WWW.HEALTHCARE-IN-EUROPE.COM

EUROPEAN HOSPITAL @ ECR 2018

SPECIAL ISSUE FOR THE EUROPEAN CONGRESS OF RADIOLOGY

VIENNA • AUSTRIA • FEB 28 – MAR 5 2018

Hopes for AD prediction

New information on dementia biomarkers is emerging, as increasing results from population studies become available. However, although the list of risk factors lengthens, the value of these predictors, and more generally the cause of disease, remain to be determined, according to Gabriel Krestin, professor and chairman of the Department of Radiology & Nuclear Medicine at Erasmus MC, University Medical Centre Rotterdam.

Report: Mélisande Rouger

Are brain microbleeds predictors of dementia? Ever since radiologists spotted microscopic hemosiderin deposits on MRI, their association with the development of Alzheimer's disease (AD) is increasingly acknowledged.

Gabriel Krestin is the architect of population imaging in the Rotterdam Study, a large epidemiological cohort of 15,000 elderly subjects who have been followed for more than 25 years. He coordinated the installation of a dedicated imaging infrastructure 12 years ago and, since then, more than 14,000 brain MRI and 3,000 CT scans have been carried out to find out what brain features are associated with the development of dementia. For Krestin, there is no doubt that microbleeds and dementia correlate.

Detecting microbleeds

'There is an association between microbleeds, or signal voids, and cerebrovascular disease and the development of dementia. Here we have a potential predictor of an increased risk and development of disease,' he said.

Thanks to MR techniques using susceptibility imaging, researchers involved in the Rotterdam trial have detected a significant portion of microbleeds – enough to be able to prove the link between these lesions and not only AD, but also overall mortality.

'Even one single microbleed increases the risk of mortality; if there are more than five, mortality significantly increases, and so do cardiovascular and other diseases. Microbleeds are a strong predictor of increased mortality,' Krestin confirmed. There is also a strong association between incidence of microbleeds and the use of antithrombotic drugs. But the prognostic value of these haemorrhages has yet to be clearly demonstrated to issue proper recommendations, he explained.

'What is the predictive value of microbleeds? Should we recommend all our patients not taking aspirin? A lot of attention has been given to this information since over the past years. Truth is, we still don't know for sure.'

There is a consensus on several risk factors and associated predictive imaging biomarkers of AD, and the best known is hippocampus atrophy. 'There is a relation between the size of the hippocampus and the development of neurodegenerative disease. The smaller the hippocampus is, the earlier on the onset of dementia. The risk of developing dementia increases in individuals with smaller volumes of the hippocampus and amygdala,' Krestin explained.

Coronal T1-weighted MR image of the brain demonstrating hypocampal atrophy (predictive imaging biomarker of Alzheimer's disease)

Transversal susceptibility weighted MR image of the brain demonstrating multiple microbleeds (signal voids) associated with cerebrovascular disease and development of dementia

Volume changes of the hippocampus are even stronger predictors of dementia, and Krestin and his team have shown that accelerated atrophy is even a stronger predictor of AD. 'Even the shape of the hippocampus and the fact that not all its parts are decreasing at the same pace may predict AD development,' he added.

Analysing white matter microstructure

White matter lesions (WML) and silent lacunar brain infarcts are additional acknowledged biomarkers. Early on, the Rotterdam Study showed that the number of lesions was related to cognitive decline. 'The more WML there are, the faster the cognitive decline of the subjects is. Increased periventricular WLM load is associated with cognitive decline and the risk of dementia,' he said 'There is also a relationship between silent or small brain infarcts and AD.'

Even when radiologists don't see anything, they can measure alterations of the white matter microstructure thanks to diffusion-weighted imaging (DWI). According to Krestin, such 'underwater' or invisible markers are associated with impaired brain executive functions and may also predict the development of dementia.

His team is now focusing on assessing the microstructure of the white matter to detect invisible lesions in that area. 'The integrity of white matter microstructure is a very strong predictor. Even before lesions are visible, diffusion parameters are measurable and predict the development of disease,' he explained.

Using probabilistic tractography, the Dutch researchers have shown that lower tract microstructure integrity was associated with cognitive decline. Krestin believes they could even go a step further and establish relations between the brain's functions and its microstructure and other functions of the body, since there are some associations between kidney function and probably cardiac function and brain microstructure.

The professor and his colleagues are now looking into the disconnectivity hypothesis, i.e. integrating structural MRI and resting state fMRI to build up to the so-called connectome.

'We want to look at these connections and the function of white matter tracts in order to predict development of cognitive decline at an earlier stage.'

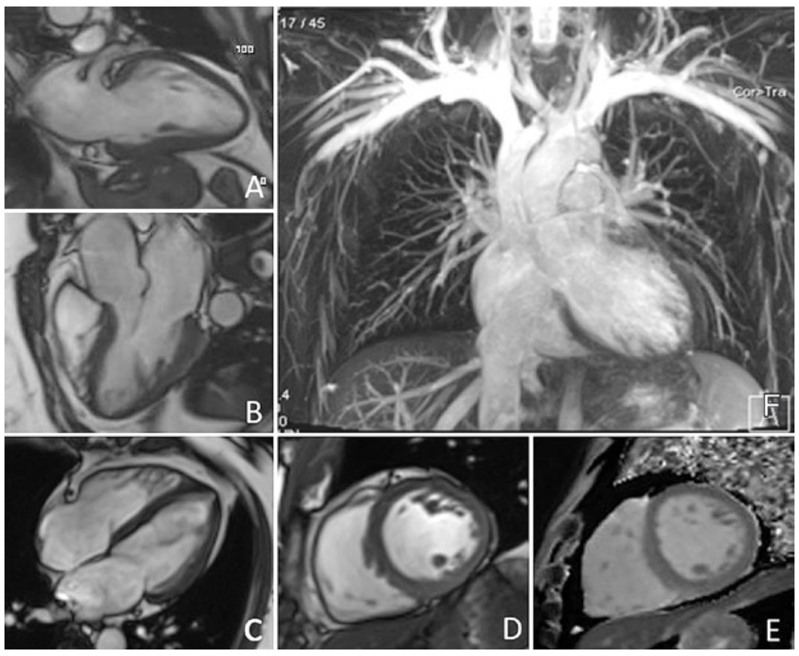
Continued on page 8

Professor Gabriel P Krestin MD PhD is professor and chairman of the Department of Radiology & Nuclear Medicine at Erasmus MC, University Medical Centre Rotterdam, The Netherlands. He is also the Scientific Director of the European Institute of Biomedical Imaging Research (EIBIR).

Big Data in cohort studies analysis will boost disease prediction

Population imaging

Population imaging is key to determining disease prediction and risk prevention, and Big Data will be key to extracting information and drawing analysis from imaging results, experts highlighted during the annual meeting of the European Society of Magnetic Resonance in Medicine and Biology (ESMRMB) held in Barcelona in October.



Examples of MR images acquired as part of the cardiovascular protocol:
A–C: Long-axis MR images obtained with the cine steady-state free precession sequence
D: Short-axis MR image obtained with cine steady-state free procession sequence
E: MR image obtained with T1 mapping (modified look-locker inversion recovery)
F: Native thoracic MR angiogram

Source: Bamberg F, Kauczor H-U, Weckbach S, et al. Whole-body MR imaging in the German national cohort: Rationale, design, and technical background. Radiology 2015;277:206-220.

Interest in cohort studies has been increasing over the years and population imaging is on the verge of becoming a major medical topic, according to radiologist Professor Fabian Bamberg from Tübingen University.

'Most of our services are based on delivering care to people who are already sick, but a more meaningful approach would be to identify subjects who are at risk for early disease or death at a very early point in time, to modify lifestyle, medication, and just prevent the future development of disease. Ideally, we'd assess genetic determinants right at birth and act accordingly,' Bamberg suggests.

For 15 years the professor has been involved in improving and developing imaging tools. While knowing the determinants – genetic, physiological and environmental information – and outcomes, cancer, dementia, etc., is a key, the issue remains the determination of what occurs in the meantime. 'We don't really know what's in between. I'm convinced that, between determinants and outcome, there is something else to disease, and imaging is a powerful mean to assess and quantify it, and come out with a more individualised risk assessment over time – and this is due to new achievements in MRI.'

MRI can provide new information, but researchers need large data to derive these parameters. Cohort studies can help prove that those imaging biomarkers are really predictive for the occurrence of disease over time.

Famous studies have already stressed the power of population imaging. The Framingham heart study, which observed 3 generations between 1948 and 2017 to predict the occurrence of cardiovascular disease, has helped identify various risk factors, such as high blood pressure, increased cholesterol, diabetes, smoking and family history, by notably using imaging. More recently, the Rotterdam study, which used brain MRI, has revealed that the presence of silent brain infarcts is associated with cognitive decline and increased risk of dementia over time.

The next big thing will be the German National Cohort MRI study, Bamberg said, as it will provide comprehensive characterisation and phenotyping in more than 30,000 participants with 3-T whole-body MRI. 'It's a unique opportunity to substantially impact on imaging-based risk stratification leading to personalised and precision medicine,' he explained.

The study is part of a national, government-funded effort: the GNC study (in German: NAKO), which includes 200,000 participants recruited through 18 centres (and 8 clusters). All participants are invited to take part in physical and medical examinations, collection of biomaterials, personal interviews, and to fill in questionnaires. In 2019, participants will be re-invited for a second examination five years after baseline recruitment.

The participants will undergo complex whole-body imaging sequences – MRA, T-1 mapping of the myocardium, and high-resolution imaging of the neurocranium, torso, hip, and spine – to provide a comprehensive image of the human body and help answer longstanding questions. Results will go along developments in Big Data, radiology, IT and radiomics, to achieve comprehensive characterisation of disease-phenotypes using advanced image-analysis, Bamberg forecasted. 'All this detailed information will help us characterise disease and early disease states much better. For instance, we can cluster patients with lung cancer by applying advanced post-processing methods with similar radiomic expression patterns. Results obtained with this type of imaging analysis are much more relevant and precise for predicting clinical outcome and genetic tumour type,' he pointed out.

Two major challenges to the GNC study remain incidental findings and the internal variability of the MRI studies – although the latter has been addressed by implementing similar MR technology with identical protocols, he explained.

One solution may be related to deep learning, and the field is currently growing exponentially. For instance, convolutional neural network (CNN) has already helped develop and validate a deep learning algorithm to detect diabetic retinopathy in retinal fundus photographs (JAMA, 2017, Gutshan et al.).

'Prevention of disease is increasingly relevant and there's a high potential of subclinical disease assessment. MRI is an ideal tool for whole-body phenomapping and radiomics is an ideal target for big data approaches,' he concluded.

Paul Matthews, from Imperial College London, presented the UK Biobank prospective longitudinal study, which includes 500,000 women and men aged 40-69 years at the time of the baseline assessment in 2006-2010. The study, which is supported by independent academics, includes extensive baseline questions and measurements, follows up a wide range of disease outcomes by linking to health record systems and direct contact, and will offer adjudication of health outcomes to confirm or refute and to sub classify phenotype.

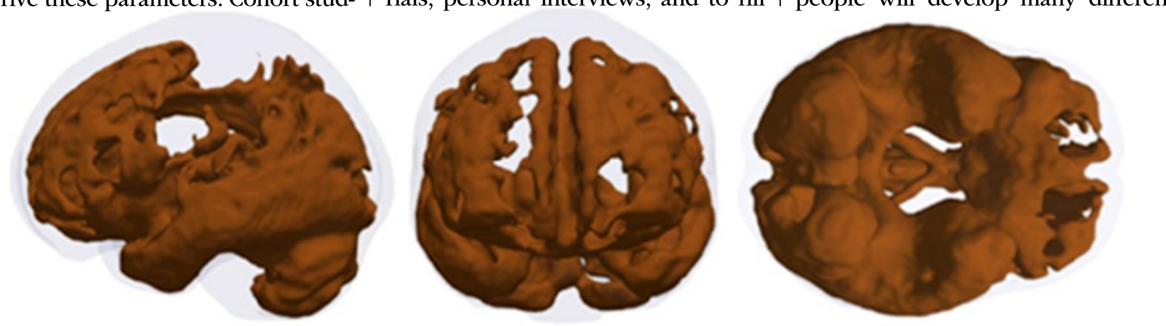
'Sufficiently large numbers of people will develop many different conditions to assess causes reliably. Having 500,000 volunteers in the study will provide enough power for future cohort designs,' Matthews said. He also highlighted the role of population imaging in defining risk factors, biomarkers of presymptomatic disease and contributory mechanisms for important and common disease.

'Cohort studies create opportunities to investigate gene-environment associations with phenotypic markers and longer-term outcomes. We need to understand disease from the start, decades before they appear. Lifestyle and environment interact with underlying genetic susceptibilities to influence the risks of brain disease. We need to understand how these factors – the exposome* – influence the brain through life,' Matthews explained. 'We can't change your genes, but we can change the environment; people are motivated to do so if we define the risks.' MR

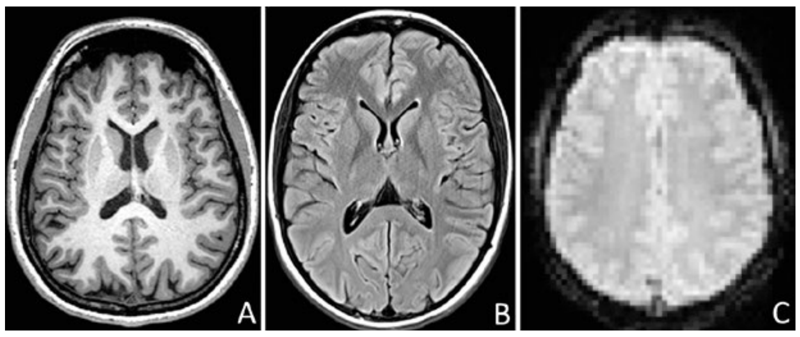
* Exposome: a potential vehicle the better to incorporate environmental components into the study of disease and health.

Paul Matthews OBE, DPhil, FRCP, FMedSci is the Edmond and Lily Safra Professor of Translational Neuroscience and Therapeutics, and Head of the Division of Brain Sciences at Imperial College London, and Associate Director of the UK Dementia Research Institute. He is an NIHR Senior Investigator and lead researcher for the Imperial College Healthcare Trust Biomedical Research Centre Neuroscience Theme. He is also a Fellow by Special Election of St. Edmund Hall, Oxford, UK, and holds other honorary academic appointments in Oxford, Maastricht, McGill and the LKC Medical School of Nanyang Technological University, Singapore.

Professor Fabian Bamberg MPH is currently Associate Chair of Radiology at the Department of Diagnostic and Interventional Radiology at the University of Tübingen, Germany. He received his medical degree from the University of Witten-Herdecke, Germany and gained a Masters in Public Health from Harvard School of Public Health in 2007. After serving as a faculty member in the Cardiac MR PET CT Program at Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA, he joined the Department of Radiology in Munich, Germany, in 2008, where he completed Residency and Fellowship at the Ludwig-Maximilians University and subsequently directed the MRI program as an attending physician.



