ECR TODAY 2019

EUROPEAN CONGRESS OF RADIOLOGY

DAILY NEWS FROM EUROPE'S LEADING IMAGING MEETING | SUNDAY, MARCH 3, 2019

BY MÉLISANDE ROUGER

AI

AI could help to manage, predict and even reduce patient exposure to ionising radiation

Every field of imaging is looking at the opportunities offered by artificial intelligence to advance imaging's contribution to healthcare.

ESR EUROSAFE IMAGING

So what is it that AI can do to improve radiation protection and safety? From dose reduction to managing dose during diagnostic and therapeutic procedures that use ionising radiation, AI has a lot to offer. A panel of experts will look at the likely developments in a dedicated session today at the ECR.

When it comes to radiation protection, artificial intelligence (AI) is sure to make a notable contribution. "We will have a chance to reduce dose even further with AI – this is certain," said Prof. Christoph Hoeschen from Magdeburg, Germany.

Prof. Guy Frija from Paris, France, who will co-moderate the session with Hoeschen, agrees.

"AI could help to reduce ionising radiation dose by further improving image quality, using existing reconstruction and scatter reduction methods. We could achieve a significant reduction in dose in CT, PET or SPECT scans," Frija said.

Most patients would benefit from such new developments. Research on AI for scatter reduction and image reconstruction is going on all around the world.

A second interesting working track for AI development in radiation protection focuses on managing and adjusting dose to individual patients. The idea is to use AI methodologies to quantify image acquisition parameters and optimise procedures before or during each examination.

"We are just at the beginning of something there. We are starting to build systems, based on computer systems, to determine image quality directly from existing patient images. This would be a prerequisite for the learning process of an AI tool," said Hoeschen. "For example, for a dedicated task in a CT or SPECT application, you start acquiring images and during the generation of those images, you find out what is your already achieved image quality acquisition and just stop the examination altogether. During an interventional procedure, one could also give an indication of how to perform irradiation, in which direction or from which angle," he said.

AI could also be used to predict rather than measure dose during an intervention, which would improve the safety of said intervention. This might be applicable to any interventional diagnostic procedure or angiographic CT.

There is a third path to enable radiation protection by means of AI, using radiogenomics to derive aspects of susceptibility of patients to ionising radiation and modulate dose accordingly. This development might influence diagnostic and

