendor, all of these software tools enable registration, tracking, and analysis of radiation doses applied to patients.

The basic dose information that is given in CT is the CT dose index (CTDI), the dose-length-product (DLP) as well as the size-specific dose estimate (SSDE). For in-house quality assurance, an individual patient’s dose values are automatically matched with those of other patients who have undergone the same CT protocol, thus enabling the establishment of institutional diagnostic reference levels. These data can also be used to meet any statutory requirements by allowing easy comparison of dose data from one institution with national or international reference values.

An additional feature of the software allows comparison,
immediately after completion of the scan, of the actual dose received by an individual with the preset dose thresholds. If the thresholds have been exceeded, the software releases a dose notification, which is visible on the overview window of the software. Through this, it is possible to immediately assess whatever reason (or reasons), were responsible for the excess dose. Such information is very useful for avoiding future repetition of excess doses. The system allows the implementation of real-time monitoring of patient dose, which can be summarized as the process of reading dose data and receiving feedback on the reason(s) for exceeding thresholds directly upon completion of each scan. Such real-time monitoring of patient dose approach can be effectively integrated into the clinical workflow as shown by two recent studies [11, 12] which described the practical implementation of real-time monitoring of patient CT dose in clinical routine.

In their studies, the authors analyzed the reasons for dose notifications and found that the two most frequent causes were the patient being overweight and improper patient centering with regard to the isocenter of the scanner [11, 12]. Being overweight, defined as BMI ≥ 25 kg/m² (BMI: body mass index, the weight in kilograms divided by the square of height in meters) is a factor that can only be influenced by the patient herself/himself. In contrast, centering of the patient depends significantly on the technologists’ performance. Several studies have demonstrated that even small deviations of 2-6 cm from the vertical position can negatively influence image quality and dose by preventing optimal operation of the bowtie filter whose role is to modify the spatial distribution of emitted radiation within the fan beam. As a consequence of errors in patient centering, dose values can increase by up to 51% [13, 14].

“... the two most frequent reasons for dose notifications were the patient being overweight and improper patient centering...”

Assuming that the performance of technologists depends both on their level of training as well as on the time pressures they are faced with when positioning the patient on the CT table, it could be expected that improper patient centering would be more of a problem in an emergency setting than in routine scanning of out-patients. However, in reality in one of the two studies the very opposite was seen [11], while the other study did not find any significant difference between emergency or routine scanners [12].

The third most frequent cause of the issuance of a notification was scan repetition due to severe motion artifacts, which can hamper adequate diagnostic imaging reading. Motion artifacts can result from improper/impractical patient positioning in the head-holder or can occur with confused or agitated patients, who are unable to keep still. From a quality improvement point of view, and just as with overweight patients, there is little the technologists can do to reduce number of scan repetition notifications except for trying to reassure the patients as much as possible. As confused or agitated patients are more often scanned in an emergency setting, it was again anticipated that scan repetition notifications would occur significantly more frequently on the emergency scanner than on the out-patients scanner. This was indeed shown in one of the studies [11]. However, the other study again did not demonstrate any significant difference between both scanners as far as the number of scan repetition notifications was concerned [12].

Other, more rare causes of dose notifications included orthopedic hardware located within the scanning field, leading to upregulation of the current. Yet other causes were scanning of the patient on a spine-board or the patient’s inability to lift arms [11, 12].

Since the dose management software enables real-time monitoring of patient dose, and involves technologists’ active participation, the aim of one of the two studies was to evaluate whether in practice the technologists’ dose awareness would actually increase after the implementation of such a real-time monitoring of patient dose [12]. The study was again carried out on two scanners, one predominately used for emergency and intensive care patients and the other mostly for out-patients. When the number and reasons for dose notifications were compared before and after the implementation of real-time monitoring of patient dose in clinical CT routine, it was found that the total number of notifications decreased significantly on both CT scanners after the introduction of real-time monitoring of patient dose. The main reason for this decline was a...
significant reduction — almost 75% — in the number of improper centering notifications issued.

In the authors’ opinion, this in turn is the result of the increased dose awareness on the part of the CT technologists, induced by their involvement with the dose management software. This assumption was supported by the fact that although the number of all other notifications, which cannot directly be influenced by technologists also showed a small decline in both scanners when real-time monitoring of patient dose was used, nevertheless the level of such declines did not reach statistical significance. The authors therefore concluded that, in addition to the radiation dose-based information provided, the increase in dose awareness by the CT technologists should be regarded as an additional strength of dose management software. In this context, one practical finding was that by placing the computer screen with the dose management software next to the CT console the collaboration of the CT technologists was stimulated and their involvement increased [Figure 1].

CONCLUSION

The management of reasonable dose in computed tomography is an important part of overall quality assurance in radiology and can be achieved with dose management software that provides dose data upon completion of the scan. The main features of such software are the ability to perform real-time monitoring of patient dose and the easy comparison of dose data with other institutions or with national or international diagnostic reference levels. Moreover, from a less “pure dose value” point of view an important impact of the dose management software is that it increases the general awareness of dose that the technologists have, and is associated with a decline of dose notifications due to human error. Now it will be the aim of future studies to determine the long-term effect of dose management software on such technologists’ dose awareness and to evaluate further dose-saving strategies from the data provided by the software (e.g. constitution-based CT protocols using SSDE).

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This book is the first single-source, multi-disciplinary reference, based on the didactic sessions presented at the annual ‘Clinical Trials Methodology Workshop’ for radiologists, radiation oncologists and imaging scientists (RSNA). It focuses on educating radiologists, radiation oncologists and those involved in imaging research with how to design and conduct clinical trials to evaluate imaging technology and imaging biomarkers.

The internationally renowned contributors take a broad approach, starting with principles of technology assessment, and then move into specific topics covering the clinical trials of therapy and clinical research in imaging guided interventions including radiotherapy. They discuss the use of imaging as a predictor of therapeutic response, screening trial design, and the practicalities of how to run an efficient clinical trial and good working practices. Later chapters provide a comprehensive array of quantitative methods including: an introduction to statistical considerations in study design, bio-statistical analysis methods and their role in clinical imaging research, methods for quantitative imaging biomarker studies, and an introduction to cost effectiveness analysis.
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Colorectal cancer (CRC) is the most frequent cancer in Europe, with more than 400,000 new cases per year, and is the second cancer-related cause of death, with more than 200,000 deaths per year [1].

The prognosis of CRC can be radically improved if it is detected at an early stage and progression can be prevented by endoscopic removal of the precursor of CRC, the adenomatous polyps [2]. These characteristics make CRC suitable for the application of population-wide screening approaches. Population screening for CRC has been implemented in many European countries, but the optimal strategy is still under debate. Several tests and procedures are available for the identification of CRC and adenomas, such as fecal occult blood test (FOBT), fecal immunochemical test (FIT), flexible sigmoidoscopy and colonoscopy. Each method has its own advantages and disadvantages.

FOBT has been shown to reduce mortality from CRC in randomized trials and is currently the most widely used strategy for population screening in Europe [3]. FOBT is a cheap, easy test and is well accepted by the people being screened, with a participation rate ranging between 48% and 62% [4, 5]. However, FOBT may produce false negative results, since CRC and polyps do not always bleed. On the other hand, false positive results are also possible, for example due to hemorrhoids.

Colonoscopy is regarded as the gold standard examination method for the diagnosis of CRC and adenomas, but it is invasive, costly and suffers from low participation in screening programs [6]. Since 2003, CT colonography (CTC) has been proposed as a less invasive screening test alternative to colonoscopy [7]. The technique has been validated in large multicentric trials in Europe and in the US [8, 9], in which the accuracy of CTC in detecting cancer and large polyps (≥10 mm) was found to be comparable to that of colonoscopy.

In Italy, a randomized trial (SAVE study) was designed and is currently underway to compare the performance of CTC against FIT and colonoscopy as a primary screening test for CRC.

The primary aim of the trial was to compare participation rate, detection rate and costs of the three screening strategies. Results after the first FIT round were recently reported [10].

STUDY DESIGN AND CTC SCREENING PROCEDURES
The SAVE study is a single-centre, randomized trial with four parallel groups that is currently on-going in the city of Florence, Italy. The trial involves 16087 subjects, aged 54-65 years, who had never been screened before by the regional programme for CRC. The participants were randomized into four groups who were then invited by mail to participate in one of four interventional procedures:

1) biennial FIT for three rounds,
2) single reduced preparation CTC,
3) single full preparation CTC,
4) colonoscopy.