Brain regions showing age-related atrophy from the initial 5,000 individuals imaged for UK Biobank. To generate this figure, T-1 structural brain MRI images from each of the participants were represented in a common, standard brain space. Age related differences in brain volume across the population were assessed. Those areas showing the greatest change with age are illustrated with a dark brown wash. (Image courtesy of Dr Hideaki Suzuki, Imperial College London).



MR images obtained as part of the neurologic MR imaging protocol
A: T1-weighted 3-D magnetisation-prepared rapid acquisition gradient-echo sequence
B: Two-dimensional fluid-attenuated inversion recovery sequence
C: 2-D gradient-recalled-echo echo-planar imaging blood oxygen level–dependent sequence (for resting-state functional MR imaging)

Source: Bamberg F, Kauczor H-U, Weckbach S, et al. Whole-body MR imaging in the German national cohort: Rationale, design, and technical background. Radiology 2015;277:206-220.

Hopes for AD prediction remain

Continued from page 7

Meeting the challenges of harmonisation

Genome-wide association studies (GWAS) may contribute to finding associations between genetic alterations and particular imaging biomarkers.

However, there are many challenges ahead. 'You need extremely large populations and to pull the data from different cohort studies possibly including 20-50,000 subjects, to find significant genotypic alterations related to certain imaging phenotypes. You also need a high level of harmonisation in terms of image acquisition, sequencing and data processing,' he added.

The Rotterdam Study collaborates in the CHARGE consortium, including large population cohorts in the Netherlands, Iceland and the USA. A network of researchers in epidemiology genetics and imaging that cooperates to better understand neurodegenerative brain disease. For instance, they found a mutation on chromosome 17, which is associated with WML. They are not sure how to interpret this information yet. 'Is this genetically determined? Is the presence of such mutations associated with earlier dementia onset? We don't know,' Krestin said.

GWAS are only showing associations with and increased risks of developing certain diseases, but not necessarily the cause of disease, he pointed out. 'The utility of these studies is unclear. We find out something about pathophysiology, but not really the cause of this association yet.'

Despite shortages and low recognition

Emergency radiology advances

Emergency radiology is no longer a babbling field; professionalisation will bring more recognition to this young subspecialty, according to Elizabeth Dick, a London-based consultant, who will coordinate part of the new European Diploma in Emergency Radiology (EDER), the European Society of Radiology's new tool. During the International Day of Radiology (IDoR) in November 2017, which focused on emergency radiology, **Mélisande Rouger** interviewed the radiologist, who spoke of her daily practice and why she loves her job.

In London, the Imperial National Health Service (NHS) Trust is a major trauma centre, covering a radius of over 12 miles (20km). 'In the capital this means a lot of people. We also treat abdominal and chest pain, and paediatric emergencies, explained Dr Elizabeth Dick, who estimates her radiology department carries around 20-30 emergency CT scans a day. A consultant for the past 15 years, she has worked in emergency radiology for as long as she can remember. 'I have grown with the specialty, which wasn't established until the late 1990s,' she said.

What's so special about emergency radiology?

'I like the fact that we can make a difference and we are really crucial to the patient pathway. Everybody wants to know what's on CT, so we really influence patient management.

'I enjoy the team approach. We are 15 people in the room, all trying to figure out together how to best treat the patient. Being in emergency radiology myself, I know it's really important in a person's life. No one wants to be there, but if we can make a difference, it's really inspiring.'

Emergency radiology is a young specialty; as such, this field needs more recognition according to radiology consultant Elizabeth Dick

How do you cope with staff shortage?

'This is not just a local problem; it's a worldwide issue. We prioritise our patients and try to train our juniors very well. We encourage them to ask questions and support them as much as we can. In the end we try to provide a full seven-day service, but we're not able to do that. We provide a full five-day service with emergency cover out of hours, which I find frustrating.

'The hospital is open 24/7 and you will always get good care. But we should have at least daytime consultant lists every day and we're far from that. We have resident juniors with back up from consultants who come into the hospital and are always at the end of a phone.'

Is teleradiology helpful in this context?

'Like every other hospital in the UK, we use teleradiology for all kinds of out-patient imaging. If we can sort those out, that gives us more time for emergency work.

We don't use teleradiology at night, but other hospitals do. It's obviously a very good short-term solution. However, it doesn't really solve the problem of not having enough radiologists.

'I know that a lot of people working in teleradiology work in the NHS, so they are working less directly in their hospital. Additionally, however great Skype or the phone is, it's not quite the same as working together with someone you've known for a while. You lose a lot in translation.'

What other challenges exist for emergency radiologists?

'ER is a young specialty and needs more recognition as such. People often think within their own specialty and that's it. In ER, the skills you need are very broad. Pretty much everyone I know has other interests and that's good because you can bring in different skills. You end up covering the whole body between the staff.'

Is cooperation good with other emergency specialists?

'It's one of the things I really love about emergency medicine in general: teamwork is amazing. Emergency medicine is very young too; we are very much on the same line. Emergency physicians are fantastic to work with; they really want to communicate. That's a real attraction: who wants to work with grumpy colleagues?'

Will Brexit impact on ER?

'Personally I believe Brexit will be a disaster for UK Healthcare. It will have a big impact on our work because about 20% of our healthcare staff comes from Europe. The uncertainty is already driving people home. Instead of thinking of building a future here, people head back. For everyone, their income dropped by 20% when the pound devalued. The impact of the loss of European funding for research and development has already been felt so Brexit is already impacting on healthcare in a variety of ways.'

Are there European trends in emergency radiology?

'More radiology studies are being done. When I started as a radiologist, if people came with an appendicitis they'd go straight to the operating theatre. Now they undergo CT, unless the clinicians are very certain. Imaging definitely increases diagnostic confidence in clinicians before they come to the theatre. Postoperative outcomes are also much better. 'Emergency radiology is not a subspecialty everywhere in Europe. In the UK it is a less established and probably the youngest radiology subspecialty.

'Another big trend is professionalisation within radiology. The ESR has produced diplomas in chest, neuro and now emergency radiology.'

What is the European Diploma in Emergency Radiology?

'This diploma began in January. It consists of 10 webinars and 10 workshops and one exam, so the first candidates will graduate in 2019.

'The idea of having a Europe-wide diploma is great, because it means that wherever you go in the world you'll find someone with the same experience as in your country. This also brings international recognition of their skills to radiologists, and improves their career perspectives abroad.'

Dr Elizabeth Dick is consultant radiologist and lead for emergency radiology at the Imperial College NHS Trust in London, UK. She is president of the British Society of Emergency Radiology and president elect of the European Society of Emergency Radiology (ESER).

Size and mobility is saving time and lives

At the scene: point-of-care ultrasound

Time is of the essence in an emergency, and can be the difference between life and death. Ambulance crews on the front line must decide rapidly whether or not a patient is suffering from a life-threatening condition requiring specialist treatment, and point-of-care ultrasound can provide vital guidance.

SonoSite is at ECR 2018 Hall X5, Stand 503

Geert-Jan Deddens, an emergency care nurse practitioner with the Rotterdam Ambulance Service in the Netherlands, describes the benefits of using hand-carried ultrasound systems to assess suspected abdominal aortic aneurysms, allowing patients to be taken to the most appropriate hospital immediately, avoiding delays due to onward transfer to another medical facility.

'I joined the Rotterdam Ambulance Service in 2006 as an ambulance nurse, going on to train as a nurse practitioner in emergency care five years later. We look after a population in the region of 1.2 million people, covering a large area in and around the city. As a nurse practitioner, I attend emergency call-outs to provide additional support to the ambulance crews when needed, for example, in cases of cardiac arrest.

Geert-Jan Deddens scanning a patient via point-of-care ultrasound

'A couple of years ago, a vascular surgeon at one of Rotterdam's hospitals contacted the ambulance service to discuss the potential benefits of using point-of-care ultrasound to identify and assess patients with an abdominal aortic aneurysm (AAA) in a pre-hospital setting. Without ultrasound, we might suspect the patient has an aneurysm, but we can't be sure. This means that the hospital has to be prepared to carry out emergency surgery, with an operating theatre and emergency room staff on standby to treat this life-threatening condition, when the patient may have a completely different abdominal pathology that is less serious.'

More accurate assessments

'We realised that introducing ultrasound into pre-hospital care would allow us to scan the aorta in the ambulance and make a more accurate assessment of whether or not the patient has an aneurysm, and also to estimate its size. Once we know that, we can quickly transfer the patient to the most appropriate hospital, and provide more exact information to the surgeon much earlier.

'This means that the hospital is better prepared, and does not tie up resources unnecessarily. It also eliminates potentially life-threatening delays caused by avoidable transfers between hospitals, as the patient is taken to the correct medical facility first time.

'At the end of 2015, we began a pilot study – Pre-hospital Assessment Rotterdam Aortic Aneurysm (PARA2) – to evaluate pre-hospital assessment of the abdominal aorta using point-of-care ultrasound (POCUS).

'Fujifilm SonoSite provided two hand-carried ultrasound systems and, together with an emergency physician with extensive POCUS experience, trained three ambulance nurses and two nurse practitioners to scan the abdominal aorta. It quickly became part of our daily routine to scan patients' aortas, gaining as much practice as possible.

'As nurse practitioners, we also received more advanced training in point-of-care ultrasound, including Extended Focused Assessment with Sonography for Trauma (eFAST), to allow additional conditions to be triaged.

950 abdominal scans in the first 16 months

During the pilot study we scanned as many patients as possible, evaluating how easy it was to perform the procedure and the length of time it took to obtain a good view of the aorta. We carried out 950 abdominal scans during the first 16 months, finding 14 patients with an AAA where the aorta measured more than 3 cm.

'Of these, four patients were immediately directed to a vascular surgery team for urgent treatment, potentially saving their lives. At the same time, we were able to identify other life-threatening conditions pre-hospital, for example, differentiating between wet and dry lung problems, looking for blood in the abdomen following an accident, as well as using ultrasound during a cardiac arrest.

'This all helps to ensure the patient is directed to the right facility first time, whether that's a specialist trauma or cardiac centre, ensuring that they receive the most appropriate treatment at the earliest possible opportunity. For patients with an acute AAA, this may well be a life saver.'

HOLOGIC®
The Science of Sure

The clear choice, from every angle.

NEW

Introducing Clarity HD High-Resolution 3D™ Imaging

- The fastest and highest resolution images in the industry with the same 70 micron pixel size as Hologic FFDM.[1]
- Cutting-edge detector technology and advanced 3D™ algorithm deliver exceptional 3D™ images for women of ALL breast sizes and densities.
- Designed to clearly see subtle lesions and fine calcifications to help detect cancers early.

Learn more at 3DimensionsSystem.com

Clarity HD   3Dimensions™

1. Data on file and from public sources, 2017.

New MRI technique visualises seepage that might cause AD

Seeking a leaky blood-brain b

Report: Madeleine van de Wouw

'With our new MRI method, we can finally visualise tiny leaks in the blood-brain barrier. They shed light on the vascular contribution to dementia and may indicate Alzheimer's disease. However, the MRI scan is only a tool to diagnose cerebrovascular damage. We have not yet found a cure for Alzheimer's,' confirms Walter H Backes, medical physicist and professor at Maastricht University Medical Centre.

The blood-brain barrier (BBB) separates blood from the brain tissue and protects the brain by allowing certain substances to pass while keeping others out. Backes, with his interdisciplinary team of Maastricht UMC and Leiden UMC, are hot on the tracks of Alzheimer's disease (AD) as they aim to visualise small vessel leakage in BBB.

Contrast-enhanced MRI

While conventional MRI visualises neither small vessels nor markers or leakage, the dynamic scan traces even extremely low concentrations of the marker fluid everywhere through the bloodstream and brain tissues, no matter how small the vessels are. 'Contrast-enhanced MRI is a combination of vision, technical knowledge and computer power,' says Backes, adding: 'We now can investigate with medical imaging in a non-invasive way and we don't have to rely on post-mortem tissue or spinal tap samples anymore.'

Initial clinical tests yielded exciting insights: 'Since we couldn't test our new scanning method in healthy volunteers with an intact BBB we immediately scanned Alzheimer patients and saw damages in the barrier with fluid leaking from the smallest blood vessels to the brain.'

New insights in the vascular contribution of dementia

Due to the leakage, unwanted substances can enter the brain and damage the tissue. 'At first, blood vessels were not considered a player in the development of AD. While animal experiments had shown leaking blood vessels, these leaks were not thought to be associated with cognitive decline and dementia. What we discovered in the human brain is somewhat of a fluke, an accidental breakthrough. While we can show the leak, we cannot determine yet whether it is AD. This requires further research. Nevertheless, the connection between BBB impairment and AD pathology was strengthened by the fact that the addition of diabetes and other non-cerebral vascular diseases did not change the results.'

The condition of the blood vessel system, Backes concludes, seems to play a very important – and previously underestimated – role in the development of Alzheimer's disease. 'Earlier research focused the deposition of amyloid-beta proteins as a possible cause of AD. This theory appears to be disproven today: When we wipe out the protein stack with medication, the condition of the patient remains unchanged. Finding this leakage is therefore an important contribution to the research on the development of AD. We have shown that in people with Alzheimer's disease not only the brain but also blood vessels are damaged, and that the damage is substantial.'

While there is no cure yet for Alzheimer's, Backes' research might indicate that keeping our vascular system in good condition – with good nutrition and physical as well as mental exercise – could help stave off AD.

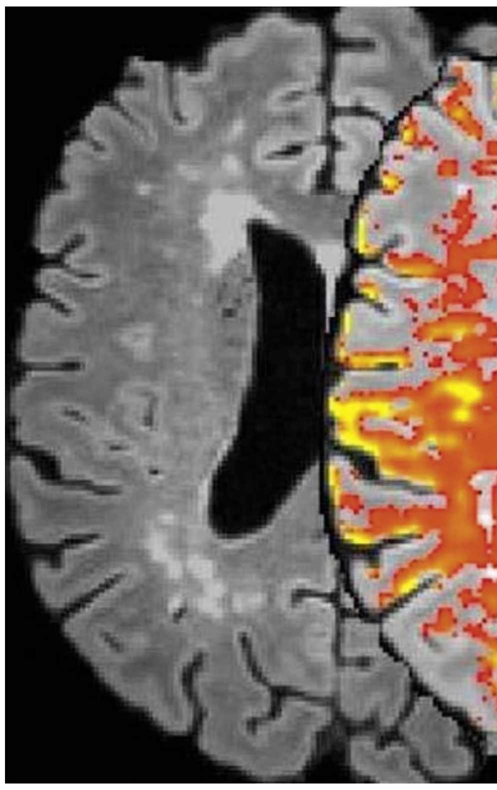
Further research

Unfortunately, the new MRI method is not yet widely available. Therefore, as the physicist explains, 'We are focusing on making the technique easier to apply, so more people can be examined, even those who do not yet show symptoms. With our new knowledge of the leaks, we might be able to send medication to certain places in the brain. However, we don't yet exactly know how vascular medication works in vascular disorders. This will need further investigation.'