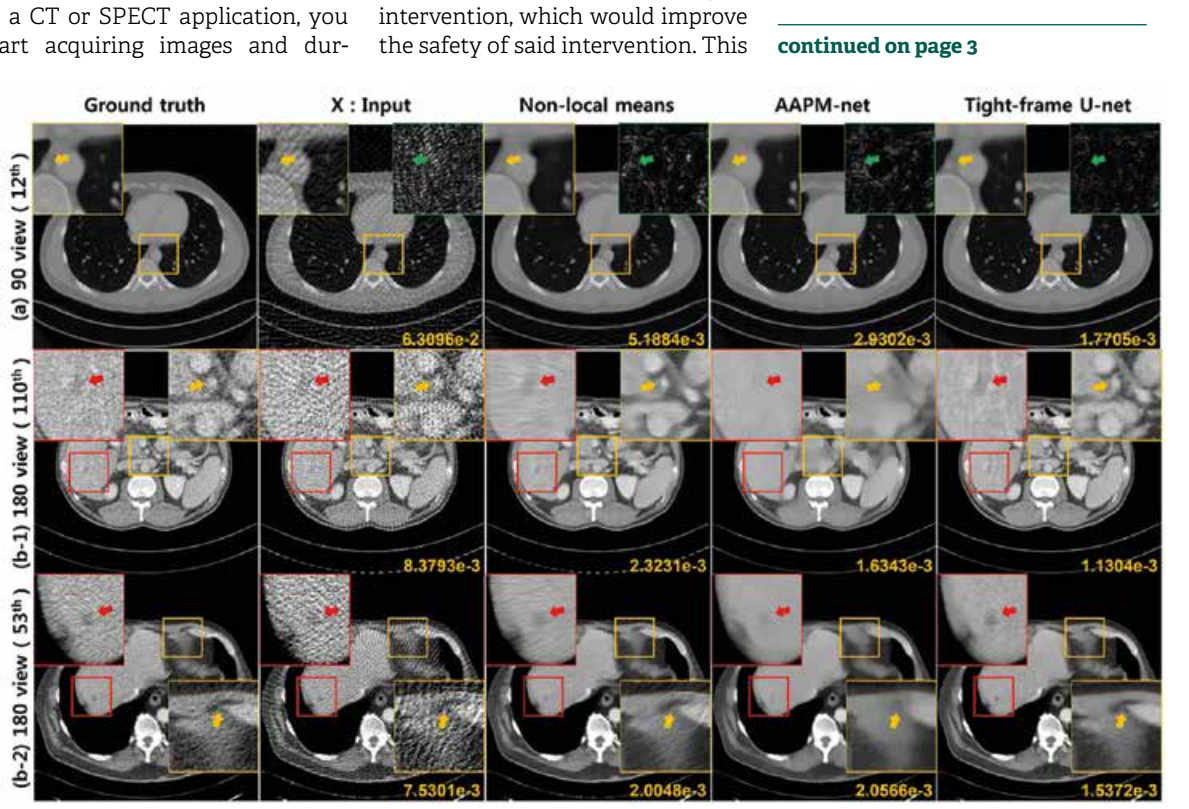
continued on page 3

EuroSafe Imaging Session

Sunday, March 3, 08:30–10:00, Room N
EU 7 Artificial intelligence and radiation protection

- **Chairpersons' introduction**
  G. Frija; Paris/FR
  C. Hoeschen; Magdeburg/DE
- **Artificial intelligence: a tool for quality and safety improvement in radiation protection**
  G. Frija; Paris/FR
- **Artificial intelligence for scatter reduction and optimising imaging procedures**
  C. Hoeschen; Magdeburg/DE
- **Artificial intelligence for intelligent reconstruction methods for radiation protection measures**
  C.T. Whitlow; Winston-Salem, NC/US
- **Using artificial intelligence for optimising procedures reflecting radiosusceptibility of patients**
  C. Hoeschen; Magdeburg/DE
- **Discussion**

This session is part of the EuroSafe Imaging campaign.



Reconstruction results by non-local means, AAPM-net and proposed tight frame U-Net. (a) 90 view full-dose data, and (b)(c) 180 view quarter-dose data. Yellow and green boxes illustrate the enlarged view and the difference between images, respectively. Red boxes indicate the lesion region. The number written on the images is the NMSE value. From Han Y and Ye JC, Framing U-Net via Deep Convolutional Framelets: Application to Sparse-view CT. *IEEE Trans Med Imaging. 2018 Jun;37(6):1418-1429. doi: 10.1109/TMI.2018.2823768.*

continued from page 1

therapeutic procedures, using radiation in different ways for specific patients, according to Hoeschen, who recently spearheaded a Horizon 2020 project application in this field that is currently under evaluation by the European Commission.

Such an approach can also be used to personalise the imaging application of ionising radiation to avoid negative effects on sensitive patients. For such patients, one could even try to avoid imaging technologies based on ionising radiation and replace them with other techniques such as ultrasound or MR imaging.

Collecting sufficient and relevant data remains a challenge in radiation protection, even if the datasets that are required are not as big as for genomics. But training has to be done on sufficiently large datasets, the size of which depends on the question to be addressed. Image quality descriptors need large datasets and so does scatter reduction. For scatter reduction, Hoeschen suggested, one could use CT datasets that already exist and try to mimic them by Monte Carlo simulation methods, i.e. a broad class of computational algorithms that use randomness to solve problems that might be deterministic in principle.

One needs to be careful at the time of using data in research and also in clinical applications, especially to differentiate data used for training and testing, Hoeschen warned: "There are always studies in AI that use the same data for training and testing, but for clinical practice this is very critical." And Frija added: "If we want to use these things to have machines make suggestions, we have to be scientifically precise and that means separating training from testing to a large extent."

AI is a hot topic, but it is crucial to understand the concept, as some results can be very misleading. "We have to be careful to avoid funding things just because it says 'AI' in the title. We have to do one thing at a time, not all at once, otherwise we could have a problem," Hoeschen said.

Frija points out that AI may help to significantly reduce the contrast agent dose in MRI examinations, thus making AI useful beyond radiation protection in terms of patient safety for radiological procedures.

And of course, ethical questions remain to be tackled, which will require input from radiologists and patient representatives.

"In the end, AI applications for radiation protection will only be of benefit to patients and staff, if radiologists, mathematicians, IT people and medical physicists work closely together," Hoeschen said. "The fact that the session will be co-chaired by a radiologist and a medical physicist clearly demonstrates the importance of teamwork here. For the radiologist, it is important that, once implemented, AI should become invisible to make sure it is widely used. It would be integrated, like in a smartphone which uses AI," Frija added.