Each single round of CTC or colonoscopy was compared to three rounds of FIT, because it has been shown that the latter has to be repeated in multiple rounds every one or two years to be effective.
Subjects invited to participate in the FIT group were asked to collect the test in any pharmacy of their choice in the city, whereas those assigned to the CTC or colonoscopy groups were requested to contact the screening centre to make an appointment for their examination.

The “reduced” preparation for CTC consisted of a low-fibre diet and a small dose of light cathartic agent (MOVICOL, Norgine, Milano, Italy) administered at the main meals for 3 days before the examination, whereas the “full” preparation comprised a three-day low fiber diet and a 2-liter cathartic solution the day before the exam (MOVIPREP, Norgine, Milano, Italy).

CTCs were performed with 64- and 128-slice CT scanners (Somatom Sensation 64 and Definition AS 128, Siemens, Erlangen, Germany) using a low dose protocol (120 kVp, 50 mAs effective), which yielded an effective dose of 3.4 – 4.2 mSv. Colonic distension was obtained using an automatic carbon-dioxide insufflator (PROTOCO2L, Bracco, EREM, Lake Success, NY, USA) after intravenous administration of 20 mg. of scopolamine butylbromide (BUSCOPAN, Boehringer Ingelheim Italia, Milan, Italy).

Participants in the CTC groups had the possibility of having the examination carried out in the hospital closest to their home. The images were then transferred by teleradiology to a centralized reading centre, where one of two experienced radiologists interpreted them using computer aided detection (CAD) with a “first reader” approach (CAD-COLON, Im3D, Turin, Italy).

The radiologist first examined candidate polyps prompted by CAD, after which a quick scroll of axial CT images was carried out in order to locate any lesions missed by CAD [Figure 1].

The radiologist did not perform a specific search for extra-colonic findings, reporting only those that were seen during colonic evaluation and judged as being potentially important, e.g. solid or complex cystic renal lesions, other solid abdominal masses, aortic aneurysms or non-calcified lung nodules > 10 mm.

Subjects with at least one polyp ≥ 6 mm at CTC and those with a positive test in the FIT group were referred to colonoscopy.

The main outcome parameters of the trial were

1) participation rate, i.e. the number of invited subjects who actually underwent the screening test as a proportion of the total number of invitees.

2) detection rate, i.e. the number of subjects with screening-detected advanced neoplasia (cancer or advanced adenoma) as a proportion of the total number of participants.

**PARTICIPATION IN SCREENING**

It was found that the participation rate for CTC, whether in the reduced preparation group (28%) or the full preparation group (25%), was higher than that for colonoscopy (15%) but lower than that for FIT (50%) (p<0.001) [Table 1].

![Figure 1](image-url) Large sessile polyp identified in the rectum by “first reader” CAD in a screening CTC.
Thus, interestingly, the participation rate in CTC screening was almost double that in colonoscopy screening, suggesting that colonoscopy is still perceived as a burdensome examination by subjects. However, CTC failed to reach the high participation rate of FIT, probably because FIT is the easiest test but perhaps also because of a relative lack of public awareness about screening CTC, which is a relatively new test.

The SAVE study thus finally demonstrated that the offer of a reduced bowel preparation increases participation in screening (28% for reduced preparation vs. 25% for full preparation CTC, p=0.047), an issue that had previously only been speculated upon. It is also interesting to note that the participation rate in reduced preparation CTC was higher in men (31%) than in women (26%) (p=0.01), whereas FIT was preferred by women (53%) rather than men (47%) (p<0.001). This preference by men for CTC could be advantageous in screening since the incidence of CRC is higher in men.

**DETECTION RATE**

About 10% of subjects screened by CTC had a positive result and were referred to colonoscopy. This percentage was lower than previously expected and is an important finding because a high referral rate to colonoscopy leads to elevated endoscopic workload and raises overall costs of CTC screening. The detection rate for advanced neoplasia of CTC (5.2%) was threefold higher than that of one FIT round (1.7%) (p<0.001). However, it has to be borne in mind that the sensitivity of FIT for CRC and adenomas is cumulative and can increase round by round. Thus, for a definitive evaluation of the performance of FIT it is necessary to wait for the results of the two subsequent FIT rounds that are currently on-going.

The SAVE trial confirmed that the use of a limited bowel preparation for CTC did not negatively affect the rate of detection of advanced neoplasia; the detection rate in the reduced preparation CTC group (5.5%) was similar to that in the full preparation CTC group (4.9%) (p=0.65).

Important extracolonic findings were found in 5% of subjects screened with CTC. This is not a negligible percentage, and is important as extracolonic findings often require further diagnostic work-up with consequent increases for the screening programme and potential harm for the patient. Moreover, the clinical benefit of diagnosing asymptomatic extracolonic pathology is still under debate.

**CONCLUSIONS**

The SAVE study is the first randomized controlled trial to compare CTC, FIT and colonoscopy for population screening of CRC. The results of screening CTC were encouraging. Participation rate in CTC screening was lower than that in FIT screening, but CTC detected more advanced colorectal lesions.

In order to further evaluate the possible role of CTC as a primary screening test for CRC, other factors should be investigated by future research, such as the management of extracolonic findings, the optimal polypl size threshold for colonoscopy referral, and, most importantly, the cost-effectiveness.

Currently, it appears that CTC can play a role as a complementary second level examination in screening programmes for CRC based on FOBT or FIT. In this context CTC is recommended in FOBT-positive subjects who decline colonoscopy and in those with incomplete colonoscopy [11].

**REFERENCES**


**TABLE 1.** Main results of the SAVE trial.
Leipzig - Germany
7-10 December 2016

EuroEcho Imaging 2016

20th Annual Meeting of the European Association of Cardiovascular Imaging, a registered branch of the ESC, in cooperation with the German Working Group of Echocardiography.

Important Deadlines
Clinical case submission 18 May 2016
Abstract submission 31 May 2016
Early registration 30 September 2016
Late registration 31 October 2016

#EuroEcho
www.escardio.org/EACVI
At the helm of Philips imaging businesses

It’s more than a year since Rob Cascella was appointed CEO of Philips multi-billion dollar group of imaging businesses. Now that he has had time to really get to know the divisions under his care, we thought it was time to catch up with this industry veteran who is just as passionate as ever about the medical imaging business.

Q. Let’s start at the beginning. Please tell us a bit about your career prior to joining Philips.

I’ve been working in Medical Imaging for almost my entire career, first as an entrepreneur, then as a business leader. I love it. It’s not just that imaging makes the invisible visible, but there’s nothing more important for diagnosis and treatment.

When I joined Philips in 2015 I was serving on several boards of imaging companies but prior to that I had spent the last 10 years as president and then CEO of Hologic where we became the market leader in women’s health.

Q. So with you involved in all these activities, what was it that attracted you to Philips?

I have always admired Philips, particularly for its record of innovation and its loyalty to serving healthcare.

I can remember walking around RSNA 2014 being truly impressed by the Company’s broad product portfolio. I also remember thinking — why is this company not yet the out and out market leader?

And then, surprisingly, shortly after that RSNA I was contacted by a recruiter to ask if I would interested to meet with Frans van Houten, CEO of Royal Philips, to talk about joining the company.

Q. And now, after more than a year on board, what are your impressions of Philips from the inside?

Of course, imaging is more important than ever as we integrate data from other tools to drive toward definitive diagnosis as well as adaptive treatment, which are at the heart of our company strategy.

However, what makes us different is that Philips is taking a holistic view of the entire health continuum: we cover the full range of consumer and patient needs, from prevention and healthy living, to diagnosis and treatment, to home care.

A huge technology enabler is the HealthSuite digital platform, our open, cloud based platform that allows the creation of the next generation of connected health and clinical IT innovations. So for example, Philips has been able to develop smart Imaging Data Analytics designed to analyze and assess modality performance to anticipate service requirements before they occur. These kinds of innovation enable new value propositions, and that’s really exciting.

Q. So let’s look ahead now. What’s your perception of future opportunities or trends to set?

Well first of all, value-based medicine is a reality. We believe that as a company in this field, we must enable
our customers to do more with less; which is why we are committed to driving “first time right” imaging. Reimbursement now — and increasingly into the future — will depend on getting it right the first time as we move from a “fee per procedure” health system to a much more efficient health care delivery mechanism.

Q. Do you see any particular areas with especially high technological growth potential?

We are continuing to see an industrialization of healthcare, so we are investing heavily in our unique ability to make radiology departments more efficient and more valuable to their institutions. Philips’ Radiology Solutions tools analyze data across the department to create predictability, reduced operating expenses, and continuous improvement.