Indeed, two follow-up studies are planned, each lasting about four years. Backes: 'In eight years we should have a better understanding of the cause of Alzheimer's. Approximately one hundred people with and without diagnosed AD will participate in each trial.'

Award-winning research

During RSNA 2017, the article Backes and his team published in 'Radiology'* received the Alexander R Margulis Award for the best sci-



entific article of the past year. For Backes the award did not come as a surprise because his research had attracted considerable attention: 'It

Healthcare artificial intelligence

AI – Radiology's next frontier

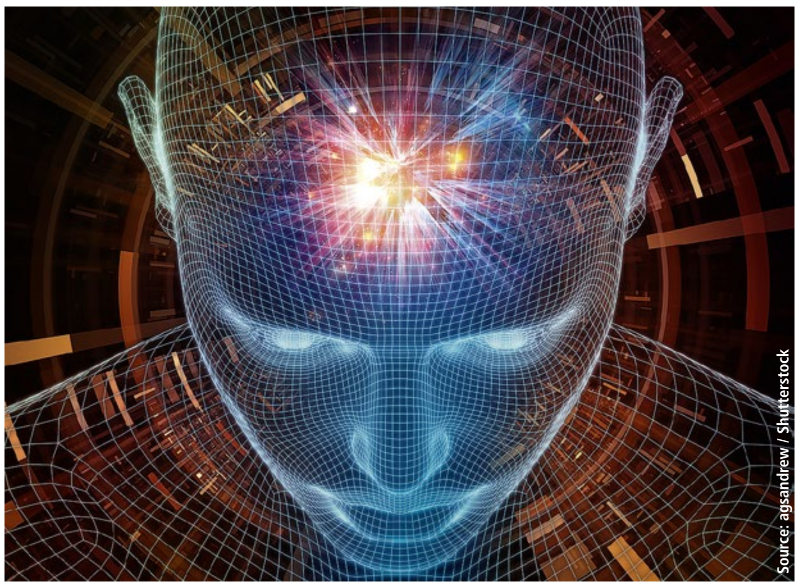
Artificial intelligence (AI) technology and its role and future impact on the radiology profession was the dominant theme at RSNA 2017, whether in scientific presentations or in the technical exhibitions. Keith J Dreyer DO PhD addressed this subject head-on in his presentation 'Healthcare AI – Radiology's Next Frontier.'

Report: Cynthia E. Keen

Dr Keith Dreyer, vice chairman of radiology informatics and chief data science officer at Massachusetts General Hospital in Boston, is an acknowledged expert on information technology (IT) innovations in radiology. His prediction, at a packed lecture hall during the joint RSNA/AAPM scientific session, was that an AI future is very bright for radiology and radiologists. Once AI becomes an established technology in radiology, it will allow radiologists more time to work with both clinicians and their patients. Rather than being diminished, radiologists will assume the leadership role of being aggregators of all data that passes through the diagnostic process. Acknowledging the large number of AI-oriented companies exhibiting for the first time and veteran vendors incorporating the subject of AI into their exhibition booths, Dreyer rhetorically asked where the radiology profession is on the pathway to AI expectations? At the very beginning, he answered.

Potentially diagnostic imaging AI will take decades

Building an AI algorithm can be surprisingly easy, but converting an algorithm into a sophisticated product that works consistently in clinical use is very complex. He disagrees with deep learning pioneer Professor Geoffrey Hinton, a computer scientist at the University of Toronto, whose remarks at the 2016 Machine Learning and Market for Intelligence Conference that medical schools should stop training radiologists now because they will not be displaced by AI technology in five to 10 years made global headlines.



Source: agsandrew / Shutterstock

Digital technology has radically changed the radiology profession: with increasing complex modalities, with electronic health records and the more specialised radiology information systems, with digital imaging and PACS, with cloud storage and global digital image exchange capabilities, and with speech recognition dictation systems and auto-populating structured reporting templates. But these technologies and their adoption have evolved over decades. Diagnostic imaging AI will also potentially take decades because there is a staggeringly large amount of work to do.

The potential for AI has stirred excitement since the 1950's, but deep learning only began to flourish in 2010. The growth in AI applications over the past five years has been fuelled by rapid advances in technology, growth, data, and massive investment from tech titans, by powerful new applications for known AI techniques, the proliferation of open source software, and sharing of advances. Imaging diagnostics is a hot area for investment, and it behoves organisations like the American College of Radiology (ACR) and the RSNA to get very involved.

'What you see on the exhibition floor are very narrow applications of AI, focusing on a very specific radiology application. Is this application needed? Just how good does it need to be? What can it solve better than a radiologist?' Dreyer compared the global diagnostic performance of radiologists to a bell-shaped curve, ranging from random guesses to perfection. What should the standard for an AI algorithm be? He observed that there are many places on the globe where good AI assistance in a very narrow application would be adequate.

Complex work and interaction by multidisciplinary community is needed to have clinical AI take place on a broader scale, and a platform to support all the development of algorithms to deal with thousands of findings and tens of thousands of medical conditions. AI will need to focus on image interpretation, patient care and safety, and radiology practice optimisation for productivity and quality. To show how these AI products reduce costs and improve outcomes will require clinical translation and industrial-grade integration into routine workflow.

Current obstacles include lack of a healthcare AI ecosystem. No standard methods exist to annotate data for AI model training and testing, nor is there a standard mechanism for clinical integration into existing systems and modalities and future ones. AI healthcare standards need to be developed.

This is a role that the recently established ACR Data Science Institute (www.acrdsi.org) is tackling. Its objective is to advance data science solutions for radiology care that are clinically relevant, safe and effective. The Institute is working with the USA's Congress, federal agencies, the healthcare AI industry, professional societies and the healthcare community. Dreyer discussed in detail the numerous issues that need to be addressed with respect to clinically viable AI applications.

Easing the AI premarket approval process

Radiology has an enormous opportunity to leverage AI to become a centre of intelligently aggregated, quantitative, diagnostic information. This is of great interest to the USA's Food and Drug Administration (FDA), which sees the potential for medical device development tools to ease the process of AI premarket approval and programs such as the National Evaluation System for Health Technology (NEST) to improve post market surveillance through a continuous data feedback loop, as is being implemented by

arrier

provocative investigation that breaks with the current view that blood vessels play no role in the Alzheimer's process.'

So where is AD research heading? 'Since the BBB not only allows nutrients but also medication to pass', Backes explains, 'we might be looking at opening the BBB with sound waves and thus administering medication locally. Many questions remain to be answered: in the event of a leak, the liquid seeps through everything, but how will that work when we open the barrier artificially. Will the opening close again? Will such a procedure improve the quality of life? Can we possibly administer medication indirectly?

In short, the possibility to visualise the leak in the blood-brain barrier opens many doors for all kinds of new research. There is still a lot to be done and even more to be expected.'

*http://pubs.rsna.org/doi/10.1148/radiol.2016152244

Magnetic resonance brain image of an Alzheimer's patient with colour-coded blood-brain barrier leakage

Medical physicist **Walter H Backes** is professor at Maastricht University Medical Centre in the Netherlands, where his research focuses on magnetic resonance imaging of neurological and vascular diseases. In 1999, he established functional imaging of brain diseases for research and clinical examinations. Since then his imaging research expanded to include oncology, vascular and neurologic applications.

Currently, his research examines novel imaging techniques, including (contrast-enhanced) angiography, perfusion and diffusion imaging and functional MRI of brain networks in diabetes, epilepsy, Alzheimer's and small-vessel disease. He initiated and supervises a certified post-academic training program in medical physics and lectures on various radiological imaging topics.

feels very special to get the prize as a physicist. I am not a physician, not a radiologist. It is certainly an incentive to continue. The jury thought it was a

Keith J Dreyer DO PhD is Vice Chairman of Radiology and Director of the Center for Clinical Data Science at Massachusetts General Hospital, USA. He is also Associate Professor of Radiology at the Harvard Medical School. The author of numerous scientific articles and papers is an expert on informatics and focuses his research on various fields including cognitive computing, clinical decision support and digital imaging standards. He has held diverse board and committee positions with healthcare organisations, including the Radiological Society of North America and the American College of Radiology.

the ACR registry process. Financial reimbursement relating to the use of AI tools in diagnostic imaging must be addressed, a separate but related additional layer of complexity.

Once these hurdles are overcome, Dreyer predicts that the combination of radiologists and AI working in tandem will be far better than either working alone. He told the audience to imagine interpreting an exam in PACS that has already gone to the cloud where quantified findings were made, a patient's medical record analysed and compared with data, and structured recommendations and guidelines provided.

Radiologists will be able to work more intelligently, more accurately, and more efficiently. They will be able to do things that they never could do before. Radiology and AI will further expand the impact of diagnostic imaging. It is a goal our entire profession needs to work toward and embrace.

We need to determine the benefits and potential risks

Reason must prevail in debates on GCCAs use

Luis Martí-Bonmatí MD PhD is Director of the Medical Imaging Department and Biomedical Imaging Research Group (GIBI230) at La Fe Polytechnics and University Hospital and Health Research Institute in Valencia, Spain. He is also professor of radiology at Valencia University

Radiologists must ensure precise scientific data and radiology-based evidence are used to regulate the use of Gadolinium Containing Contrast Agents (GCCAs), a Spanish leading radiologist explained in closed-door leadership meeting earlier this year in Barcelona.

Findings showing GCCAs deposits in different parts of the body have triggered a profusion of publications and decisions that now directly affect radiology practice. The good news is that radiologists can use their abilities to bring science back into the discussion, according to Luis Martí-Bonmatí, Director of the Medical Imaging Department and Biomedical Imaging Research Group at La Fe University Hospital in Valencia, who addressed a panel from the academy and the industry.

'There's been a real tsunami; large quantities of diverse information and opinions that have pushed the authorities to make decisions, which affect our daily practice but are based on neither accurate nor precise data,' he said.

Radiologists now understand the full extent of the deluge. 'We may not have valued these decisions properly at the time. Usually we are not involved in these discussions, so it's not easy to form an initial opinion,' Martí-Bonmatí explained.

In the past three years, concern has grown about gadolinium deposits in the brain of patients undergoing GBCA-enhanced MR examinations. In 2017, the Pharmaco-vigilance Risk Assessment Committee (PRAC) of the European Medicines Agency (EMA) recommended suspension of some GCCAs marketing authorisations based on linear chelators, due to the potential risk of gadolinium retention in the human body; the recommendation was further extended by EMA's Committee for Medicinal Products for Human Use. As a result, four linear GCCAs are no longer marketed in the EU (Omniscan, Magnevist, Optimark and MultiHance).

Clear clinical evidence is missing

However, even if long-term safety of GCCAs remains unclear, current scientific evidence for gadolinium retention has several methodological limitations, most experts feel. 'No clear clinical evidence exists indicating that gadolinium retention causes neurotoxicity. We need this evidence to formulate a hypothesis,' Martí-Bonmatí said. 'If we don't use that approach, hypotheses simply do not stand.'

In Spain, the Medicine and Medical Devices Agency is following the EMA recommendation, arguing that clinical benefits do not overcome potential risks. But it still enables the use of Primovist and MultiHance for hepatic studies, an exemption Martí-Bonmatí finds intriguing. 'That's a backroom door! If risks do exist, then they should be relevant in any application and in all contrast media,' he said. 'Even more importantly,' he added, 'we know today that all GCCAs are retained in tracer quantities in different compartments, but without any histological toxicity or clinical sign.'

Debates on potential risks of cutting-edge technology had spurred in the past over the use of radiofrequency and, more recently, magnetic resonance imaging, as an EU directive planned to limit the exposure of workers to magnetic resonance. Eventually, the proposal was withdrawn.

'This draft would have significantly restricted the use of a technique that has showed its benefits in millions of patients. GCCAs have been administered more than 300 million times, with a very low frequency of acute adverse events. People tend to overestimate the occurrence of very unlikely events and magnify them in the decisions they make. And generally, people lack abilities to correctly interpret statistical probabilities,' Martí-Bonmatí pointed out.

Precise data to evaluate risks is needed

Radiologists can help evaluate reliability and relevance of risk management investigation using their scientific reasoning. 'What the world needs now are cool, reason-based facts to evaluate risks appropriately. We need to use the scientific method, i.e. to carry out consequent observation using experimentation, measurements, formulation, analysis and hypothesis renovation, to generate evidence,' he said.

However, as they offer their expertise to help advance knowledge, radiologists must demand strong data in return.

'Us radiologists should have a clear idea on how to evaluate data precision, and trust our critical and criteria appraisal for the patients benefit. Each time an institution, academy, committee, person or group approaches us with recommendations on how to act in our clinical practice, we should ask which data and evidence they base their opinion on, to be able to use our reasoning,' he said.

Bias awareness

When faced with the vast amount of studies on the potential risk of GCCAs, radiologists must be aware of bias inherent to scientific investigation. In radiology, bias can originate from samples, tools and data used in measurements and analyses.

But even when trials are carried out properly, results often prove useless, Martí-Bonmatí explained. 'Not only are most investigation results false but also, when they are accurate, they are useless. That's because, deep down, we base our evaluation on statistical probability and we can't or don't know how to, or haven't properly extrapolated small samples' results from the general population. And,' he added, 'we haven't been able to properly manage these small probabilities.'