BY KATHARINA MIEDZINSKA

Optimising the management of the diabetic foot

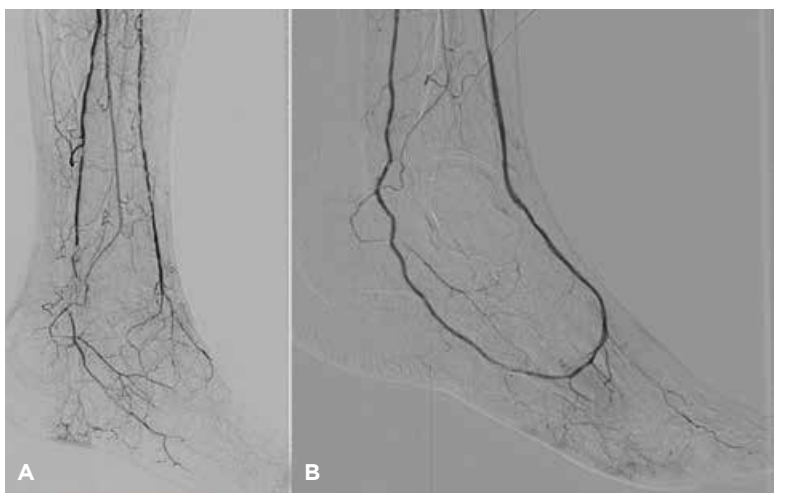
A session presented by a panel of experts from the General University Hospital Attikon in Athens aims to provide a practical, comprehensive, and timely update about how to manage diabetic foot complications, a significant cause of morbidity and mortality in diabetic patients.

Diabetes mellitus (DM) is a chronic metabolic disorder and a growing health problem worldwide. At present, the world is facing an epidemic of both type 1 and type 2 DM, according to the World Health Organization (WHO), with DM currently affecting more than 422 million people worldwide, a number that is rising. As a multi-systemic disease, DM afflicts the body in a comprehensive way, resulting in a variety of complications involving multiple end organs. Complications are common among both patients with type 1 and type 2 diabetes and are responsible for significant morbidity and mortality.

Chronic DM complications can be broadly divided into microvascular and macrovascular, with the former including neuropathy, nephropathy, and retinopathy, while macrovascular complications comprise cardiovascular disease, stroke, and peripheral arterial disease (PAD). In this session, a panel of experts will take a multidisciplinary look at the diabetic foot, defined as the presence of foot ulcers associated with neuropathy, PAD, and infection, which particularly affects the soft tissue and bones, and its complications.

The diabetic foot is a significant cause of morbidity and mortality in patients with DM. Early diagnosis is of crucial importance, as it allows early treatment. With delayed treatment, progression toward a not only limb-threatening, but also life-threatening stage is often simply inevitable.

"Approximately ten percent of people with diabetes have a foot ulcer, meaning that more than 42 million people are suffering from diabetic foot disease. It has been estimated that every 30 seconds one leg is amputated due to diabetes. According to estimates, diabetes is responsible for more than one million limb amputations per year, while following an amputation, up to 50 percent of people with diabetes will die within the next two years," said Prof. Dr. Elias Brountzos, who will chair today's session.



65-year-old male patient with diabetes and Rutherford class 5 gangrene of the big toe. Selective digital subtraction angiography (DSA) demonstrating occlusion of the anterior and posterior tibial arteries with absent pedal arch (A). Final DSA following revascularisation of the anterior and posterior tibial arteries and pedal arch reconstruction (B).
(Image provided by Prof. Stavros Spiliopoulos)

61-year-old male patient presenting with a non-healing wound following minor amputation (A). Complete wound healing achieved three months following infrapopliteal stenting of the anterior tibial artery (B).
(Image provided by Prof. Stavros Spiliopoulos)

Foot ulcers and infections are among the most frequently occurring complications in the diabetic foot. Sensory neuropathy in the distal regions of the extremities predisposes many patients to traumatic injuries, which in further consequence may lead to skin breakdown, ulceration, and infection. Impaired perfusion as a result of PAD and microvascular abnormalities reduces wound healing capacity and the ability to recover from infection. A vicious circle that must be broken at the earliest stage possible, according to Brountzos.