This is a different kind of relationship with a provider, because we create a joint commitment to quality, efficiency, and cost metrics. This approach creates value for patients, departments and the healthcare institution.

Q. And just what are the strengths that Philips have in this new healthcare environment that you envisage?

I repeatedly hear our customers say that our innovation and our people are extraordinary; the best in the industry. We have an all-digital portfolio connected to smart analytics which enables us to scale partnerships and drive new value. But innovation can’t mean complexity: our systems need to be simple to use and reliable, with a high level of automation – focusing on workflow and efficiency. We are continuing to invest in advanced applications that, again, are simple, reliable and easy to use. This is what the world is asking for.

Q. Moving out from Philips now, what are the challenges facing the industry as a whole?

We believe that radiology has a unique ability to transform healthcare by leveraging practice management and the other elements described here. The entire industry, across every market, is facing extraordinary challenges. We can no longer think in terms of equipment or even equipment and service — we must talk about data-driven performance improvement to optimize imaging volumes.

“...we can no longer think in terms of equipment — we must talk about data-driven performance improvement to optimize imaging volumes...”

Q. How do you see future growth in Philips?

We will continue to invest in organic growth opportunities to strengthen our Health Tech business, and will also continue our disciplined approach to Mergers and Acquisitions.

Q. Now, turning to the crystal ball, where do you see Philips in, say, ten years?

By focusing on Health Tech, we see an opportunity to leverage advanced technology coupled with deep clinical and consumer insights, to deliver integrated solutions that enable better outcomes across the health continuum. In the future our customers will say that they partner with us because Philips delivers the most continuous value. They will call us patient-focused and user-obsessed with innovations that are connected and smart. I envision scanners so comfortable and safe that patients ask for us by name, saying, “I want a Philips scan.” Our connected solutions will help transform personal health and health systems, making a difference in the lives of patients, families, health professionals and communities.
Varex Imaging new name
For Varian’s Imaging Components Business

Varian Medical Systems have announced that Varex Imaging Corporation will be the name for its Imaging Components business upon the completion of the planned spin-off of that business as a new, stand-alone public company in a transaction due to be completed by the end of 2016.

The Varex Imaging name draws from the 65-plus years of technology leadership and strong industry brand recognition of Varian and the excellence in X-ray imaging technology that customers can continue to count on from the new company. As an independent company, Varex Imaging will pursue new growth strategies by leveraging its position as a global leader in components, software and services for expanded imaging applications and markets.

Varian Imaging Components president Sunny Sanyal, who will assume the role of CEO of Varex Imaging upon completion of the spin-off, stated, “As a trusted imaging components partner, we have a laser focus on providing our customers with high-quality and cost effective products that enable them to develop and deliver new next-generation imaging systems. Excellence in imaging is a top priority and this is evident in the new company.”

Varian Imaging Components is a leading global supplier of components, software and engineering services for imaging equipment manufacturers and system integrators in the medical diagnostics, dentistry, veterinary care, security and industrial inspection industries. It manufactures X-ray tubes, high energy x-ray sources, flat panel image detectors, connectors, collimators and image processing software; all key components of X-ray imaging systems.

VARIAN MEDICAL SYSTEMS, PALO ALTO, CALIFORNIA
www.varian.com

First spectral detector-based CT installed since receipt of CE mark for diagnostic use

Philips has just announced the installation of its IQon Spectral CT, the industry’s first spectral detector-based CT system at the University Medical Center Utrecht (UMC Utrecht) in the Netherlands. This is the first IQon installation in the world following recent CE marking for diagnostic use. This installation builds on UMC Utrecht’s ongoing commitment to selecting innovative solutions designed to improve patient care.

The Philips IQon Spectral CT provides multiple layers of retrospective, diagnostic data in a single, low-dose scan with seamless integration into existing hospital system protocols. It can provide sufficient information with only one scan to help clinicians make fast, confident diagnoses, driving improved clinical and economic outcomes.

Offering high-image quality, the IQon Spectral CT allows clinicians to uncover critical information to help inform fast diagnosis and treatment even in the most challenging cases.

“Unlike traditional CT images, which can be limited in structural detail and require additional scans, Philips’ IQon Spectral CT allows our clinicians to identify the composition of materials in the body in one scan,” said Prof. Tim Leiner, Imaging Division, UMC Utrecht. “In a patient-focused care environment, comprehensive solutions that enable ‘first-time right’ testing and diagnostics without compromises can be revolutionary in addressing many of our greatest challenges, including workflow and patient satisfaction.”

“In healthcare environments where providers are challenged with increasing throughput and quality, while reducing waste, advancements in CT technology that allow for quick, confident diagnosis make a significant difference — for providers and patients,” said Henk Valk, General Manager. “Providing more data and high-quality images in a single scan delivers on Philips and UMC Utrecht’s shared goal to improve patient care, while also addressing some of the biggest issues facing providers and affecting patients.”

PHILIPS EINDHOVEN, THE NETHERLANDS
www.philips.com

Cloud-Based Regional Image Sharing Project in Île-de-France Region

Carestream Health has been selected to implement the Shared Regional Medical Imaging Services (S-PRIM) project in the Île-de-France, the largest region in France, with 12 million residents, making up 19% of the French population.

The S-PRIM project will enable rapid implementation of a shared medical imaging infrastructure to ensure the continuity of basic services, such as migration of archiving and PACS, used by existing members. It also will make new, innovative services available both to public and private establishment across the Île-de-France, including Carestream’s Clinical Collaboration Platform that will be offered as a cloud-based service, creating the speed for migration and scalability necessary to allow growth for future subscribers.

The tender was issued by the Healthcare Co-operation Group (Groupement de Coopération Sanitaire [GCS]) and known as Service Numérique de Santé (Sesan). It updates a previous framework agreement, Region Without Film (RSF), which ended in April 2015.

These cloud-based services will provide secure exchange and sharing of medical imaging data, allowing healthcare professionals and patients
across the Île-de-France to collaborate on patient care. Examples of services offered include:

- The creation of a unique and holistic patient folder at a regional or territorial hospital group (GHT) level, giving privileged access to all prior images available, no matter in which S-PRIM member facility the preceding exams were carried out.
- The ability to create integrated clinical pathways and treatment plans, for example to manage requests for second opinions from selected experts.
- The capacity to share results with prescribing doctors and patients via a portal that is fully integrated with the regional digital health space (l’Espace Régional Numérique de Santé or ENRS), and which will offer all users unique, simplified and secure access to their data, no matter in which establishment the exam was carried out.

The 39 organizations participating in the RSF framework today will migrate the 10 million exams already archived to S-PRIM, in addition to managing two million exams per year. This will be one of the biggest enterprise repository of medical data in Europe designed with scalability for growth. Numerous other establishments in the region have also expressed interest in joining the project and at least one of the services proposed in the new six-year Framework Agreement.

“We are proud to welcome GCS Sesan, with the S-PRIM project, into the community of partners putting their confidence in Carestream,” added Patrick Koch, Managing Director, Carestream France and Benelux. “This includes the hospitals in the AP-HP hospital group (the Greater Paris University Hospitals—the largest hospital group in Europe), the Midi-Pyrenees, Central, Pays de la Loire and Provence-Alpes-Côte d’Azur. Subscribing hospitals will be connected gradually to our Vue Cloud platform, which is already being used by more than 100 healthcare establishments in France and for which we have accreditation from the French government to host personal medical data.”

TeraRecon accelerates R&D Investment

TeraRecon, a leader in advanced visualization, enterprise medical image viewing and image sharing solutions, announced the addition of two new executive leadership positions and has opened a new R&D facility in Research Triangle Park (RTP) in North Carolina, USA.

Hitachi to distribute fusion imaging biopsy system

The German company MedCom and Hitachi Medical Systems Europe have entered into an agreement whereby Hitachi will distribute BiopSee, MedCom’s fusion imaging system for stereotactic, navigated, targeted prostate biopsy & therapy guidance, for use in conjunction with Hitachi ultrasound systems. Hitachi will be the sole distributor of the BiopSee products in this territory for Hitachi’s installed base and will be bundled with Hitachi’s products. The BiopSee fusion imaging station combines multi-parametric MRI with real-time ultrasound. It offers exceptional precision in stereotactic and navigated interventions with intuitive workflow that can bring state-of-the-art technology to everyday urology practice. The BiopSee software supports 3D ultrasound image acquisition, rigid/elastic fusion with MRI, planning, navigation, reporting of interventional procedures, and interfaces to focal therapy devices. An electronically tracked stepper provides millimetric precision for a transperineal approach, while a magnetically tracked freehand probe can be used for navigated TRUS and abdominal procedures.