To this day the only known adverse effect linked with GCCAs use is nephrogenic systemic fibrosis, which had a very low incidence; the risk has almost disappeared since doses are now tailored to each patient. Recent research even suggests it has no effect in patients undergoing dialysis or with chronic renal disease.*

Differentiation is important

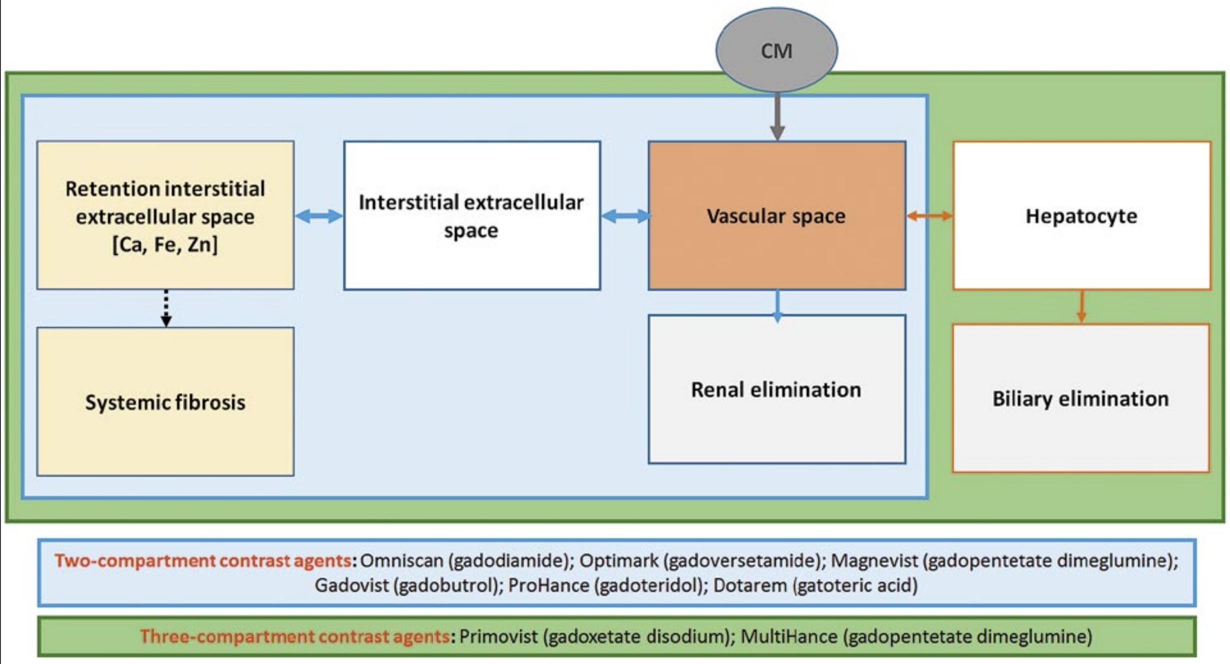
Martí-Bonmatí recommends evaluating contrast agents separately, as they have different retention profiles, and conducting prospective controlled trials. Radiologists should also be aware of poorly controlled CA administration numbers and doses, and of the importance of confusion variables, such as age, sex, patient condition and the interval between dose administrations.

'Patients with different diseases and treatments should not be mixed and the effect of pharmacokinetics should be taken into account. We also need histological and/or mass spectroscopy confirmation, as it is absent from most series,' he added.

Last but not least, radiologists use different MR equipment and parameters, and therefore have to watch out for T1 signal variations.

'Retention in bones, skin, liver, or central nervous system is different depending on which CA is being used,' he said. Instead of fighting over which CA is safe to use or not, radiologists should use their energy and skills to determine benefit-risk ratio. Finally, Martí-Bonmatí concluded: 'Political appreciation has ruled in risk management evaluation so far. The time has come to determine which are the benefits and potential risks when using contrast agents.' MR

*https://www.ncbi.nlm.nih.gov/pubmed/28731375



Administration of gadolinium containing contrast agents

ECR 2018
Wednesday 28, February
16:00-17:30 Room G
Special Focus Session, Level II

SF 4 Gadolinium deposition: is it harmful?

RSNA 2017 highlight – The InnerEye Project

AI drives analysis of medical images

Some time in the distant future artificial intelligence (AI) systems may displace radiologists and many other medical specialists. However, in a far more realistic future AI tools will assist radiologists by performing very complex functions with medical imaging data that are impossible or unfeasible today, according to a presentation at the RSNA/AAPM Symposium during the Radiological Society of North America's 2017 meeting.

Report: Cynthia E. Keen

Research scientist Antonio Criminisi, and colleagues at Microsoft UK's InnerEye project in Cambridge, have been developing machine-learning techniques for the automatic delineation of tumours and healthy anatomy for ten years. Intended applications are extraction of targeted radiomics measurements for quantitative radiology, rapid treatment planning for radiotherapy, and precise surgical planning and navigation. At the RSNA/AAPM Symposium he explained how the team developed algorithms for AI-drive analysis of medical images and their future use.

AI types to simulate human intelligence include robotics, computer vision, and machine learning. Computer vision utilises algorithms for automatic image analysis that understands semantics. Deep learning, just one type of practical machine learning, is part of life – e.g. analysing online buying and consumers' interactions via computer.'

AI research for medical image analysis originated with Microsoft Kinect, developed for game play, Criminisi explained. Kinect uses machine learning that takes input test depth images and, through pixel classification, determines body part segmentation to replicate 3-D human movement. 'Eureka!' The researchers decided that Kinect's technology could help create 3-D images of CT, MRI, and PET scans. Thus InnerEye began a decade of research in automatic semantic segmentation of radiology images.

The goal of automatic 3-D segmentation? To build useful radiomics tools. Criminisi showed how data from two axial slices of the same CT scans overlaid could create 3-D images in seconds. 'Voxel-wide semantic segmentation is difficult to achieve,' he explained. 'The sources of variability factors are huge. These include the same Hounsfield unit (HU) for different anatomies, large deformations, beam-hardening artefacts, different image resolutions, differing degrees of image noise, the presence/absence of contrast medium, and different patient preparations. All these need an algorithm, and the only way to deal with these large sources of variability consistently is through machine learning.'

Algorithms must work with everything, so training data must represent all these variables. For algorithm training, the researchers gathered image data from hundreds of patients in hospitals worldwide, produced by various modalities/models, with different acquisition protocols and image resolutions.

From this, a representation data set was created for segmentation, with each voxel and pixel in an image assigned to an anatomical structure. Supervoxels created from clusters of voxels were taught to associate voxels with anatomical structures. Hundreds of millions of voxels from data of hundreds of patients were used to create a ground truth model.

Decision tree techniques created forests of decision tree layers. A cascade of forest layers, each with unique probabilities, creates a trained deep decision forest model. 'Designing a task-specific algorithm addresses a task at hand, but often doesn't teach us how to address other tasks. When using a decision forest technique, for each new task the model remains the same, as do the training and runtime algorithms. We just enable new families of visual features.

Deep decision forests vs. cellular neural networks

'Once a deep decision forest model for semantic segmentation is developed, it's then applied to previously unseen images to train it, with feedback applied to make improvements continuously. We use the word "deep" because this means we are reusing the output layer to create new layers, each of which improves upon the segmentation image being developed.' At the event, Criminisi then demonstrated the cloud-based radiomics service.

Forests may be better for medical image analysis, so are preferred instead of cellular neural networks (CNN) for the semantic segmentation algorithms. Algorithmically they differ little, but Criminisi advised forests need less training data, may be faster, do not need GPUs, and may deal better with class imbalance.

'Our algorithms have been extensively validated on diagnostic images of both boney structures and soft tissue. In accuracy, there has been no statistical difference between ours and expert radiologists. When compared with comparable regulatory agency-approved algorithms, our algorithms results were as good or better.'

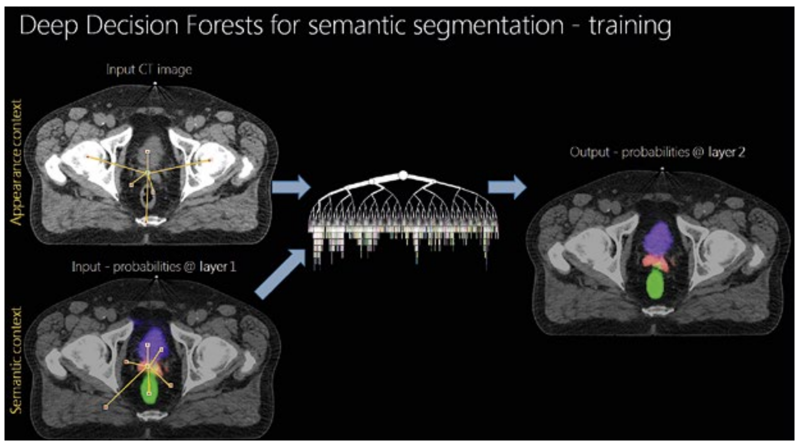
Assistive AI for radiotherapy planning

Currently, the clinical workflow for image-guided radiotherapy is first to acquire a planning scan, perform manual 3-D delineation and calculate the prescribed radiation dose. Manual 3-D delineation and dosimetry takes hours. The InnerEye process takes about five minutes. 'We want to eliminate critical, laborious and tedious tasks for radiologists and dosimetrists,' Criminisi explained.

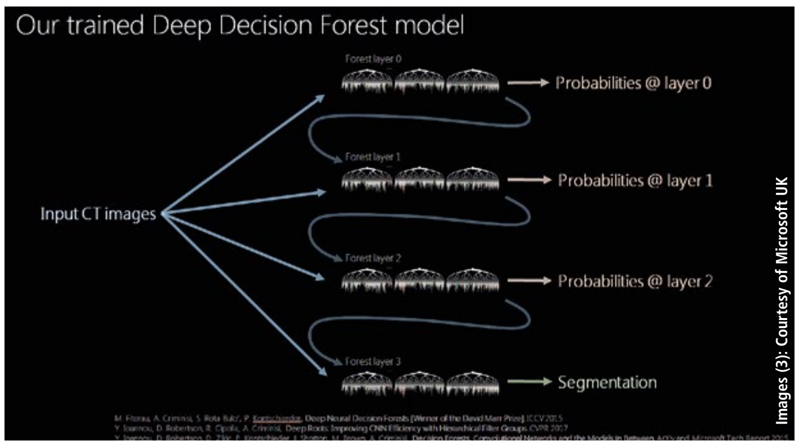
Another application is to monitor disease progression during treatment and perform quantitative radiology automatically. The InnerEye model creates easier visualisation of a tumour from images acquired over time and can create plot lines showing volumes of an active tumour. Criminisi showed a brain tumour that disappeared during treatment – no tumour could be visualised, non-negligible oedema was detected.

'AI can make monitoring cancer treatment effectiveness and disease progression much easier and potentially much more accurate,' he said. 'This is just one aspect of potentially being able to provide more efficient, quantitative image analysis workflow within a clinic. We want to turn this research into a real technology for clinical use,' he concluded, inviting medical software providers into partnership. 'Our expertise is in AI research, not healthcare. InnerEye cloud services are intended to be integrated components in third-party medical imaging software. We invite interested companies to contact us at innereyeinfo@microsoft.com.'

Antonio Criminisi gained his PhD at the University of Oxford in 2000, the same year he joined Microsoft, where today he is a principal researcher at Microsoft Research in Cambridge, UK, working on artificial intelligence, machine learning, computer vision and medical image analysis. He has authored numerous scientific papers and won several awards, including the David Marr Best Paper Prize at the International Conference on Computer Vision 2015 in Chile. He now leads Microsoft's InnerEye project that uses AI to create medical image analysis tools.



The InnerEye researchers prefer to use deep decision forests for their semantic segmentation algorithms instead of cellular neural networks (CNN)



By reusing the output of previous layers as input for the subsequent layer, they are developing a cascade of decision forests that eventually provides more precise results

Images (3): Courtesy of Microsoft UK

Canon – a bright future in healthcare.

Healthcare IT

Offering leading-edge diagnostic support systems and network solutions utilizing ICT.

In-vitro Diagnostic Systems

Supporting examination workflows with high resolution and rapid analysis of blood and other specimens taken from patients.

Introducing Canon Medical Systems

As of January 4, 2018, Toshiba Medical Systems Corporation has changed its name to “Canon Medical Systems Corporation”.

Technology that's made for life.
Canon—having welcomed Toshiba Medical Systems Corporation,
a company renowned in the field of medical imaging,
into the Canon Group—celebrates today on January 4th, 2018,
the birth of Canon Medical Systems Corporation.
Made for Partnerships. Made for Patients. Made for You.
Based on our "Made for Life," philosophy, we aim to support the wellbeing,
safety and security of humankind globally.

Canon Medical Systems will contribute to even further developments in healthcare through three pillars of advanced technology: Diagnostic Imaging Systems, Healthcare IT and In-vitro Diagnostic Systems.

Diagnostic Imaging Systems

Meeting clinical needs with high resolution imaging from CT, MRI, X-ray and Ultrasound systems.

Images are for reference purposes only.

The race is on – radiologists must pick up the ball and run!

Liquid biopsy versus radiomics

The development of new procedures to monitor cancer treatments is gathering momentum. One such innovation is liquid biopsy. This new lab technique allows non-invasive identification, characterisation and monitoring of circulating tumour DNA. Thus, liquid biopsy can potentially revolutionise oncological diagnostics – and put a spoke in the wheel of radiology. High time to act, says Professor Dr Jens Ricke, Chair of Radiology at Ludwig Maximilian University (LMU), Munich, and Director of the Clinic and Polyclinic of Radiology at LMU Hospital. He is confident that radiology has several aces up its sleeve – one is radiomics.

Interview: Daniela Zimmermann

Why is liquid biopsy such a success?

'As soon as liquid biopsy has identified circulating tumour DNA, it's also possible to identify gene mutations that might influence the therapy,' the Professor explains. 'This effect can be seen in the personalised therapy of colorectal cancer: an RAS or RAF mutation of the metastasising colorectal tumour impacts systemic therapy. Liquid biopsy can indeed detect this mutation in circulating tumour DNA.'

What does that mean for imaging?

'That's exactly the sore point. Methods such as liquid biopsy are mere lab procedures. They have only recently been introduced and are still under development. This phase, no doubt, will continue for a while. Nevertheless, we radiologists have to get a move on today if we want to actively shape the future of oncological imaging. If liquid biopsy keeps its promise, it may well replace the tight imaging follow-up in oncology. Obviously, that won't mean that radiologists will be out of work. But, we do have to think about our future now and, above all, we need to tap the full potential of radiology. For a long time, we have applied RECIST (Response Evaluation Criteria in Solid Tumours) criteria and accepted their imprecisions. However, we do need unambiguous standards. The current procedure relies on mere volume measurement: tumour growth or regression, however minute, is evaluated. This, however, does not allow a reliable prediction of therapy response. There are better parameters, which have not yet been clinically validated and are thus not accepted as follow-up variables.

'Enter radiomics: future developments in radiomics may well yield suitable criteria to gauge therapy response in oncology. However, as yet there is no proof that the parameters really predict patient survival linked to therapy response. Current data are incomplete and their analysis and successful transformation into criteria will take years. Therefore, we must hurry up.

'The competition is on the ball. This is why we should invest more resources in radiomics. I'm sure we do have the means and the possibilities to create useful alternatives.'

What exactly needs to be done to shape this future?

'Above all, we need validation studies. Firstly, imaging methods need to be established, which might encompass entirely new forms of analyses. The idea underlying radiomics is to cull more information from image data than meet the human eye. This involves complex statistical analyses, what's usually subsumed under the buzzword Big Data: computational drudgery. Every large data set has to be analysed over and over until patterns with predictive value regarding therapy response – or the lack thereof – become visible.

'MRI has already offered promising techniques. But this is just the beginning. The more methods are being developed, the more important is the validation of those methods. Prospective clinical studies that define and show innovative imaging endpoints for therapy response are indispensable.