"Prompt diagnosis and revascularisation should be offered in subjects with diabetes and PAD, in order to promote wound healing and avoid infections. PAD and neuropathy are responsible for approximately 45 percent of diabetic foot ulcers and such patients are at high risk of infection. Patients with PAD and a foot infection are at very high risk for major amputation, for which emergency treatment is required. These patients should be assessed by a multidisciplinary team as part of a comprehensive care plan in centres of excellence, in which rapid diagnosis and endovascular treatment options or surgical treatment are available."

Endovascular treatment options will be one of the key topics of the presentation by Prof. Stavros Spiliopoulos. "Today, endovascular revascularisation is an established treatment with excellent results and should be offered in subjects with diabetes and PAD, while for a substantial proportion of patients with non-healing ulcers, endovascular revascularisation might be the only treatment option in order to enable wound healing and avoid major amputation. Endovascular techniques have evolved over the years to become first-line treatment options in everyday clinical practice. Moreover, the number of endovascular procedures performed over recent years has greatly increased to even outnumber open surgical procedures for PAD, both in the US and in Europe, while in experienced centres the 'endovascular-first' approach has already been adopted," he said.

After familiarising ECR delegates with the indication areas of interventional treatment, Spiliopoulos plans to thoroughly discuss endovascular devices, methods, and techniques used to promote wound healing and avoid limb amputation, including plain balloon angioplasty, stenting and novel drug-elution technologies such as drug-eluting stents (DES) and drug-coated balloons (DCBs), among others.

"Today, various endovascular methods and techniques are performed in experienced vascular centres, including infrapopliteal angioplasty and DES, pedal arch reconstruction, revascularisation of long iliac and femoropopliteal chronic total occlusions, and ulcer-guided revascularisation," noted Spiliopoulos. "Moreover, tissue perfusion methodologies can be used in order to accurately quantify tissue perfusion following endovascular procedures such as intra-operative 2D perfusion angiography, microwave radiometry and near-infrared spectroscopy (NIRS)." Spiliopoulos also plans to specifically address the results of IR treatment and discuss the strengths and weaknesses of endovascular treatment, technical and limb salvage rates, and data demonstrating improved patency rates following endovascular revascularisation.

"A technical successful intervention should achieve a direct flow to at least one of the foot arteries. Very satisfactory long-term limb salvage rates have been reported for subjects with diabetes and critical limb ischaemia. The 'Achilles heel' of endovascular treatment is restenosis leading to loss of patency, clinical relapse and re-intervention. Recent data from multicentre randomised trials and their meta-analyses demonstrate that DCBs and DES achieve superior patency rates compared to plain balloon angioplasty and bare metal stenting in femoropopliteal and infrapopliteal arterial disease. Most important, however, is that foot ulcerations should always be treated by a multidisciplinary team including vascular surgeons, diabetologists, podiatrists, and interventional radiologists. Furthermore, close monitoring and strict follow up schemes are crucial keys to clinical success," he concluded.

Another central topic of this session will be the magnitude of the diabetic foot as a societal problem. "The societal and economic impact of diabetic foot ulceration or major amputation is remarkable. People with diabetic foot ulcerations experience a significant reduction in their quality of life, are unable to work, receive chronic treatment and require frequent medical visits and hospitalisations, while patients who suffer a major limb amputation require leg prosthetics, rehabilitation and, psychological support," said Brountzos, speaking to *ECR Today* ahead of the congress.

Dr. Vaia Lambadiari will report in detail on this complex issue, while Dr. Olympia Papakonstantinou and Prof. George Geroulakos will cover imaging evaluation and the surgical management of the diabetic foot, respectively. The session will close with a multidisciplinary case presentation and discussion, focusing on the role of imaging and the selection of patients for medical, interventional radiological, and surgical treatment.

Multidisciplinary Session

Sunday, March 3, 08:30–10:00, Room M 4
MS 17 Multidisciplinary approach to the diabetic foot

- **Chairperson's introduction**
  E.N. Brountzos; Athens/GR
- **Diabetic foot: a societal problem**
  V. Lambadiari; Athens/GR
- **Imaging evaluation of the diabetic foot**
  O. Papakonstantinou; Athens/GR
- **Interventional radiological treatment (IR)**
  S.C. Spiliopoulos; Athens/GR
- **Surgical management of the diabetic foot**
  G. Geroulakos; Athens/GR
- **Multidisciplinary case presentation and discussion**
  E.N. Brountzos; Athens/GR