Hitachi Medical Systems Europe
ZUG, SWIZERLAND
www.hitachi-medical-systems.eu

TeraRecon accelerates R&D Investment

TeraRecon, a leader in advanced visualization, enterprise medical image viewing and image sharing solutions, announced the addition of two new executive leadership positions and has opened a new R&D facility in Research Triangle Park (RTP) in North Carolina, USA.

Dave MacCutcheon is the new VP of Product Management and Pratik Nanavati is VP Software Development. Both bring many years of experience and expertise in Healthcare IT software development, specifically in the areas of Overlay PACS Viewing technologies, advanced visualization and agile software development. Jeff Sorenson, President and CEO of TeraRecon, said “We have a history of innovating well ahead of market demand and this requires substantial investment in R&D. In the past 10 months, we have increased R&D spending significantly, and I am committed to maintaining double-digit annual increases. Bringing Dave and Pratik’s deep expertise into our company bolsters a fantastic group of proven innovators on the engineering and product management teams. Opening our cutting-edge office in RTP allows us to scale engineering and continue to attract top talent who want to solve imaging problems differently and really re-invent enterprise imaging workflow altogether.”

The new space in the RTP will also provide for an expansion of the company’s sales and customer support teams to enhance the customer experience.

TeraRecon
FOSTER CITY, CA, USA
www.terarecon.com
Cancer Imaging: More Than Meets The Eye
International Cancer Imaging Society Meeting & 16th Annual Teaching Course

3rd-5th October 2016
Technology and Innovation Centre, Glasgow, UK

ICIS 2016 will focus on quantitative and functional oncologic imaging and the multidisciplinary management of oncology patients. There will be a spectrum of sessions ranging from innovative and state-of-the-art imaging, practical hands-on-workshops and essential refresher courses.

- **4 Plenary sessions** including “Cancer Imaging: More than Meets the Eye” with lectures on Imaging Tumour Biology, Tumour Heterogeneity and Radiomics and “Implementing PET/MR in Clinical Practice”
- **12 Interactive workshops** including “Renal Tumours”, “Lung Cancer” and “Lymphoma”
- **2 Keynote lectures** ‘Immunotherapy: Imaging Challenges’ and ‘Towards the Cure of all Children with Cancer: Global Initiatives in Paediatric Oncology’
- **6 Computer hands-on workshops** using Siemens workstations
- **4 Scientific sessions** dedicated to proffered papers, and a poster exhibition with prizes for the best overall paper and poster

CPD accreditation has been sought from Royal College of Radiologists and EACCME. The course party will be held at the Trades Hall of Glasgow, tickets £40 each including dinner and wine.

Accreditation will be sought from the European Accreditation Council Continuing Medical Education (EACCME) and the Royal College of Radiologists (UK)

Programme Planning Committee: ICIS President Beth McCarville (USA), Dow-Mu Koh (UK), Olivier Lucidarme (France), Andrea Rockall (UK), Heinz-Peter Schlemmer (Germany)

For further information please contact:
ICIS, 45 Queen Anne Street, London, W1G 9JF  T: +44 (0)20 7036 8805  E: louise.mustoe@cancerimagingsociety.org.uk
cancerimagingsociety.org.uk
Bernd Montag, CEO of Siemens Healthcare explained "We have an exceptional track record of engineering and scientific excellence and are consistently at the forefront of developing innovative clinical solutions that enable providers to offer efficient, high quality patient care. Going forward as Siemens Healthineers, we will leverage this expertise to provide a wider range of customized clinical solutions that support our customers business holistically. We are confident in our capability to become their inspiring partner on our customers’ journey to success. Our new name is a bold signal for our ambition and expresses our identity as a people company – 45,000 employees worldwide who are passionate about empowering healthcare providers to optimally serve their patients."

There is no doubt that globally healthcare is changing rapidly. Everyone in the industry works on discovering new ways to improve peoples' health while structures, incentives, and processes are radically changing to support the growing patient population. Strategies of consolidation, industrialization, and population health management are being developed to stand up to the rising pressure. Siemens Healthineers understands these challenges including the need for continually driving metrics around clinical, operational and financial efficiencies.

BERND MONTAG
CEO
Siemens Healthcare

"With the opening of its ‘One Campus’ headquarters in Belgium, Barco is looking to the future with confidence. Located in the city of Kortrijk, the 230,000 m² ‘One Campus’ site is a true landmark for the region – an all-glass, circular building surrounded by green spaces and connected to three other state-of-the-art Barco facilities. The campus will not only be the new home to Barco’s 1,250 Belgian employees but will also serve as an open house for customers, partners, foreign colleagues and other stakeholders. One Campus also marks a new way of working, centered around dialogue, collaboration and, consequently, innovation. Barco is convinced that its new operating base will be of great support in the future evolution of the company."

The new One Campus, which replaces Barco’s older premises in Kuurne and Kortrijk, includes 48,000m² of general facilities, surrounded by a pound and grass. Standing proudly, at the heart of the campus, is The Circle, which is connected to the Lab (the R&D and test-unit), the Pulse and The Engine (the production facility), by a footbridge to stress the campus feeling. The Circle comprises airy, flexible office areas, R&D offices and test areas, a multipurpose auditorium (170 seats), a training center, a three-tier meeting deck and an atrium that features a first-class company restaurant. The showpiece of The Circle, however, is the Barco Experience Center, which is equipped with Barco’s most advanced visualization solutions.

BARCO
KORTRIJK, BELGIUM
www.barco.com

A consortium of Elekta, Philips, The Institute of Cancer Research, London, and The Royal Marsden Hospital in London, recently began installation of the first high-field (1.5 Tesla), MR-linac system in the United Kingdom. Elekta’s MR-linac integrates an ultramodern radiotherapy system and a high-field MRI scanner with sophisticated software that allows a physician to capture diagnostic quality images of tumors and surrounding tissue during radiation delivery allowing physicians to rapidly assess and respond by modifying the radiation treatment, a responsive intervention approach. The MR-linac is designed to improve targeting of tumor tissue while reducing exposure of normal tissue to radiation beams. It will allow physicians to precisely locate a tumor, as well as lock onto it during treatment, even when tumor tissue moves during treatment or changes shape, location or size between treatment sessions.

Tomas Puusepp, President and CEO of Elekta said “MR-linac has the potential to transform the future of cancer care and we are grateful to all of our global consortium members and partners for their dedication to advancing leading-edge technologies that were previously thought to be impossible.”

The ICR and The Royal Marsden are the fourth global site to install the MR-linac system, which is already under functional evaluation at The Netherlands Cancer Institute in Amsterdam, University Medical Center Utrecht and The University of Texas MD Anderson Cancer Center.
According to the latest white paper on teleradiology issued by the European Society of Radiology, the field of teleradiology (TR) is defined as “the exchange of radiological images and patient-related data between geographically different locations for the purposes of primary interpretation, expert consultation and/or clinical review by digital transmission” [1]. The overall aim of teleradiology and the rationale behind its introduction is to improve the overall quality of the health system and to reduce healthcare costs [2]. Practical implementation of TR has been dramatically facilitated by the recent rapid expansion of high speed information technology (IT) highways, by the low cost of large data storage facilities and finally by the ready availability of picture, archiving and communication systems (PACS). However, in practice, PACS technology is not evenly distributed across the European Union. PACS availability is in general particularly high in northern Europe while it is low in some southern Europe countries [3]. The demand for TR is driven both by a shortage of radiologists and by geographical concerns. Thus, in many Northern European countries, TR is routinely utilized for workload balancing or to provide remote, out of hours radiological coverage, for emergency readings or, to a lesser extent for subspecialty readings [4, 5]. These reasons are behind the emergence over the past decade of several national and international commercial TR providers in Europe, which have facilitated the outsourcing of diagnostic readings [4, 6, 7].

In contrast to northern Europe, TR is not as common in southern Europe. There are several possible reasons for this, such as a technological gap in implementation, the larger availability of radiologists and also more restrictive legislation and guidelines in some countries [8, 9].

DESIGN OF SURVEY OF ITALIAN TELERADIOLOGY

In June 2014 the Italian Informatics Chapter of the Società Italiana di Radiologia Medica (SIRM) conducted a questionnaire, web-based survey of radiologists to obtain an overview of the current status of the implementation, infrastructure and application of TR in Italy. A section of the questionnaire was devoted to determining the opinion of TR held by radiologists and to assess how the future of TR was perceived [10]. The basic questionnaire was developed by two Italian radiologists and incorporated improvements and suggestions provided by a multidisciplinary group of Italian experts. The survey was sent via the mailing list of the SIRM to all radiologists actively working in Italy, in both private and public hospitals. Survey Monkey statistical tools were used for the analysis of the quantitative data [11].