'Today, FDA and EMA require clinical trials for regulatory approval of a pharmaceutical to be based on the RECIST criteria. However, we also have to think about the validation of potentially new imaging endpoints.'

How quickly can results be produced?

'The validation of such procedures is time-consuming. This is another reason why the projects have to be launched as soon as possible. Validation is always tied to a specific endpoint of the study as such, which might also include long-term survival studies. However, not only studies themselves can take years, the preparation also takes a lot of time.'

Is there political or industry support for these methods?

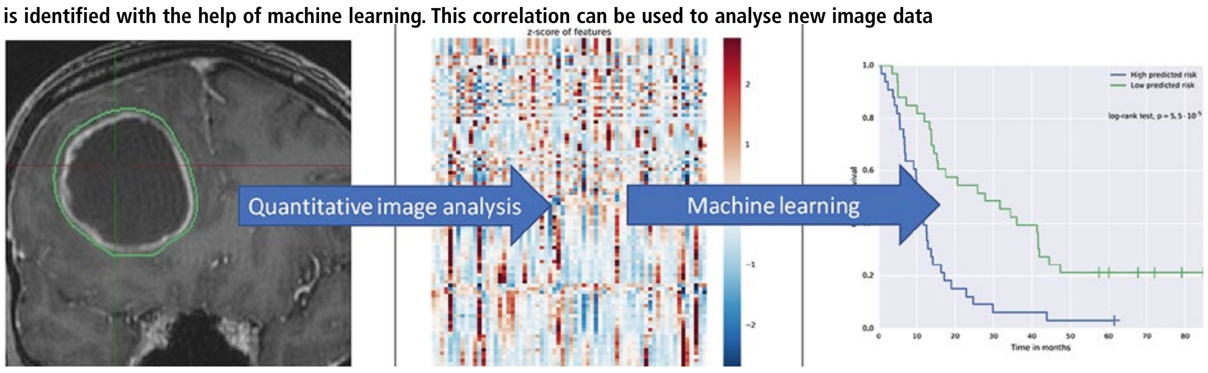
'Such studies are eligible for public funding; but even more interesting is the interest of the pharmaceutical industry. Validation would require clinical trials that include new imaging standards. These studies are rarely publicly funded.

'By the way, within the pharmaceutical industry the awareness that new imaging endpoints need to be defined has markedly increased with the success of immunotherapies. This is because, in the initial phase of immunotherapy, a response in the traditional sense cannot be determined. Quite to the contrary: tumours tend to grow despite an initially positive response. This is caused by tumour infiltrating lymphocytes, which in fact trigger an inflammation. This is an accompanying effect of immunotherapy. These lymphocytes cause pseudo-progression of the tumour, which a conventionally trained radiologist or oncologist might interpret as tumour growth – an undesired outcome – and discontinue the therapy.

However, in many cases, initial tumour growth during immunotherapy turns into tumour regression – the therapy should have continued rather than stopped. To account for these new insights RECIST criteria were expanded: the new so-called iRECIST criteria recommend a different evaluation of immunotherapy response.

'If tumour growth is recorded, further controls are performed in

Radiomics: Radiology images (below, left) undergo feature extraction and quantitative image analysis in order to be converted into a high-dimensional data space (centre). A correlation between this data space and a clinical outcome, such as overall survival (right), is identified with the help of machine learning. This correlation can be used to analyse new image data



Radiology: An era of turbulence and innovation

The birth and rebirth of imaging

The New Horizons Lecture at the RSNA annual meeting is a keynote address that looks to the future, and the inventor of a major innovation in magnetic resonance imaging (MRI) technology, Daniel K Sodickson MD PhD, did just that. His lecture entitled 'A New Light: The Birth and Rebirth of Imaging' looked back at how MRI has evolved and forward at what it will become.

The change will be radical. Today's radiology images may be irrelevant. MR protocols will become obsolete – but radiologists will not be, Sodickson emphasised, because radiologists are in a position to transform the field. 'We invented diagnostic imaging. We figured out how to visualise and understand human inner space. This is both a turbulent age for imaging and a golden age for innovation. We need to embrace the theme of RSNA 2017, and 'Explore, Invent, Transform.' Modern imaging science is information science. Let us be the scientists who create new forms of information. In a world increasingly dominated by information, what more valuable contribution can we make?'

Sodickson explained that the era of continuous, comprehensive imaging data has arrived, and that with this change, the era of the 'carefully framed snapshot' of a high-resolution image will pass. 'Radiology is not just copying our eyes. Instead, it is starting to emulate the way that our brains process multiple, streaming multi-sensory experiences.'

Courtesy of Daniel Sodickson MD and NYU School of Medicine

Daniel Sodickson and the Radiology Research team of NYU School of Medicine, who are involved in the development of new techniques for biomedical imaging

In his lecture Sodickson described the building blocks that created MR technology, from 1973 when the idea was first published to the revolutionary changes and relentless innovation that have ensued. This rapid-fire overview clearly illustrated how radiology progresses, adapts, and advances diagnoses through imaging.

Dramatic improvements of the 1990s

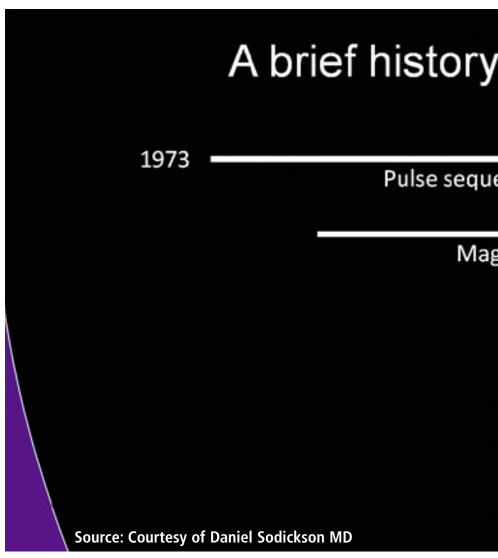
Sodickson spoke of the evolution from the first magnetic field gradients to diffusion imaging. The introduction of functional MRI, implemented in 1990, enabled radiologists to see different types of biophysics, reflecting brain activity. In the 1990's, some dramatic improvements were made to gradients and to radiofrequency coils, enabling advances in speed and image information content. The concept of moving from a sequential imaging device to a parallel acquisition device decreased the time to acquire images. Parallel acquisition made it possible to reduce corruption of images by motion from the abdomen and heart, and also to make the process easier for patients.

In 2007, compressed sensing was introduced. In addition to making the acquisition of images faster, it made feasible the use of multiple dimensions of data, which could be integrated together. Non-traditional data sampling patterns, such as radial patterns, gained new prominence. One particular example Sodickson described used a golden angle radial pattern, which enabled motion robustness during continuous data acquisition.

With the introduction of continuous three-dimensional acquisition, it became possible to perform multidimensional sorting along distinct motion dimensions. This enabled the creation of unique cardiac motion dimensions or respiratory motion dimensions, as an example. More innovations enabled radiologists to determine how the heart contracts and relaxes at any stage, or to look at the morphology of the great vessels or coronary arteries and freeze the images at any stage, thus enabling better heart disease diagnoses.

Creating a dictionary of pre-simulated fingerprints

The addition of 4-D, 5-D, and 6-D image processing algorithms led radiologists away from a mode of carefully tailored and adjusted snapshots toward a much simpler paradigm of rapid and continuous



Source: Courtesy of Daniel Sodickson MD

Professor Jens Ricke qualified in radiology at Charité, Berlin, Germany and, from 2004 to 2006, was professor of interventional radiology at the Department of Radiotherapy there. From 2006 to 2017 he was tenured professor of radiology at Otto von Guericke University Magdeburg, and Director of the Department of Radiology and Nuclear Medicine at Magdeburg University Hospital in Germany. In June 2017, he joined Ludwig Maximilian University, Munich, Germany, where he is Chair of Radiology and Director of the Clinic and Policlinic of Radiology.

short intervals to determine whether this is a bona fide progression or whether the tumour indeed shrinks after a while.

'The oncology community doesn't yet appear to be entirely convinced of the progression/regression dynamics; that's why, in clinical practice, we see immunotherapy medication being discontinued sooner than in the trials. This is obviously to the detriment of the patient, because successful medication is no longer administered.

'At the same time it is to the detriment of the pharmaceutical companies, because their turnover decreases. This is why the pharmaceutical industry, patients, oncologists and radiologist have a common interest in the development of new imaging endpoints. We should pick up the ball and run.'

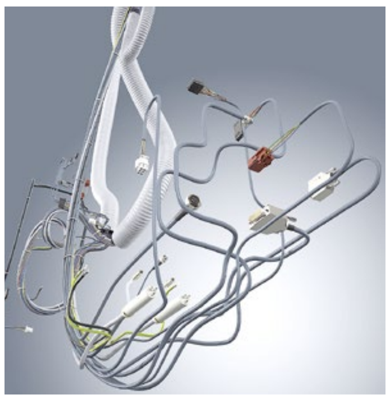
Clever cabling makes devices mobile

The integrated wiring of a medical device imposes great requirements on the cable system's producer as well as the device manufacturer. This calls for a partnership collaboration particularly in development to ensure the system solution exerts a positive effect on mobility, user friendliness and robustness – long-term and reliably.

'Qualified wiring is one of the success factors for large pieces of medical equipment,' Leoni's Healthcare Business Unit confirms. 'Freedom of movement and user friendliness for staff, easy positioning and mobility for multifunctional use in, for example, hybrid operating rooms – the manufacturers' requirements of the system technology are high.

'Installed cables and cable systems must reliably withstand not only sometimes heavy tensile forces or repeated flexing but must also be fitted in such an efficient way that they do not obstruct any other components and allow short maintenance times. The reliability of the permanent transmission of data, signals, power, light and media is meanwhile essential.

'Leoni's Healthcare Business Unit meets the market's challenges concerning innovative system solutions with more than 35 years of experience, know-how and a comprehensive portfolio. We can assist medical equipment manufacturers as early as the development phase of their device and provide input from the "cable's perspective".'



For mobile C-arm X-ray machines, Leoni develops and produces dedicated cable conduits to facilitate permanently smooth mobility of radiators and detector units

Clever cable routing facilitates flexibility

'The key way to develop the wiring of a medical device involves optimally adapting the system technology and related cables to the movement sequences. That sounds easy, but it entails major challenges. Routing can cross rollers, sharp edges, joints or drag chains with the cables and components being pinched, rubbed, worn or dragged out.

'To develop the specific system solution, Leoni's engineers consider the movement sequences and speeds of the device or prototypes on the manufacturer's site. Such early-stage involvement in the development process can yield innovative cable storage modules or spring return systems that reduce the mechanical forces on all components.

Leoni is at ECR 2018 Hall X1, Stand 139

'Spare cable length for long travel or high degrees of flex can be cleverly integrated in a device with innovative cable routing. In all cases the jacketing with an additional fabric, or other sleeve, ensures the desired robustness and that the system technology can be more easily disinfected.'

Leoni's in-house rigorous testing facility cables are checked for lasting functionality in a mobile application

Tobias Höft, Global Business Development Manager of Leoni's Healthcare Business Unit

Less is often more

'In addition to ready-to-connect system technology, Leoni can develop and produce application-optimised cables; such tailor-made cables can give the device manufacturer input on ways to save not only space, but also costs.

'For example, because of the slower speeds involved, standardised drag chains are often a costly solution for medical equipment and do not even provide mobility in all directions. An application-optimised cable can be a more durable alternative.

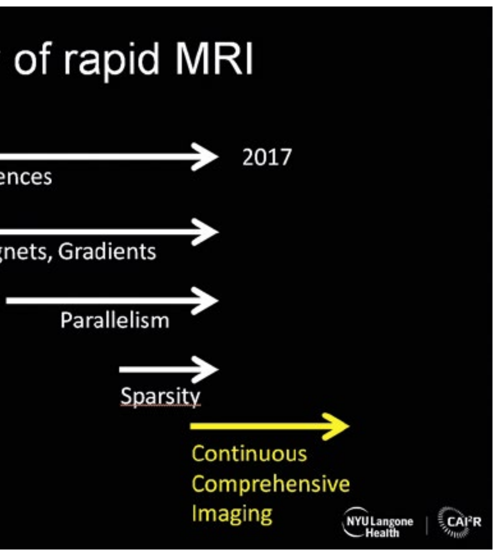
'In other cases, multifunctional and ready-to-connect hybrid cables can replace complex cable systems and simultaneously increase the mobility and robustness of a device.'

Contacts: tobias.hoeft@leoni.com
Phone: +49 4491 291 124 or
+49 160-90192902

streaming images. A variant of this paradigm, magnetic resonance fingerprinting, was developed in 2013. Rather than standard image reconstruction, MR fingerprinting created a dictionary of pre-simulated fingerprints for different types of tissue and matched acquired singles to these fingerprints to create quantitative maps of tissue properties.

MR fingerprinting offers the promise of scanner- and operator-independent scanning. If this promise is delivered, the feasibility of conducting clinical trials in radiology with tens of patients could easily expand to thousands, thus making clinical trials more accurate.

Findings of such huge clinical trials could advance precision radiology.



Assessing a continuously acquired multidimensional data stream

Enter artificial intelligence (AI). 'The artificial intelligence I see benefiting radiology is not merely image interpretation but rather data interpretation,' Sodickson said. 'AI neural networks can learn the various tricks of parallel imaging, compressed sensing, and other transforms we don't know yet.

'These could create images that are better than ones any existing image processing algorithms can produce and by doing so, they can help radiologists to make better diagnoses."

This is happening now, he said; but is happening with single slices and static images. What if you could have an AI neural network to assess a continuously acquired multidimensional data stream? AI would be the perfect way to economically produce actionable information, with biological fingerprints of disease as the output.

However, if AI could determine all this, would images even be needed? And how would MR scanners change? Could MR scanners be stripped down to the bare minimum of simply acquiring continuous data with the push of a button? And what would be the role of radiologists?

Sodickson has suggested that, in the new era radiologists are facing, they would be information traffic controllers. They need to control and interpret the information content and context, and make it relevant for the treatment of patients.

Courtesy of Daniel Sodickson MD and NYU School of Medicine

Daniel K Sodickson MD PhD is vice chair for research in the Department of Radiology, director of the Bernard and Irene Schwartz Center for Biomedical Imaging, and Professor of Radiology, Physiology and Neuroscience at the NYU School of Medicine in New York City, USA. He also chairs the National Institutes of Health (NIH) study section on biomedical imaging technology. He is credited with founding the field of parallel imaging, which allows distributed detector arrays to gather MR images at previously inaccessible speeds. As a result of his discovery, most MR scanners have parallel imaging hardware and software, and parallel imaging acceleration is used routinely in clinical MRI examinations and research imaging studies worldwide.