The survey contained 19 questions designed to gather information on the geographical location, age, institution and title of the participating radiologists, on the TR infrastructures available to them, as well as the radiologists' practical experience of TR and finally on the overall opinion of the interviewee on TR. Responders were also asked to select the major advantages and disadvantages of TR from a provided list of possible answers.

RESULTS

A total of 1599 radiologists, corresponding to 17% of all Italian SIRM members, participated in the online survey. The majority of responders worked in public hospitals. Out of the total number of survey participants, 29 % occupied academic positions or were directors of radiology units. Eighty-nine percent of responders had a PACS available

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This article describes the results of a recent survey designed to evaluate the attitude of Italian radiologists to TR.
in their working environment. There was no difference in PACS availability between private and public practices. Sixty-five percent of participants had a digital signature available at the time of the survey. Table 1 shows the number of radiologists using TR in their clinical practice and in which physical location.

The large majority of TR users sent their reports via a direct connection with the RIS. In contrast, clinical information on the patient was obtained via a direct connection with the RIS in only approximately half of cases. In a smaller number of cases, clinical information was obtained by phone, fax or via a dedicated IT platform. A small minority of respondents received relevant clinical data by e-mail or by text messaging.

The majority of survey participants (81%) used an intra-mural implementation of TR, meaning that they report examinations from a radiology unit physically located within the same hospital or in a different hospital belonging to the same group or Institution. The main use of TR was for emergency calls, followed by night and weekend coverage and in a smaller number of cases for smoothing out uneven workload distribution [12]. Only a small minority (12%) of responders reported using an extra-mural set-up, that is one in which the interpreting radiologist was working for completely separate company or institution and not related or affiliated to the one that is providing care to the patient [1].

TR outsourcing was used more frequently in private institutions than by public hospitals. Only a very small percentage of radiologists used TR to report cases from home or using a mobile device.

Several reasons were cited for requesting a second opinion by TR. In decreasing order of importance these were: difficult cases; neuroradiology consultation; to assess indications of interventional procedures. A small minority of respondents requested a second opinion from a pediatric radiologist.

Sixty-two percent of participants in the survey held an overall positive opinion of teleradiology while 80% (thus including 18% who currently had a negative opinion), were convinced that TR has a positive future. Radiologists already using TR had a higher opinion of the approach than those who had not yet adopted TR in their clinical practice. Radiologists working in private practice had a higher level of positive attitude to TR than those working in public institutions. Academic radiologists and Directors of Radiology units were generally more positive regarding TR than radiologists working in other positions.

The survey found that the main concerns of survey participants regarding TR were: fear of losing control over their business; instability in the job market and in radiologists’ income; reduced quality of reports; loss of radiological skills, negative effect on resident’s training and slowness in communicating the results of urgent examinations [Table 2].

DISCUSSION

TR is looked on favorably by the majority of Italian radiologists who, in general think that the approach has a positive future. In Italy insourcing (i.e. use of Teleradiology within the same institution) is the prevalent form of TR, while outsourcing is rare. In the large majority of cases, insourcing is adopted for emergency coverage, and at nights and for weekend shifts. Requesting a second or subspecialty opinion is another common application of TR.

This relatively conservative approach is in stark contrast with the northern

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Break-down of responses to the question whether the responding radiologist used teleradiology and, if so where?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Where do you usually use Teleradiology?</strong></td>
<td><strong>Answers</strong></td>
</tr>
<tr>
<td>I don’t use teleradiology</td>
<td>45.26%</td>
</tr>
<tr>
<td>Within hospital on a dedicated workstation</td>
<td>47.52%</td>
</tr>
<tr>
<td>At home</td>
<td>8.82%</td>
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<tr>
<td>Everywhere using a mobile</td>
<td>5.93%</td>
</tr>
<tr>
<td>Total responders: 1551</td>
<td></td>
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</tbody>
</table>

| TABLE 2 | The survey also investigated the concerns of radiologists regarding Teleradiology. The responses are shown above |

**Radiologists could lose control of their business**

<table>
<thead>
<tr>
<th><strong>Strongly disagree</strong></th>
<th><strong>Disagree</strong></th>
<th><strong>Neutral</strong></th>
<th><strong>Agree</strong></th>
<th><strong>Strongly agree</strong></th>
<th><strong>No opinion</strong></th>
<th><strong>Total</strong></th>
<th><strong>Average evaluation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>5.98% (90)</td>
<td>24.65% (371)</td>
<td>5.78% (87)</td>
<td>39.58% (595)</td>
<td>22.52% (339)</td>
<td>1.53% (23)</td>
<td>1,605</td>
<td>3.59</td>
</tr>
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**Instability of jobs and/or income for radiologist**

<table>
<thead>
<tr>
<th><strong>Total</strong></th>
<th><strong>Average evaluation</strong></th>
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<tr>
<td>3.68</td>
<td>1,477</td>
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**Loss of quality radiological reports**

<table>
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<th><strong>Total</strong></th>
<th><strong>Average evaluation</strong></th>
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<tr>
<td>3.20</td>
<td>1,493</td>
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**Dangers of missing urgent pathology**

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<td>2.83</td>
<td>1,467</td>
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**Negative effect on training of residents**

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<th><strong>Total</strong></th>
<th><strong>Average evaluation</strong></th>
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<tbody>
<tr>
<td>3.12</td>
<td>1,462</td>
</tr>
</tbody>
</table>

**Loss of radiological skills**

<table>
<thead>
<tr>
<th><strong>Total</strong></th>
<th><strong>Average evaluation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.00</td>
<td>1,480</td>
</tr>
</tbody>
</table>
European and North American vision of TR, where outsourcing is very common [13–18]. There are several possible reasons for these discrepancies. 

First of all, Italy has a very high population density and the second highest number of radiologists per head of population in Europe (after Denmark) [19], so the need for extra-mural TR is correspondingly lower.

Secondly, Italy has restrictive guidelines on the use and implementation of TR, in that outsourcing is allowed only in those screening examinations, such as mammography, which require double reading. Italian guidelines allow routine intra-mural TR between different locations, if these are within the same radiology unit and in the same hospital, or between radiology units or departments when they are located in different hospitals within the same institution.

A subject of recent debate in Italy has been whether a technologist may be allowed to carry out conventional radiograms without contrast media administration to outpatients upon the prescription of the referring general practitioner, without a radiologist being present in the health facility to justify the request and to obtain informed consent. In a recent lawsuit, the ruling was that justification of each individual X-ray examination is the sole responsibility of the radiologist [20].

Thirdly, language barriers probably represent a limitation to cross-border implementation of teleradiology. White papers on radiology from both the European Society of Radiology (ESR) and the American College of Radiologist (ACR) state that “patients are the primary focus; first and foremost, all TR relationships should be patient-centred” [18, 21, 22] The UK’s Royal College of Radiologists (RCR) similarly affirms that an “optimum radiology service is one provided locally where radiologists can maintain a regular dialogue with both referrers and those acquiring the images; only in this model can patients benefit fully from the integration of imaging into the pathway of care” [23–25].

Italian radiologists also seem to believe that the best radiology service is one provided locally as described above by the RCR. However, they also believe that there are other circumstances in which TR can be beneficial, in particular for obtaining a specialist second opinion or subspecialty expert opinion or for overnight and weekend coverage wherever the use of TR in such situations is approved.

There is a significant methodological limitation to this study in that only 17% of all radiologists registered with the SIRM responded to the survey. Also, the individuals responding to the questionnaire might have been more motivated to answer because of their personal interests or because they are more familiar with and knowledgeable of IT in general. For this reason the results of this survey do not necessarily reflect the opinion of the entire Italian radiological community.

CONCLUSION

The survey found that Italian radiologists feel that the most important advantage of teleradiology is the possibility of working in a collaborative network. A major point of concern to radiologists is that teleradiology is too impersonal and that contact with the patient and referring clinician may be lost.

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Coronary CT angiography: radiation dose reduction using iterative reconstruction and the impact on diagnostic image quality

In this article, we present a summary of our work, in which we evaluate the use of CT iterative reconstruction (IR) for radiation dose reduction and the impact on diagnostic image quality particularly in coronary CT angiography (CCTA). We demonstrate that IR is a powerful tool that enables radiation dose reduction without significant impact on diagnostic image quality.

Coronary artery disease (CAD) is one of the leading causes of death worldwide. In Australia, it affected almost 640,000 people in 2014 and accounted for 18% of all deaths [1]. The need for early identification of CAD and appropriate investigation are central components in reducing the risk factors and improving patients’ health status. Although in many cases, the patient history, physical examinations and tests such as the determination of cardiac enzyme levels and electrocardiogram (ECG) are sufficient, most patients usually need further imaging investigations.

Currently, the interventional coronary angiography (ICA) is the gold standard examination to rule out CAD, but it does cause some patient discomfort due to the long imaging time and invasive nature of the procedure [2,3]. In contrast, a coronary CT angiography (CCTA) is quick and minimally invasive procedure to the patient. CCTA has also been shown to be a reliable imaging tool to exclude CAD and is used routinely in clinical practice. However, CCTA has the disadvantage of a high patient radiation dose with the potential risk of DNA damage or cancer over a lifetime [4].

In recent years, many different dose-saving strategies have been developed by CT vendors to overcome high radiation dose in CCTA. These include prospective ECG-gating, tube current modulation, low tube voltage and high pitch acquisition. A newer approach to dose-saving that has recently received more attention among imaging professionals, is the CT image reconstruction algorithms. Filtered back projection (FBP) is the most widely used of CT image reconstruction techniques. FBP is a fast and robust algorithm, but also may lead to noisy images when using low exposure factors which thus limits its performance to allow dose reduction.

Iterative reconstruction (IR) is an alternative CT image reconstruction technique which may allow reconstructed images comparable to FBP, while scanning at lower radiation dose. IR can reduce the appearance of noise by incorporating a statistical model into the process of image reconstruction, comparing the images reconstructed from acquired projection data to a modelled projection to reduce error. Principally, in every cycle, the reconstructed image is continuously updated to produce final images that have similar or superior diagnostic image quality to that using FBP despite a significant reduction in acquisition exposure factors.

Over the past years, many studies have been performed with the use of IR in CT, but only a few studies have investigated IR in CCTA. Due to the use of different diagnostic image quality metrics, conclusions drawn may not apply to CCTA. Therefore, we carried out this systematic review to evaluate the potential for radiation dose reduction using IR for CCTA and its impact on diagnostic image quality compared to FBP.

Selection of studies

Seven databases (MEDLINE; Web of Science; EMBASE; CINAHL; Science Direct; IEEE Xplore; and SPIE Digital Library) were used for the literature search based on a Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) strategy [5]. All studies were selected based on the inclusion and exclusion criteria developed using Population, Intervention or Exposure (PECO), Comparison, Outcomes (PICO) methodology [6]. The first commercial IR for clinical use was released in late 2008. Therefore, articles that compared the radiation dose and diagnostic image quality of IR and FBP in adult patients who underwent CCTA between 2008 and 2015 were included in the search. We excluded studies that used phantoms or animals, as they did not specifically analyze the detection and classification of human coronary arteries.

Radiation dose and diagnostic image quality

Fourteen articles were included with a total of 3,428 patients. The ratio of male to female was 1,664 to 1,706 patients.
Statistical analysis showed differences in the means and standard deviation (SD) indicating that there was a significant reduction in radiation dose when using IR compared to FBP (P<0.05) with no significance difference (P>0.05) regarding assessment of diagnostic image quality [Figure 1]. The mean and SD difference of computed tomography dose index volume (CTDIvol), dose-length-product (DLP), and effective dose (ED) were 14.70 ± 6.87 mGy, 186 ± 201 mGy.cm and 2.9 ± 1.7 mSv respectively. The mean and SD difference of image noise, the signal-noise ratio (SNR) and the contrast-noise ratio (CNR) were 1.05 ± 1.29 HU, 0.88 ± 0.56 and 0.63 ± 1.83 respectively.

These results reveal that IR permits the use of lower exposure factors which provides a significant reduction in patient radiation dose by reducing the image noise during image reconstruction. Although different types of IR have been included in the review, the result of our analysis showed that all types of IR significantly reduce radiation dose with no significant impact on diagnostic image quality between FBP and IR. However, the range of dose reduction varies widely across the included studies. Most selected studies had a range wider than in the current literature. For example, the DLP range across the selected studies is from 164 to 504 mGy.cm (so a variation by a factor of 3.1) while in the current literature is only from 129 to 337 mGy.cm (that is a variation by a factor of 2.6) [7].

**Dose-saving strategies**

Therefore, a combination with other dose-saving strategies is necessary to narrow down the range and further reduce radiation dose. From our review, most studies showed that 25-75% of radiation dose reduction could be achieved if IR combined with low tube voltage technique and prospective ECG-gating. Five studies compared the use of 100 and 120 kVp CCTA protocols with IR, and reported a reduction in radiation dose from 27% to 50% while maintaining diagnostic image quality. Comparing prospective and retrospective ECG-gating using IR, 80% of studies performed reported an effective dose of lower than 5.0 mSv which is similar to the 4.7 mSv mean effective dose reported by other previous studies [8].

**Review challenges**

Despite the advantage of reducing radiation dose while still maintaining diagnostic image quality, the descriptors of diagnostic image quality used should not be used as end-points of IR performance since spatial resolution and artefacts were not included. The diagnostic efficacy of detecting CAD at lower doses was also not evaluated. Therefore, the results of the analysis should only be used to provide an overview of the radiation dose reduction reported by literature, not the impact on diagnosis. However, differences in the types of CT scanners and other radiation dose reduction strategies can influence diagnostic efficacy, so making it analysis difficult.

**Conclusion and future work**

This review demonstrates that the use of Iterative Reconstruction in CCTA leads to a significant reduction of radiation dose compared to Filtered Back Projection. For the diagnosis of CAD, the diagnostic image quality obtained with IR at a reduced dose (30-41%) is comparable to that obtained with FBP at a standard dose. It is recommended that future studies should include more types of IR to verify these findings. The different parameters or settings of IR should be highlighted, particularly hybrid options or strength levels, so that possible dose reduction can be maximized. Moreover, the use of IR with other dose-saving strategies should also be investigated along with cost effectiveness. This could help to identify the most effective approach to reduce CCTA radiation dose while maintaining the diagnostic image quality.

**References**


**Further information**

This mini-review article is a summarised version of an article originally published in the Journal of Medical Imaging and Radiation Oncology from The Royal Australian and New Zealand College of Radiologists, where more comprehensive information can be found [see reference 9].
High performance dual source CT for multiple applications

With the launch of the new Somatom Drive CT system Siemens Healthineers, the only manufacturer to produce computer tomographs with two X-ray tubes and detectors, has strengthened its Dual Source portfolio. Several innovative technologies in the new system make it suitable for use in all clinical applications. Patients benefit from precise diagnostics, examinations with especially low X-ray and contrast media doses, as well as imaging without breath-hold. As for radiographers, they benefit from the intuitive operability of the new touch panels and the fast examination procedures which are necessary to meet the growing demand for CT scans in the future.

INNOVATIVE TECHNOLOGIES.

“With Somatom Drive, we are offering a high-performance CT scanner allowing significantly more users to give their patients the advantages of Dual Source technology: remarkable precise imaging and very low dose values,” said André Hartung, Head of Siemens Computed Tomography division. This is achieved through a range of innovative technologies. For example, the system’s new Straton MX Sigma X-ray tubes and Sigma generators precisely deflect the X-ray beam, allowing for more targeted beam focusing and enabling examinations to be performed with very high energy levels at low voltages. With these lower voltages, the amount of administered contrast media — often a major challenge for seriously ill patients or those with reduced kidney function — can be lowered accordingly.

Users can freely set the X-ray tube voltages in 10 kV steps between 70 kV and 140 kV. This means that the voltage and, therefore, the appropriate dose can be selected for each individual patient. Scanning patients at a lower kV reduces their exposure to radiation. This is of benefit, for example, not only in pediatric cases but also in patients with tumors who need to be scanned frequently to monitor disease progress. Even with heavier patients, the highly adjustable kV values allow for extremely precise imaging.

OPTIMIZED X-RAY SPECTRUM

The new Dual Source CT combines a high temporal resolution of 75 milliseconds and a scan speed of up to 45.8 centimeters per second with special spectral tin filters. The filters, known as Selective Photon Shields II, optimize the X-ray spectrum by filtering out the parts of the X-ray beam that are rarely useful for imaging [See sidebar]. Lung scans can be performed at an extremely low dose, which is prove particularly beneficial for standard screening tests – for heavy smokers at high risk of lung cancer, for example. The spectral filters also facilitate low doses for calcium scoring in cardiac diagnostics. This combination of low doses and high diagnostic reliability makes the Somatom Drive ideal for future applications such as spinal diagnostics and orthopedic examinations. In addition, the Dual Energy mode of the Dual Source scanner can accurately differentiate between different materials in the body – tissue, bones, implants – and avoid metal artifacts.