'We too are a force for change, a juggernaut of extended vision and expanded mind. If we embrace emerging paradigms of technology and information, and put them to good use, we will continue to see what was once invisible. If we stay true to our rich history of innovation,' he concluded, 'we are bound to see things in a new light.' CK

New cancer treatments present radiologists with new imaging questions

Understand the treatment to understand an image

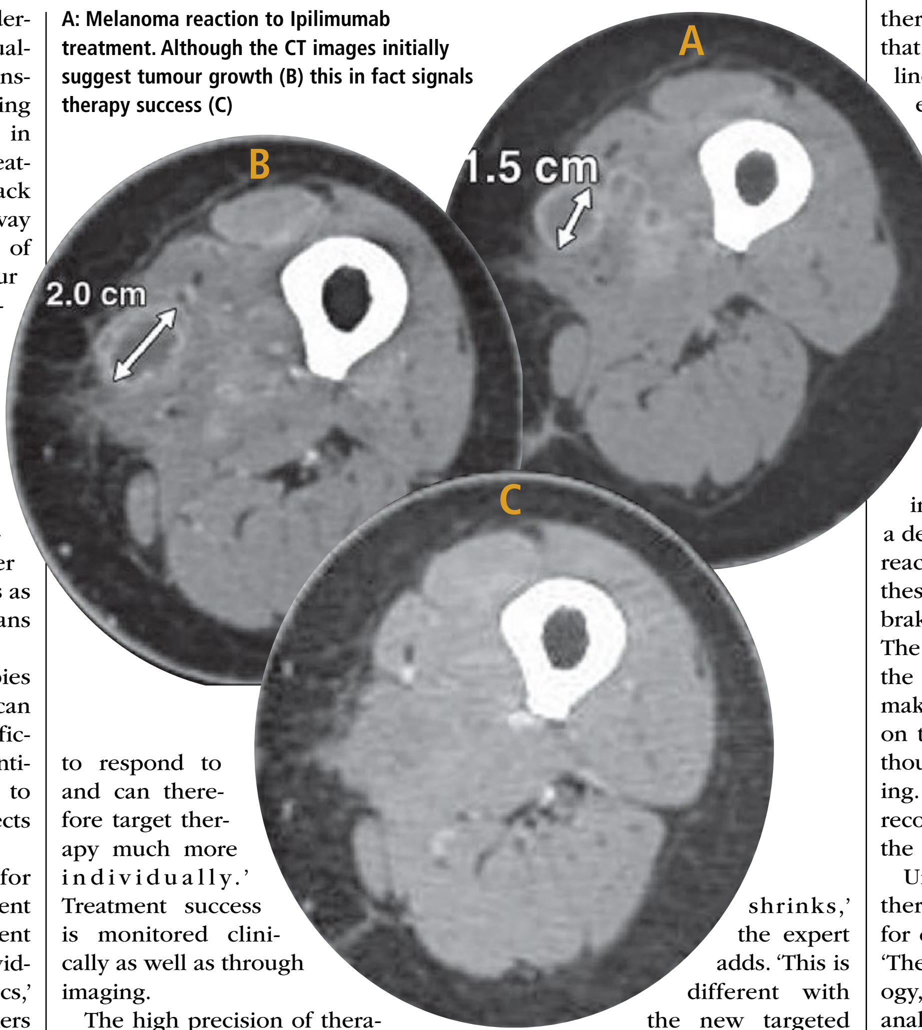
Conventional chemotherapy in oncology is increasingly yielding to new procedures such as targeted therapy and immunotherapy. The result is changes for radiologists because new procedures require familiarisation with certain imaging to ensure that the treatment process is interpreted correctly. During a recent CT symposium Professor Hans-Christoph Becker, radiologist at Stanford University Medical Centre in California, USA, discussed aspects of such changes. Wolfgang Behrends reports

'To begin with it's important to understand how the new therapies actually work,' radiologist Professor Hans-Christoph Becker advised, speaking at the CT-Symposium 2018 held in Garmisch, Germany. Targeted treatment and immunotherapy attack tumours in a very different way from chemotherapy. 'The point of chemotherapy is to destroy tumour cells. Targeted, i.e. specific cancer therapy works, for example, with specific messenger substances that activate signal paths, and explicitly interfere with the metabolism of tumour cells.' The advantage of the new treatments lies in their higher precision. 'Chemotherapy is comparatively non-selective,' Becker explains. 'It damages tumour cells as well as healthy tissue, which means it causes collateral damage.'

By comparison, targeted therapies attack the tumour cells, which can be identified with high specificity with the help of surface antigens, for instance. This can help to reduce the severity of side effects for patients.

Therefore, the objective for researchers is to make the treatment as precise as possible. 'Each patient has tumours with a certain, individual combination of characteristics,' Becker points out. These markers are determined histologically via biopsies. 'We can now differentiate with much more precision which treatments tumours are most likely to respond to and can therefore target therapy much more individually.' Treatment success is monitored clinically as well as through imaging.

A: Melanoma reaction to Ipilimumab treatment. Although the CT images initially suggest tumour growth (B) this in fact signals therapy success (C)



The high precision of therapies, however, also entails some new difficulties: 'With chemotherapy, treatment success is usually confirmed by the fact that a tumour shrinks,' the expert adds. 'This is different with the new targeted therapies. The objective is not necessarily only the destruction of the tumour tissue but also a significant impact on its metabolism.' This reduces the blood supply to the tumour. 'It leads to effects which look different from those of conventional chemotherapy.' Tumours are usually heterogeneous, i.e. they consist of different cell lines. Targeted therapy has become so specific that sometimes only some of these lines respond to it, but not others. 'This leads to a peculiar response where some tumours and metastases may shrink, whilst others even grow at the same time.'

With other procedures, such as immunotherapy, the tumour initially clearly looks bigger in the CT image – however, this does not mean that the tumour is not responding to treatment. 'To the contrary, this is a classic phenomenon of immunotherapy and the result of a deliberately induced inflammatory reaction,' Becker explains. 'Some of these therapies release the handbrake of the body's immune cells. The immune system then attacks the tumour with leucocytes, which makes the tumour appear larger on the image. What it really means though is that the treatment is working. 'Radiologists must be able to recognise these effects to evaluate the CT images correctly.'

Understanding how different therapies work is also essential for correct interpretation of images. 'The interaction between pathology, tumour treatment and image analysis is increasingly complex,' says Becker. 'Linking these areas in a meaningful way will be among the big challenges in the future.'

From 2001-2014 **Professor Hans-Christoph Becker** was a senior consultant at the Institute for Clinical Radiology at Ludwig-Maximilian-University (LMU), in Munich, Germany. In 2009 he was appointed Professor of Radiology, focusing on non-invasive cancer imaging. About three years ago he received a generous budget to set up a cancer research laboratory at Stanford University, California, USA, similar to the one he established at LMU in Munich.

AI analysis presents great potential

Automated evaluation of such imaging phenomena is also conceivable. Artificial intelligence (AI) could detect the specific reactions of tumours in the data sets and therefore measure treatment success. Stanford University Medical Center is already working on the development of such algorithms. 'The procedure is still in its infancy, but it's very exciting. It is likely that AI-supported evaluation will soon have a major impact in radiology.'

The 'new' cancer therapies referred to here are actually not that new: 'Hormone therapy was already in clinical use 20 years ago,' Becker points out. 'However, subsequently, more and more therapies have been discovered and the number of licensed targeted therapies also continues to increase.

'Many different drugs are currently being trialled, and studies into combining these with conventional treatment, as well as dose-ranging studies will continue to run.' Fundamentally, the new therapies can be used anywhere that conventional chemotherapy is used.

ECR 2018
Friday 2, March
08:30-10:00 Room C
New Horizons Session, Level III

NH 9 Immunotherapy: a revolution in cancer care?

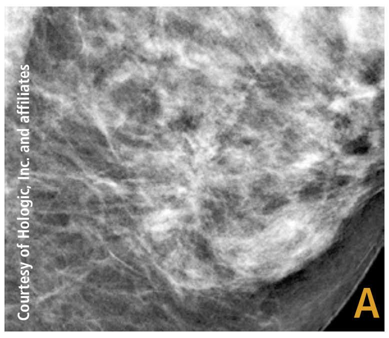
- Chairperson's introduction: What the radiologist needs to know [A-385]
  V.J. Goh; London/UK
- CT: looks bigger, but it's better [A-386]
  C. Dromain; Lausanne/CH
- The MR armoury in follow-up [A-387]
  D.-M. Koh; Sutton/UK
- Systemic and immunologic effects of image-guided interventions in oncology [A-388]
  S.N. Goldberg; Jerusalem/IL
- Panel discussion: How should radiology improve imaging to support this revolutionary care?

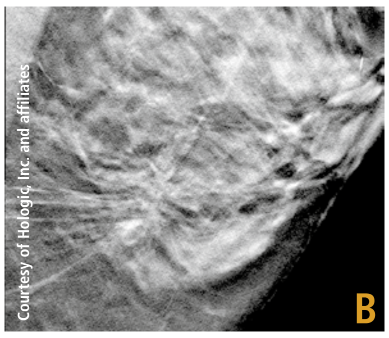
The clinical implications of breast tomosynthesis

Catching more invasive cancers earlier

What beats digital mammography to detect breast cancer in asymptomatic women? Digital breast tomosynthesis (DBT) – was a big discussion at RSNA 2017. Sarah M Friedewald MD, medical director of the Lynn Sage Comprehensive Breast Center of Northwestern Memorial Hospital in Chicago and its division chief of breast and women's imaging, discussed the clinical implications of DBT for routine mammography screening.

When digital mammography (DM) equipment was introduced in the USA its adoption by accredited women's imaging centres and hospital radiology departments was cautiously slow. By comparison, the adoption of digital breast tomosynthesis technology skyrocketed, fuelled by studies that prove its superiority in breast cancer detection.

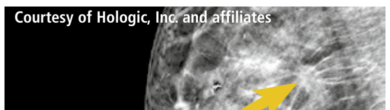




Digital screening mammography shows no definite lesion at the area of interest, left 8-9:00 position. Breast tomosynthesis demonstrates architectural distortion and shows the area for targeting for image-guided biopsy or localization. Histopathology revealed Radial scar and Ductal Carcinoma in Situ. This lesion, seen on breast tomosynthesis imaging (B), was occult (not visualized) on routine digital screening mammography (A)

In June 2005, five years after the first full-field DM system received 510(k) clearance from the USA's Food and Drug Administration (FDA), out of the 13,621 mammography systems in use at 8,911 facilities, only 6.4% systems were digital. In June 2016, five years after clearance of the first DBT technology systems, 20.8% of 16,155 systems in use were DBT capable. Just 18 months later, this has increased to 29%, with 43% of all accredited facilities having at least one DBT-capable system.

This surge is based in part on radiologists' familiarity with and recognition of the fact that full-field DM systems do increase early stage cancer detection rates. Numerous studies conducted in Europe and North America show that DBT offers even greater benefits. The USA's National Comprehensive Cancer Network (NCCN) 2016 guidelines recommend that DBT be considered for breast cancer screening exams in average-risk patients over the age of 40, thus increasing payment coverage for many women through private health insurance.



Occult cancer obscured on conventional mammogram is easily seen with tomosynthesis

Advantages of digital breast tomosynthesis

DBT improves on mammographic performance by minimising the impact of overlapping breast structures, making it easier to see invasive cancers. It improves lesion conspicuity and by removing tissue superimposition, improves evaluation of margins and localisation. Recall rates for additional testing are lower. And, for some patients, when suspicious findings of screening mammograms merit additional testing, breast ultrasound exams may be performed in lieu of diagnostic mammograms, thus avoiding additional exposure to ionising radiation.

While many think DBT is only useful to identify cancers, this is not the case. Friedewald explained that findings from a study of over 450,000 women showed that, while DBT did identify more cancers than DM, recall rates also reduced significantly. This 2014 study evaluated mammography findings and recall rates of 281,187 screening exams at 13 institutions for 12 months before they implemented DBT, with mammography plus DBT from the date of implementation through December 2012, for 173,663 screening exams. The 13 participating facilities were geographically diverse, both academic and non-academic, and with breast specialists and non-specialist radiologists interpreting the exams.

'The results from this diversity of screening centres were very exciting – they confirmed that DBT increased cancer detection and reduced recall rates, the two main criticisms of screening mammography. After tomosynthesis implementation, the invasive cancer detection rate increased from 2.9 to 4.1 per 1,000 women screened, a relative increase of 41%,' she said. Recall rates reduced by 15% overall,

Lowering the recall rate

'Of particular interest was that, when recalls were divided into categories of dense-breasted and non-dense women, there was statistically significant improvement in recall rate reduction for both categories. And, when we divided patients into the four density categories, we discovered that more cancers were being identified with DBT use in women with fatty breasts. The fat surrounding the cancers enabled us to see them better with DBT,' said Friedewald. 'For this group, the use of mammography plus DBT identified 38.2% more cancers.'

Further analysis based on stratifying the patient cohort in 10 year age groups, adjusted for breast density, showed performance outcome in identifying cancers with the use of digital mammography plus DBT screening, for women aged 40-49, was almost equivalent to digital mammography alone of women in their 50s. While there were gains from DBT use in all age categories, the relative increase in detecting invasive cancers was 69% for women in their 40s.

Friedewald also referenced a study conducted at the University of Pennsylvania in Philadelphia evaluating recall rates over three years breast screening examinations using DBT. This demonstrated that, over time, the benefit of imaging patients with DBT shifts from cancer detection to recall rate reduction. In the study, there were only 59 recalls per 1,000 examinations in the third year compared to 130 recalls per 1,000 exams in the first year of imaging.

Complicated transition from DM to DBT

In addition to cost, the disadvantages of adopting DBT technology is that radiologist need a learning curve, which may also result in increased recall rates during the time it takes for them to become proficient with the technology. 'The transition from DM to DBT is complicated because there are many more images to interpret. The time it takes to read a screening examination is two to three times as long as digital mammography. However, with the reduction in recall after screening with DBT, the volume of diagnostic imaging should decrease concomitantly, and radiologist interpretation time can then be shifted to screening,' Friedewald explained.

She advised that the way her breast centre made the adjustment and incorporated DBT into the breast imaging practice was with the initial purchase of a single system. This was used to image patients in the diagnostic setting. Because a longer amount of time was allocated for patients having diagnostic imaging, this extended time enabled the physicians to become accustomed to the new images and reading times. It also allowed the breast radiographers time to become familiar with the technology. Today, DBT is used for all routine and diagnostic breast screening examinations.

'There are many ways to deploy this exciting technology,' she said.