HIGH-SPEED SCANNING

The field of pediatrics is a clear example of how the scanning speed of the new system can help patients, for example in the case of a thoracic scan on a newborn with suspected vascular malformations or the subsequent post-operative follow-up examinations. In such critical cases, breath-hold is often not possible because the young patients cannot understand the breathing.
Reducing radiation dose in CT: in both non contrast-enhanced and contrast-enhanced scans

Although nowadays many CT scans rely on the use of iodinated contrast agents, there are still a significant number of scans which are carried out without contrast agents. Just one example of CT examinations being carried out without contrast agents is screening for lung cancer, which is currently the focus of increasing attention ever since recent studies showed that low dose CT screening can reduce mortality levels in high-risk subjects.

Non-contrast CT exams - the use of tin filters

The output of a standard X-ray tube used in CT and operating at a tube voltage of 120 kV is a broad polychromatic spectrum ranging from 30 keV to 120 keV. However low energy photons such as those in the range of 30 keV - 50 keV have a very low penetration of human tissues and are mostly absorbed in the patient's outer tissues, such as the skin or subcutaneous fat layers. These photons therefore do not contribute to the creation of the required image, and instead represent unnecessary radiation dose.

The tin-filter, known as the Selective Photon Shield II in the Somatom Drive, is a thin, homogeneous plate of high purity tin (Sn). It is situated at the level of the collimator and when swung into the X-ray beam, effectively filters out the low-energy photons in the range of 30 - 50 keV, i.e. those which do not significantly contribute to the required image.

Thus, with a tube voltage of 100 kV, the use of the tin filter provides a high-quality image with high signal/noise ratio at a significantly decreased level of overall radiation. For example, for a scan of the thorax in a patient of average size, tin filtering can reduce the received dose by as much as 50% while maintaining image quality.

In addition, the spectral filtering provided by the tin filter also produces a more narrow, i.e. more monochromatic spectrum and so reduces beam-hardening artefacts, which are caused by the differential attenuation by photons of different energies.

However, the advantages of tin filtering can only be achieved with sufficiently powerful X-ray tubes, since otherwise, if too many quanta are removed by the filtering process, the overall total flux may be reduced to an unacceptable extent. The Straton MX Sigma X-Ray tubes in the Somatom DRIVE system are sufficiently powerful to avoid this problem. The Straton tubes differ significantly from standard tubes in that, unlike conventional tubes, the anode in the Straton tube is cooled directly, creating an overall powerful tube which is nevertheless much smaller than the conventional design.

CT exams with use of contrast agents.

The situation is radically different when contrast agents are used since absorption by iodine increases significantly as the k-edge of iodine (33 keV) is approached. Thus, in the range of 33 keV to 50 keV, there is significant attenuation by iodine — this far outweighs the additional dose in this region of the spectrum. So in fact it is highly beneficial to actually increase the quanta in this range, which can be done by reducing the tube kV to 100 keV or even lower. In such cases, dropping the tube voltage from 120 kV to 100 kV or even lower enables up to 50% reduction of radiation dose with no detrimental effect on image quality.

Schematic diagram of the effect of tin filtering on the X-ray spectrum. The yellow curve represents the unfiltered X-ray beam, showing the relative amount of photons at low energy, which are absorbed by the outer tissues of the patient and do not contribute significantly to the desired image in cases where iodine contrast medium is not used. The blue curve shows the spectrum after tin filtration, with the irrelevant low energy photons effectively removed. In cases where contrast medium is administered, tin filtration is not used since iodine significantly attenuates photons in the energy range from 33 keV to 55 keV, so making it useful to retain photons in this range. In such cases, dropping the tube voltage from 120 kV to 100 kV or even lower enables up to 50% reduction of radiation dose with no detrimental effect on image quality.

Image courtesy of Dr T Flohr, Siemens
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BREAST IMAGING

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**Computer-aided Detection for Breast Tomosynthesis**

The explosion of data which a tomosynthesis exam generates can be daunting for radiologists. A typical 2D mammogram involves examining two images per breast, whereas tomosynthesis can produce hundreds of images, thus significantly increasing reading complexity and interpretation time.

To help address these challenges, the iCAD company — a specialist in the design of Computer-Aided detection (CAD) systems — has developed PowerLook Tomo Detection, a concurrent read CAD solution specifically designed for digital breast tomosynthesis (DBT).

The new system provides radiologists with a powerful tool to simplify DBT reading workflow and improve interpretation confidence. Studies have shown that the product can reduce interpretation time by up to 36.5% with an average reduction of 29.2%. The current version of the package is designed to detect soft tissue densities including masses, architectural distortions, and asymmetries.

PowerLook Tomo Detection is built on the latest deep learning technology and is designed to improve DBT reading workflow while maintaining the high sensitivity and low false positive rates associated with DBT. The algorithm used in the system is trained to identify suspicious soft tissue densities using both biopsy-proven cancer images as well as normal mammogram images.

**How does it work?**

PowerLook Tomo Detection rapidly scans each DBT plane image identifying potential areas of interest. These areas of interest are extracted from the planes and blended onto a synthetic 2D image where they are visible on a single image. The detected regions on the enhanced synthetic 2D image are also linked to the appropriate 3D DBT planes, so creating an efficient and effective navigation tool for radiologists to decrease reading time. Unlike traditional 2D CAD solutions, PowerLook Tomo Detection is designed to be used concurrently throughout study interpretation. Also unlike traditional 2D CAD no CAD marks are placed on the image.

PowerLook Tomo Detection is currently available with the GE’s SenoClaire and Seno Iris mammography workstation. This technology combined with the GE V-Preview synthetic 2D image creates an Enhanced V-Preview image. By blending the detected regions into the V-Preview synthetic 2D image, over 90% of cancers that can be seen on the tomosynthesis planes are also visible on the enhanced synthetic image.

**Digital Mobile X-ray system**

The EFX version of the MobileDaRt Evolution series from Shimadzu is digital mobile X-ray system that can be moved to any location where radiography is required, enabling on-site examinations and image verification. The system continues the company’s tradition in diagnostic imaging providing innovative technologies and industry firsts.

Designed for efficiency and high throughput, the new system is equipped with a wireless flat panel detector (FPD), so broadening its applications from clinical rounds in hospitals to critical care units, as well as operating rooms and neonatal intensive care units (NICU). The system not only improves the workflow of the X-ray technologist but also reduces the burden on patients. Instead of a traditional hard disk drive, a high speed vibration-resistant solid-state drive (SSD) has been incorporated, thereby reducing the risk of data loss. The system startup time has been substantially reduced to approximately 1 minute.

LEDs have been used as the light source to indicate the irradiation field, so increasing the brightness, contributing to improved operability for the and reducing power consumption to approximately one half of conventional levels while ensuring a long operating life and reducing periodic maintenance requirements.

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First use of Ultra High Frequency Ultrasound System in humans

Fujifilm VisualSonics recently announced a significant milestone with the installation of the company’s Vevo MD Ultra High Frequency (UHF) clinical ultrasound system at the Second University of Naples in Italy. After many successful evaluation studies of the technology in preclinical research over the last decade, the Vevo MD is the company’s first foray into the clinical market.

Dr. Roberto Grassi, Professor of Radiology at the Second University of Naples, said that the institution has now ten years’ experience of ultra high resolution ultrasound systems in preclinical studies, which have enabled the research team to study the anatomy of small animals such as mice and rats, with a resolution down to 30 microns. The new Vevo MD shows great potential for developing novel applications in the clinical sector.

“Preclinical research is a crucial step toward establishing clinical applications, but until the launch of the Vevo MD, there were no clinically-approved ultra high frequency systems for human studies,” said Dr. Grassi. “The new instrument is the world’s first CE-marked, ultra high frequency ultrasound imaging system—up to 70 MHz—for clinical use, and will transform our clinical studies, enabling visualization of superficial structures in the human body.”

Operating at much higher frequencies than any conventional ultrasound systems, the new system uses patented transducer technology capable of a range of frequencies up to 70 MHz, and provides unparalleled image resolution down to 30 microns, a significant increase in resolution compared to conventional ultrasound. The new system is compatible with Fujifilm VisualSonics UHF series of transducers and is designed for clinical application in fields such as neonatology, vascular, musculoskeletal, dermatology or other body parts located within the first 3 cm of the body surface.