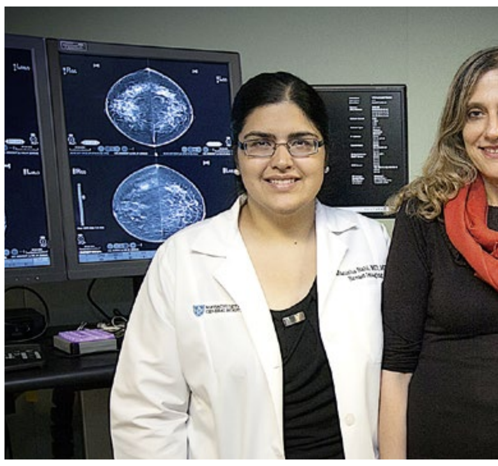
Sarah M Friedewald MD is medical director of the Lynn Sage Comprehensive Breast Center of Northwestern Memorial Hospital in Chicago, USA and its division chief of breast and women's imaging. She is also an Assistant Professor of Radiology at Chicago's Feinberg School of Medicine. In 1998 she gained her doctorate at the Columbia College of Physicians and Surgeons in New York City, followed by her internship in the surgical department at Union Memorial Hospital, in Baltimore, USA. After her residency in radiology at Johns Hopkins Hospital, she started her Women's Imaging fellowship at the University of Pennsylvania Hospitals.

'The women's imaging centre at Baylor College of Medicine in Houston, TX, began by using DBT for routine screening to maximise the technology's benefits in increasing detection of early cancer and reducing recalls. After 24 months, a hybrid model was adopted based on room availability and specific scenarios that needed DBT, such as asymmetries and architectural distortion.'

Friedewald did not present statistics relating to digital breast tomosynthesis adoption in Europe, but expressed hope that imaging centres in all countries that have converted to digital mammography will add DBT to their cancer-fighting arsenal of imaging examinations: 'It's a very exciting technology that is helping to save lives.' CK

Artificial I[…] to detect […]

Scientists are using Artificial Intelligence to […] detection. The researchers at Massachusetts […] Science and Artificial Intelligence Laborator[…] (MGH), and Harvard Medical School, are us[…] whether breast lesions identified from a bi[…]



From left:
Manisha Bahl MD is a breast imaging radiologist and director of the Breast Imaging Fellowship Program at Massachusetts General Hospital/Harvard Medical School in Boston, USA. After graduating from the Harvard School of Public Health with an MPH in Health Policy and Management, she completed a radiology residency and breast imaging fellowship at Duke University Medical Centre and joined the faculty at Massachusetts General Hospital/Harvard Medical School in July 2016.

Regina Barzilay MD is a Delta Electronics Professor in the Department of Electrical Engineering and Computer Science and

EUROPEAN HOSPITAL
European Hospital Verlags GmbH
Theodor-Althoff-Str. 45,
45133 Essen, Germany
Phone: +49 (0)201 87 126 850
Fax: +49 (0)201 87 126 864
E-mail: info@european-hospital.com
www.healthcare-in-europe.com

Editor-in-Chief: Brenda Marsh
Art Director: Olaf Skrober
Editorial team:
Wolfgang Behrends, Lena Petzold, Marcel Rasch
Senior Writer: John Brosky
Executive Director:
Daniela Zimmermann
Founded by Heinz-Jürgen Witzke
ISSN 0942-9085

Correspondents
Austria: Michael Kraßnitzer, Christian Pruszinsky. **China:** Nat Whitney **France:** Jane MacDougall. **Germany:** Anja Behringer, Eva Britsch, Annette Bus, Walter Depner, Cornelia Wels-Maug, Holger Zorn. **Great Britain:** Brenda Marsh, Mark Nicholls. **Malta:** Moira Mizzi. **Spain:** Mélisande Rouger, Eduardo de la Sota. **The Netherlands:** Madeleine van de Wouw. **USA:** Cynthia E. Keen, i.t. Communications, Lisa Chamoff.

Subscriptions
Liane Kaiser, Theodor-Althoff-Str. 45, 45133 Essen, Germany

Subscription rate
6 issues: 42 Euro, Single copy: 7 Euro.
Send order and cheque to:
European Hospital Subscription Dept

Printed by: WVD, Möhrfelden, Germany
Publication frequency: bi-monthly

Representatives
China & Hongkong: Gavin Hua, Sun China Media Co, Ltd.
Phone: +86-0755-81 324 036
E-Mail: gavin_hua@163.com
Germany, Austria, Switzerland:
Ralf Mateblowski
Phone: +49 6735 912 993,
E-Mail: rm@european-hospital.com
France, Italy, Spain: Eric Jund
Phone: +33 493 58 77 43,
E-Mail: ej@european-hospital.com
GB, Scandinavia, BeNeLux:
Simon Kramer
Phone/Fax: +31 180 6200 20
E-Mail: sk@european-hospital.com
Israel: Hannah Wizer, International Media Dep. of El-Ron Adv. & PR Co., Ltd.,
Phone: +972-3-6 955 367
E-Mail: hw@european-hospital.com
South Korea: CH Park, MCI
Phone: +82 2 730 1234,
E-Mail: mci@unitel.co.kr
Taiwan: Charles Yang,
Phone: +886 4 232 236 33,
E-Mail: medianet@ms13.hinet.net
USA & Canada:
Hanna Politis, Media International
Phone: +1 301 869 66 10,
E-Mail: hanna@media-intl.com

Out of 335 high-risk lesions the system correctly diagnosed 97% as malignant

Intelligence helps breast cancer

support more effective breast cancer Institute of Technology (MIT) Computer ry (CSAIL), Massachusetts General Hospital ing the machine learning system to predict psy will turn out to be cancerous.


(Photograph: Jason Dorfman/CSAIL)

a member of the Computer Science and Artificial Intelligence Laboratory at the Massachusetts Institute of Technology. USA. Her research focuses on natural language processing and applications of deep learning to chemistry and oncology.

Constance Lehman MD is a Professor at Harvard Medical School in Boston, USA, and chief of the Breast Imaging Division at MGH's Department of Radiology. After graduating from Duke University and receiving medical and doctoral degrees at Yale University, she became Professor and vice chair of Radiology and division chief of Breast Imaging at the Seattle Cancer Care Alliance before her recent move to Massachusetts General Hospital.

The hope now is that this research could help reduce the number of unnecessary breast cancer surgeries because it could pinpoint which lesions are cancerous more accurately and more efficiently.

In the study, the system was trained on information about such lesions and looked for patterns among a range of data points, including demographics, family history, biopsies and pathology reports. When tested on 335 high-risk lesions, it correctly diagnosed 97% as malignant. The researchers suggest that such levels of accuracy could lead to a reduction in the number of unnecessary surgeries by more than 30%.

While mammograms can detect cancers, there is also a risk of false positive results that can lead to unnecessary biopsies and surgeries – often from 'high-risk' lesions that appear suspicious on mammograms and have abnormal cells when tested by needle biopsy. The researchers say patients have the lesion surgically removed but often it is benign and the operations were unnecessary.

To address this, the team developed the machine learning system to predict if a high-risk lesion identified on needle biopsy after a mammogram will upgrade to cancer at surgery.

'Because diagnostic tools are so inexact, there is an understandable tendency for doctors to over-screen for breast cancer,' Dr Regina Barzilay, MIT's Delta Electronics Professor of Electrical Engineering and Computer Science, pointed out.

'When there's this much uncertainty in data, machine learning is exactly the tool that we need to improve detection and prevent over-treatment. A model like this will work anytime you have lots of different factors that correlate with a specific outcome. It hopefully will enable us to start to go beyond a one-size-fits-all approach to medical diagnosis.'

Using a method known as a 'random-forest classifier', the model resulted in fewer unnecessary surgeries compared to the strategy of always doing surgery, while also being able to diagnose more cancerous lesions than the strategy of only doing surgery on traditional 'high-risk lesions'.

Dr Constance Lehman, Professor at Harvard Medical School and chief of the Breast Imaging Division at MGH's Department of Radiology added: 'To our knowledge, this is the first study to apply machine learning to the task of distinguishing high-risk lesions that need surgery from those that don't. We believe this could support women to make more informed decisions about their treatment, and that we could provide more targeted approaches to healthcare in general.'

It is hoped that MGH radiologists will begin incorporating the model into their clinical practice over the next year. 'In the past, we might have recommended that all high-risk lesions be surgically excised,' Lehman said. 'But now, if the model determines that the lesion has a very low chance of being cancerous in a specific patient, we can have a more informed discussion with our patient about her options. It may be reasonable for some patients to have their lesions followed with imaging rather than surgically excised.'

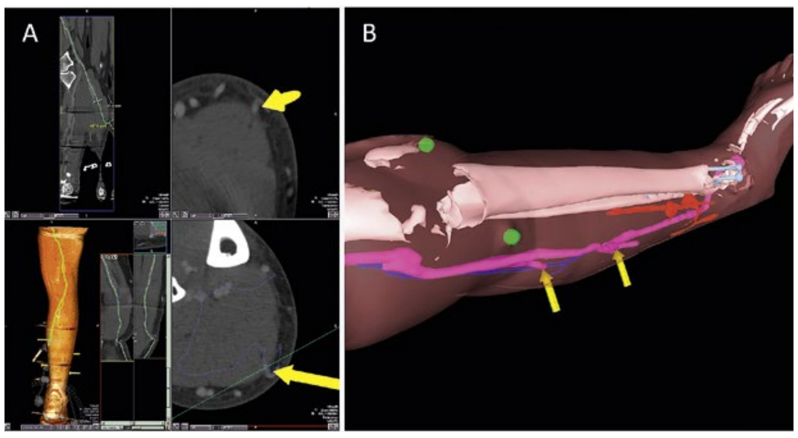
The team – which also included Manisha Bahl, director of the Massachusetts General Hospital Breast Imaging Fellowship Program – says that they are working to further evolve the model and in future hope to incorporate the actual images from the mammograms and images of the pathology slides, as well as more extensive patient information from medical records. MN

A valuable tool for reconstruction

Augmented reality lets surgeons 'see' inside limbs

Report: Mark Nicholls

Researchers at Imperial College London (ICL) have shown how the Microsoft HoloLens headset can be used during reconstructive lower limb surgery. Surgeons at London's St Mary's Hospital are using the device, a self-contained computer headset that immerses the wearer in 'mixed reality', enabling them to interact with holograms visible through the visor. In effect, the limb's interior is visible during the procedure.



a) Yellow arrows in CTA image indicate perforating arteries arrows; b) example of HoloLens rendering of segmental polygonal models

Dr Philip Pratt is a Research Fellow in the Faculty of Medicine, Department of Surgery & Cancer at Imperial College London, UK. Initially working in the banking sector, he began to explore research opportunities at the Institute of Biomedical Engineering, Imperial College, which ultimately led to a career change. He was appointed Research Fellow at the Hamlyn Centre for Robotic Surgery, Imperial College. From within the Department of Surgery and Cancer, he now undertakes very active research in image-guided surgery, and has successfully translated new technology and software into clinical practice in the operating theatre.

Identifying critical blood vessels under the skin

Testing the technology, the ICL team used the system to overlay images of CT scans – including the position of bones and key blood vessels – on to each patient's leg so the surgeon could better locate and reconnect key blood vessels during reconstructive surgery. 'We are one of the first groups in the world to use the HoloLens successfully in the operating theatre,' Dr Philip Pratt, a Research Fellow in the Department of Surgery and Cancer, confirmed.

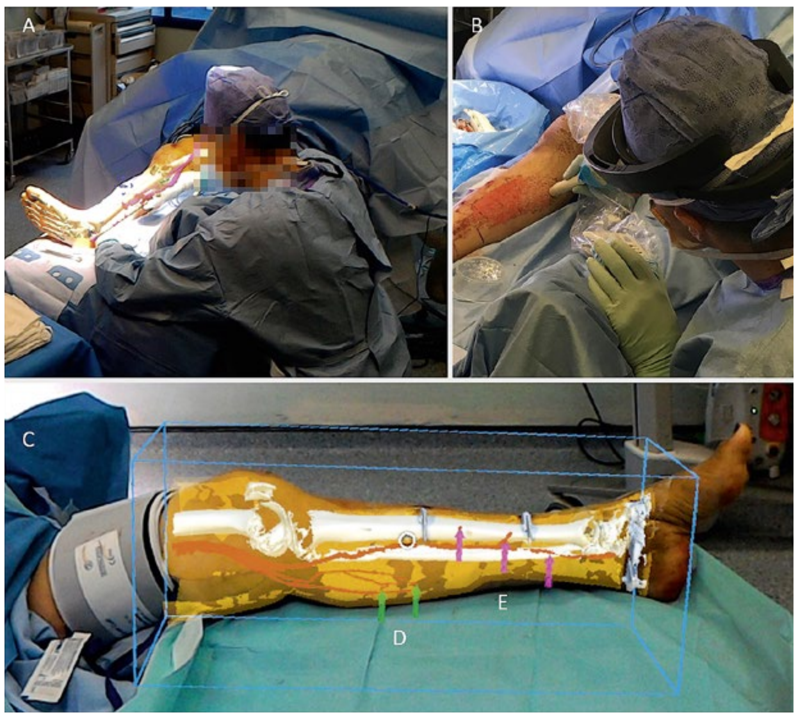
'Through this initial series of patient cases we have shown that the technology is practical, and that it can provide a benefit to the surgical team. With the HoloLens, you look at the leg and essentially see inside of it. You see the bones, the course of the blood vessels, and can identify exactly where the targets are located.'

When a patient sustains serious injury, with tissue damage or open wounds, they may require reconstructive surgery using fasciocutaneous flaps of tissue taken from elsewhere on the body, including the skin and blood vessels, to be used to cover the wound and enable it to close and heal properly. Successfully connecting the blood vessels of the new tissue to those at the wound is a vital step in the process. Presently, handheld scanners using ultrasound are used to identify blood vessels under the skin. 'Augmented reality offers a new way to find these blood vessels under the skin accurately and quickly by overlaying scan images onto the patient during the operation,' Pratt explained.

Virtual 3-D arrows guide the surgeon

During initial trials of the technology, five patients requiring reconstructive leg surgery underwent CT scans to map the structure of the limb, including the position of bones and blood vessels.

Images from the scans were then segmented into bone, muscle, fatty tissue and blood vessels by Dr Dimitri Amiras, a consultant radiologist at Imperial College Healthcare NHS Trust (ICHNT), and loaded into intermediary software to create 3-D models of the leg. These models were then fed into specially designed software that renders the images for the HoloLens headset, which in turn overlays the model onto what the surgeon can see in the operating theatre.



a) AIR overlay of models as viewed from remote HoloLens; b) co-ordination of perforator location with audible Doppler ultrasonography c) Case with overlay of bounding box with arrows highlighting position of d) Sural metal and e) posterior tibial perforators

The HoloLens is used to identify where the blood vessels are in 3-D space and uses virtual 3-D arrows to guide the surgeon. Clinical staff can then manipulate the augmented reality images to make fine adjustments to correctly line up the model with surgical landmarks on the patient's limbs.

Jon Simmons, plastic and reconstructive surgeon at Imperial College Healthcare NHS Trust, carried out the trial procedures. Already, the hospital's surgical teams believe that the HoloLens approach is more reliable and less time-consuming than the ultrasound method of locating the blood vessels.

Improving the system for future use

While the first cases have been carried out on legs, which have clearly visible surgical 'landmarks', using this technique for surgery on the abdomen may be more complicated. However, as the technique is refined it could be used in other areas of reconstructive surgery requiring tissue flaps, such as breast reconstruction following mastectomy.

'In future we hope to automate the process further,' Pratt added. 'We can use software to improve the alignment and will attach markers to the patient when they have the scan, with the same markers present during the operation to use as additional points of reference.'

With further trials planned in a larger set of patients, he acknowledged that further improvements are needed, but said that from the number of cases so far the technique could be a valuable tool during reconstructive surgery.

MobileDaRt Evolution MX8 Digital Mobile

Superior functionality a

'With Your Stories – lifetime healthcare support': this future-driven approach combines the best of two worlds, using Shimadzu's insights and expertise in medical imaging systems and laboratory instrumentation to benefit patients through ever improving prevention, diagnosis, treatment and follow-up.

In 2018, the year of the 50th anniversary of the opening of Shimadzu's European headquarters, the company has released the new MobileDaRt Evolution MX8 version digital mobile X-ray system. This features its first telescoping support column to increase convenient drivability and improve forward visibility; a large completely flat monitor screen; a lockable FPD housing compartment; an extensive selection of options and improved operability.

Digital mobile X-ray systems become increasingly essential for qualified radiography in hospital rounds, or to examine emergency patients, in neonatal intensive care units or other highly urgent medical applications. Shimadzu MobileDaRt series digital mobile X-ray systems are already used in over 60 countries around the world, with more than 3,500 units sold to date.

Shimadzu is at ECR 2018
Expo Hall X2, Stand 218

In September 2017, Shimadzu received the 'Global General Radiography Product Line Strategy Leadership Award 2017'. The award is presented to a company that introduced products and services demonstrating the highest leadership in international markets for diagnostic X-ray imaging systems in the previous year and for employing the best strategies for success. A part of the company's portfolio contributing to this award has been covered by its DR solutions.

Multifaceted support

The newly redesigned MobileDaRt Evolution MX8 version has been developed to provide users with multifaceted support based on Shimadzu's extensive technology and track record cultivated thus far.

The most important features: Collapsible column enhances forward visibility and drivability. The new design features an X-ray tube support column that can be extended or retracted and a more compact system width. The previous model was 1930 mm tall during travel; the new design is only 1270 mm tall and 560 mm wide, becoming 20 mm narrower. This shorter profile due to the collapsible column dramatically improves forward visibility during travel and the more compact size makes it easier to use the system in narrow spaces such as bedside.

Various functionalities and options help to improve hospital round efficiency. The MX8 features a new completely flat 19-inch monitor, which improves operability. The maximum X-ray focal point height is also increased by 15 mm, making it easier to examine patients on higher beds.

Security features are also considered, such as the addition of a new locking function for the FPD housing compartment. New optional features, such as a wireless hand switch for X-ray exposure operations

We need strategies to maintain quality healthcare in Spain

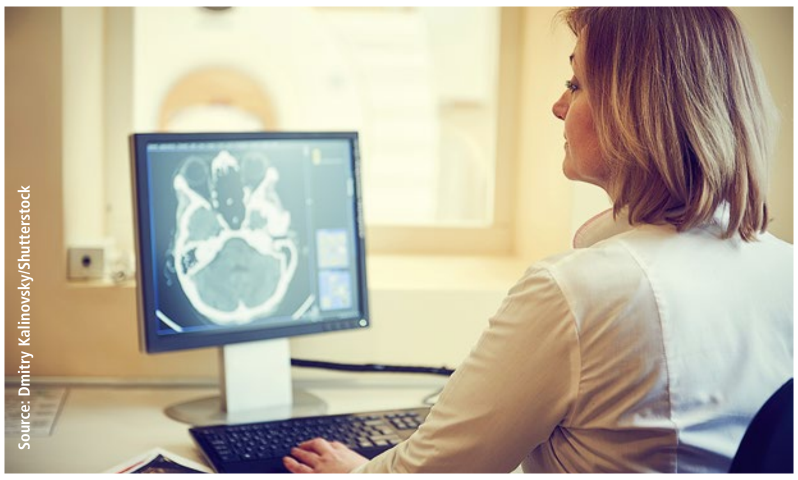
Our education plan is completely obsolete

When it comes to radiographers, Spain has one of the shortest curricula in the world. But advanced imaging and the continuously rising demand for imaging studies require properly trained imaging graduates, and universities have a role to play in the debate, according to Salvador Pedraza Gutiérrez, Associate Professor of Radiology and Director of the School of Diagnostic Imaging Technicians in Girona.

Spain has a two-year education plan for radiographers – half the time considered necessary worldwide.

'While the Spanish model was correct 40 years ago, advances in CT and MR technology have made it completely obsolete. It's just not enough and the curriculum needs to be updated. We need to have properly trained graduates in medical imaging,' explained Salvador Pedraza.

'All other countries have a three or four-year education scheme. The European Federation of Radiographers Societies is pushing a bachelor's level. The situation in Spain doesn't make any sense.'



Imaging complexity and the increased need for advanced studies make it compulsory to have adequately trained medical imaging graduates, Professor Gutiérrez emphasises

Radiographer is a new profession

'For the past 20 years, those who had a good relationship with their radiology colleagues improved their knowledge and skills in their daily practice. But these were exceptions and this was never meant to last.

'Some radiographers went abroad, for instance to Coimbra, Portugal, for further education. The problem is that when they want to validate their degree in Spain, it's not possible. The Education Ministry cannot recognise their diploma because Spain has no such university degree.

'Besides, graduates in medical imaging are not listed as healthcare professionals. So those who invested extra time and efforts cannot obtain recognition, and we cannot profit from this education in return.

'The Spanish Health Ministry has to understand it's important to include a new profession in their list and Spanish universities must obtain approbation, so these graduates can work in a public hospital. If we do both, we could have medical imaging graduates with a university level within four to five years.

'Right now we are educating technicians who cannot work abroad. This goes against work flexibility and circulation in the EU.'

Could other medics do the job?

'We need technicians who can perform CT and MR scans with a good knowledge of technical issues, and who can improve parameters, avoid artefacts and perform advanced imaging. We also increasingly rely on post-processing imaging.

'Radiographers already carry out standard ultrasound examinations on their own. This has been happening every day for the past 30 years in medical practice.

'Imaging complexity and the increased need for advanced studies makes it compulsory to have adequately trained medical imaging graduates.

'In the UK, radiographers write reports. It's a specific scenario; I'm not sure that solution can be applied to other countries. I feel more comfortable with sonographers doing the examination and radiologists then writing the report. The UK also has a cruel lack of radiologists.'

Is there a similar shortage here?

'Yes. Most hospitals outside big cities have hiring problems. Young radiologists want to work in hospitals with advanced techniques and the possibility to do everything. We need to keep equity in our healthcare system. Whether you live in the city or countryside, you are entitled to receive proper healthcare.

'There are 5,000 radiologists in Spain, but many of us will retire in the next ten years. Physician workforce is expected to drop by 20%. So today's problem will be worse tomorrow. We need strategies to keep healthcare quality and one of them is to have properly trained medical imaging graduates.

'The administration tends to not react fast enough to changes. In this case it's easy. Spain must realise that other European countries have agreed to train medical imaging graduates in three or four years, so they should just copy this model.'

'The University of Barcelona has just launched a medical imaging degree, and the radiogiology society is supporting this initiative, along with the national societies of nuclear medicine and cardiology.

'This initiative could be the first step in convincing the Health Ministry to include medical imaging specialist in the list of healthcare professions. 'The EU has expressed its support for this proposal. Having an official statement from Brussels on radiographers' education would also help.' MR

Salvador Pedraza Gutiérrez is Director of the Diagnostic Imaging Institute (IDI) in the Radiology and Nuclear Medicine Department at Dr Josep Trueta Hospital and Santa Caterina Hospital in Girona, Spain. He has been Associate Professor of Radiology at the University of Girona (UDG) since 2006 and he directs the School of Diagnostic Imaging Technicians in Girona.

X-Ray System

nd drivability

and a height-adjustable grip bar, help to improve efficiency on hospital rounds. Selectable FPD series enables flexible system configuration. FPD models are available to meet a wide variety of clinical needs, such as physical size, sensitivity and data transmission. FPDs of various sizes can be added. A liquid resistance and the combination with a lightweight FPD makes daily handling much easier. High-sensitivity compact FPD for paediatric care. The compact FPD fits inside the cassette tray of an incubator, which enables imaging neonates or infants. A high-sensitivity FPD helps reduce radiation exposure, providing powerful support for paediatric care.

Tools to support radiation management: The system is in conformity with today's needs for radiation management. The estimated Dose Area Product (DAP) is displayed prior to exposure, and the calculated DAP value is stored for post-exposure management. A DAP chamber can also be mounted if required.

Designed for sterile equipment covers: For daily use, extra storage spaces are provided to store wipes, pens, markers, etc. Grooves have been added for holding the FPD vertically while putting a sterile cover on it.

Details: Shimadzu Europa, www.shimadzu-medical.eu

The new MobileDaRt Evolution MX8 digital radiography solution provides superior drivability and functionality. It is used for hospital rounds and to examine patients in emergency rooms, neonatal intensive care units or other highly urgent medical applications.

EU v. USA – a comparison

Used imaging equipment

by Phillip F Jacobus

I've watched the used imaging equipment market for the last 40 years and it seems like every year, at ECR, I have a conversation with friends comparing the USA and EU markets. Clearly, the market is more developed in North America than it is in Western Europe. Why?

Let's look at the numbers

I think it's fair to say that DOTmed.com, a company that I started in my apartment almost 20 years ago, is one of the most important medical equipment/parts/service websites on the internet. People made fun of me because our website was free, but it proved to be a good strategy. Today, out of over 274,521 registered users there are 25,975 used equipment dealers. 18,442 are in the USA and 2,640 are in the EU, with another 881 in non-EU, European countries. There are 17,350 service companies in the US, with only 2,806 in the EU.

As far as postings of parts or equipment for sale, there are 119,220 total equipment listings with 103,994 in North America and 10,085 in Europe. There are 677,545 total part listings with 369,551 in North America and 83,159 in the EU. So, if your instinct tells you that the market for used imaging equipment is bigger in the US than in the EU, then you're probably right.

DOTmed.com is at ECR Expo Hall X2, Stand 203

Why?

There's that old conundrum... Which came first, the chicken or the egg? In the US we have a healthy pre-owned equipment industry because we have a healthy independent service industry, and we have a healthy independent service industry because we have a healthy independent spare parts industry. All of this is motivated by financial pressure. In the US there's pressure on healthcare providers to do more with less for more patients. This has carried over to in-house departments, where hospitals provide their own maintenance.

It's been said that money makes the world go round and hospitals not only found a way to lower their operating costs by servicing the equipment themselves, but now in the US there are alternative parts vendors that help these hospitals. In fact, some of these alternative parts vendors are shipping equipment to Europe and will continue to do so until the independent parts industry in the EU grows big enough to meet demands.

In my opinion, it's all a question of priorities. Europe enjoys a better rail infrastructure than North America because the governments in Europe have made it a priority. Healthcare is also a priority in Europe, even at the cost of higher taxes in some cases. In the US, healthcare is a political football whereas in Europe it seems to be an inalienable right. Or, to put it another way, healthcare providers in Europe are not under the gun to find ways to save and economise to the same extent as they are in the United States. There is an abundance of trained service labour available in the USA. Coupled with an entrepreneurial spirit, this labour has formed ISOs to offer lower cost quality alternative service to the OEM prices. Then add a robust spare parts market and you have strong alternative service options.

Will this change?

There are more people alive today in the world than there were 100 years ago and we have succeeded in making people live longer. It seems to me that it's only a matter of time before this larger population places financial pressure on European healthcare providers and they are forced to look for ways to save money. The pre-owned equipment market will be that answer, I predict.

As the rest of the world continues to grow, the need for pre-owned equipment and perhaps more importantly, pre-owned parts, will grow as well. The market in Europe will have to develop some independent engineering groups to dismantle equipment and harvest parts without missing a step. Some of these engineering groups will be asked to provide maintenance. First, they'll be asked to provide maintenance in a pinch, and then in the future, they'll probably be called upon for regular maintenance.

It's my prediction that, just like in the USA, the EU market will have a place for OEM service, in-house service and independent service. It's only a matter of time.

In the meantime, just a few companies are going to be big winners, as they dominate that space.

The President and Founder of DOTmed.com, Inc., **Philip F Jacobus** publishes HealthCare Business News magazine and HealthCare Business News online. He is also President of Owen Kane Holdings, Inc. and its subsidiaries. Jacobus was a used equipment dealer (1977-1996) and pioneered the exporting these goods to China, visiting that country 70 times. He has also sold equipment in over 30 countries. A business partner/investor in more than 90 imaging centres, he was instrumental in installing the first proton therapy system in Russia.

New monitor generation produces natural, precise colours

The i3 series improves diagnosis

JVC reports a complete redesign of its display line-up, bringing the i3 series to market. 'At first glance, the new housing design stands out; the displays bezels are much narrower than in the previous generation,' JVC points out. 'Also new are function buttons on the screen with virtual descriptions. These customisable buttons give users direct access to various functions.'

Beyond the visual, the devices have been further developed; they also offer some technological innovations. The new 3-D lookup table, for example, enables the best possible colour reproduction, the firm reports. 'By also calibrating primary colours, colours have never been so natural and precise,' says Marcel Herrmann, Marketing Manager Totoku at JVCKenwood. 'This also ensures that the image impression is the same on every monitor in the entire facility. In combination with the new colour front sensor, we can guarantee this for the entire life of a display.' As the first display systems on the market, the calibration is executed autonomously and independently from the PC, the company adds. 'The procedure is very simple: The user defines the calibration time and date, for example at night. This scheduled calibration will start automatically even if the workstation is not operating.'

JVC is at ECR 2018 Expo Hall X5, Stand 528

The sensor system of the new i3 monitors consists of a front sensor and an ambient light sensor. 'The front sensor measures continuously luminance and colour of the display and corrects those in real time. This ensures a very stable brightness and high colour stability,' Herrmann explains.

In addition, the i3 series devices include a human sensor. This detects whether someone is sitting in front of the screen, which helps to save energy when the monitor is not in use. For example, JVC adds, it can be ensured that a doctor is not disturbed by the quality control when he is busy doing his reporting.

The i3 series devices include a human sensor that detects whether someone is sitting in front of the screen, which helps save energy when the monitor is not in use