“The beauty of the Vevo MD is that it is non-invasive for our patients and allows us to examine the superficial strata, visualizing structures that we could not see using conventional ultrasound. It has enabled us to determine the fine upper limb damage that occurs in arthritis, allowing us to investigate the effectiveness of human drug treatments for these conditions,” said Dr. Grassi. “We are now using the system to perform vascular assessment of diabetic patients, and also plan to study dermatological and systemic diseases.”

Fujifilm VisualSonics
Toronto, Canada
www.visualsonics.com

Premium Ultrasound System with Zone Sonography

Mindray has just launched its new premium Resona 6 ultrasound system, powered by the revolutionary ZONE Sonography Technology, which transforms ultrasound metrics from the conventional signal processing technique of beamforming to channel data based processing. The ZST platform incorporates multiple imaging advances. These include Advanced Acoustic Acquisition, Dynamic Pixel Focusing, Sound Speed Compensation, Advanced Image Processing, and Total Recall Imaging.

With the powerful ZST platform, Resona 6 is able to deliver more valuable tools for clinical research one of which is the UWN+ Contrast imaging (UWN+ CEUS), system which enables the Resona 6 to detect and utilize both 2nd harmonic and non-linear fundamental signals, generating significantly enhanced CEUS images, resulting in greater sensitivity of minor signals and longer agent duration with lower MI.
Resona 6 also elevates clinical intelligence to a new level with smart acquisition and calculation. Smart Planes, for example, is Mindray’s unique technology to allow fully automatic and accurate detection of the most significant planes and frequently used measurements of the fetal central nervous system. This tool can improve diagnostic throughput as well as reduce user dependency.

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Two new next-generation Molecular Imaging Systems

GE Healthcare have introduced two new molecular imaging technologies that will enable clinicians to deliver personalized, quantitative results to patients.

Both the new Discovery MI system and Discovery NM/CT 670 CZT feature state-of-the-art, ground-breaking digital detectors that represent the next generation of molecular imaging systems. Xeleris 4.0 is the new nuclear medicine workstation supporting Discovery NM/CT 670 CZT and other nuclear medicine systems; its quantitative applications help clinicians achieve greater confidence in customizable, easy-to-read reports across multiple care areas.

Discovery MI was created to help clinicians continue efforts to diagnose and stage disease earlier while also enabling more compelling research with more novel, faster decaying tracers. Discovery MI is the industry’s only PET/CT system that brings together the sensitivity of digital detection, with the most innovative reconstruction technology available: the combination of Time-of-Flight (TOF) and Q.Clear. The system’s new LightBurst Digital Detector represents the next-generation for GE Healthcare’s vision for a digital future for PET. With this new detector, the system delivers up to two times improvement in volumetric resolution enabling small lesion detectability and has the highest NEMA sensitivity of any TOF/PET system in the industry. This system also features the latest diagnostic CT innovations with 100 percent better spatial resolution, with no increase in image noise with ASiR-VTM.

Discovery NM/CT 670 CZT was engineered to deliver improvements in lesion detection, image quality and patient comfort and combined with advanced quantitative applications provided through Xeleris 4.0, it can help clinicians better diagnose and monitor diseases earlier. The new system is the world’s first general purpose SPECT/CT imaging system with a new digital detector powered by cadmium zinc telluride (CZT) technology. This enables direct conversion of photons into a digital signal that eliminates the signal loss and noise inherent in conventional SPECT/CT detection technology, therefore making the technology more efficient. Until now, CZT technology has been limited to organ-dedicated devices, The combined capabilities will allow clinicians to detect smaller lesions and quantify them more accurately due to the increased spatial and contrast resolution. Having the ability to complete multiple scans in a single visit and reduce the injected dose or the scan time by 50 percent will improve patient experience.

GE HEALTHCARE
LITTLE CHALFONT, UK
www.gehealthcare.com

Toshiba launches flagship CT

The Aquilion ONE / GENESIS Edition CT scanner from Toshiba is the company’s flagship model that goes beyond the evolution of Area Detector CT. Intensive clinically focused research and breakthrough technological development have culminated in a new CT system delivering superior image quality and reduced radiation dose requirements.

The new system offers improved X-ray detector functionality through a complete redesign of the system together with high-quality image processing and lower radiation doses than ever before. The GENESIS Edition is empowered by FIRST, the world’s first volumetric Model Based Iterative Reconstruction (MBIR) that is fully integrated into scan protocols. Able to reconstruct a volume scan in just a few minutes, FIRST can be applied in clinical workflows, transforming CT image quality with improved spatial resolution at less dose. The new scanner has been designed with a unique flared gantry, providing a wide-open space for better patient experience. The industry’s only Area Detector Gantry with 30 degrees bidirectional tilt enables angled scanning to avoid unnecessary exposure to radiosensitive organs. A world first laser collimation system provides the ease of x-ray in CT, making CT scans faster and more comfortable for the patient, without the need for a scanogram.

Smaller, lighter and requiring less power than any other Area Detector CT, the GENESIS edition is designed for an installation space of just 19m² and so can be installed in most existing CT rooms, reducing costly renovations and transforming the workspace.

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T E C H N O L O G Y U P D A T E
High performance digital X-ray system for even the most demanding of radiology departments

Swissray’s new ddRAura OTC with Automatic Positioning System (APS) is a direct digital X-Ray system designed to meet the requirements of even the most demanding of radiology departments. Incorporating motorized ceiling suspension, a floor-mounted height-adjustable patient table with a 4-way floating table top and a motorized wall stand, the new system is also fitted with Swissray’s unique Automated Positioning System (APS) which streamlines the radiography workflow process by automating all positioning and image acquisition requirements. Patient data can be transferred directly from the RIS/HIS via a DICOM worklist, while all exposure and image processing parameters can be chosen with simple touch screen selections. Depending on the examination to be carried out, the advanced robotics optimally position the system by remote control.

The ceiling suspension uses 5 motors for fast and precise movements in the longitudinal, transverse, and vertical directions as well as the α and β rotations of the X-Ray tube. The patient table is also fully motorized and synchronized with the ceiling suspension to maintain the selected Source to Image receptor Distance (SID), as well as the vertical and horizontal X-ray beam position. These intelligent automation and synchronization systems enable advanced applications, such as the single focus stitching option for scoliosis and long leg images, which can combine up to five individual images.

For optimal workflow and additional flexibility, the new system is available with various detector configurations — dual fixed detectors, single portable detector or any combination of both fixed and various portable detectors. Equipped with 5-field AEC ionization chambers and precisely selected X-Ray grids for optimization of all applications, the ddRAura OTC with APS features an acquisition console with a 23” DICOM calibrated medical display and intuitive software design to facilitate streamlined workflow. The convenient 9.7” tube-mounted touchscreen console gives the technologist complete control and view of the generator, collimator, system position, patient procedure list selection and image preview, all right at the patient’s side. The concealed cabling and lightweight construction makes the system easy and convenient to use in manual positioning mode and offers unprecedented efficiency and versatility.

Point-of-care ultrasound in sports and exercise medicine

Point-of-care ultrasound is an essential tool for Dr Mark Ridgewell, an early pioneer in sports and exercise medicine (SEM) and, for the past 13 years, consultant sports physician at the Sport Wales Institute, UK. He explained: “Point-of-care musculoskeletal ultrasound has developed into an extremely useful tool for SEM, particularly in the last 10 years. Patients are now well read and aware — consultations often take the form of a discussion about managing a condition — and the ability to explain things to individuals with the help of ultrasound is a real advantage. It is excellent, for example, for assessing tendons during rehabilitation and recovery following an injury, or for looking at injuries dynamically, to work out what’s happening when a joint or tendons move. Soft tissue overuse injuries are often a lot more subtle and more difficult to explain, and the ability to use ultrasound is a huge benefit here. I also use ultrasound regularly for guiding injections, particularly in shoulders, hips and around the ankle.”

The High Performance Area at the Sport Wales National Centre in the centre of Cardiff has now been equipped with a SonoSite X-Porte system on Dr Ridgewell’s recommendation: “I’m very happy with the system for several reasons such as ease of use, clarity of picture and the size of the screen. Even some of my patients have commented on the image quality and that in itself is very important; patients will simply take themselves elsewhere if there isn’t access to this sort of state-of-the-art technology. Keeping up-to-date is extremely important; the elite sports world is constantly changing and you can’t be left behind.”

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