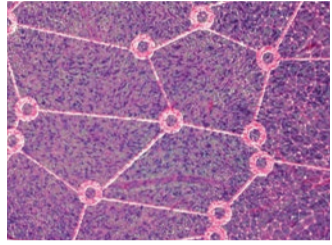


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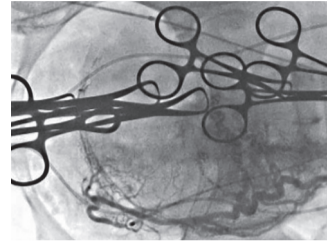
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DIGITAL PATHOLOGY

4-6

- The rocky (but worthwhile) road to digital pathology
- Digital pathology switch bears fruit
- Going digital: no reason to delay



EH @ ECR 2022

7-13

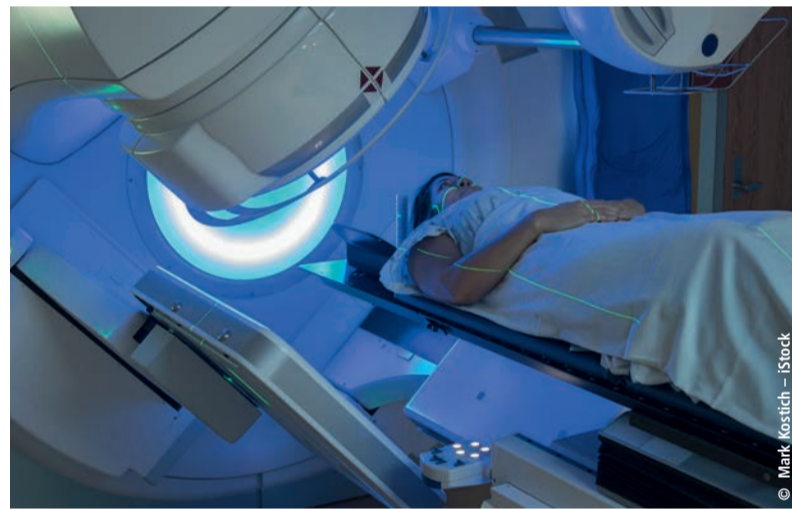
- Women in interventional radiology take center stage
- Spinal imaging in trauma
- Predicting Covid-19 death risk

Radiotherapy: Nuclear waste as a potential source?

Molecular radiotherapy shows great potential in becoming a more mainstream treatment for cancer, but the field is being hampered by a limited radionuclide supply.

Report: Mark Nicholls

Delegates to the virtual NCRI (National Cancer Research Institute) festival session “How do we make the most of molecular radiotherapy? Novel radiotherapeutics and individualised therapy” heard details of the rapidly advancing area of molecular radiotherapy with presentations covering clinical developments, radiation physics and radiochemistry. The session was co-chaired by Dr Glenn Flux, Head of Radioisotope Physics at the Royal Marsden Hospital and Institute of Cancer Research in London, and Professor Jon Wadsley, a Consultant Clinical Oncologist at Sheffield Teaching Hospitals NHS Foundation Trust and the Weston Park Cancer Centre in the UK. In his opening remarks, Professor Wadsley attested to molecular radi-



otherapy being a growth area on its way from the treatment of rare niche cancers to a more mainstream therapy. However, he conceded: ‘There is still a lot we don’t know about how we make best use of molecular radiotherapy.’

Among these areas, highlighted by the NCRI Clinical and Translational Radiotherapy Research Working Group (CTRad) to develop the field in the UK, are the need

for an appropriate infrastructure in terms of equipment and workforce; the importance of developing an evidence base for these treatments; and optimising molecular radiotherapy treatments, particularly through dosimetry and being able to personalise treatments. While some progress has been made in these regards, ‘there is still a lot of work to be done,’ he added. Advances were also being hampered by an insufficient supply of radionuclides in the UK, and funding issues for studies in this field.

The potential of molecular radiotherapy

Dr Jane Sosabowski, from the Barts Cancer Institute (BCI) at Queen Mary University of London, looked at the future growth and potential of molecular radiotherapy. During her presentation “Novel radiotherapeutics and the growth of molecular radiotherapy,” she reported on the field’s unprecedented expansion, with much excitement generated around radionuclides. Cytotoxicity of these alpha particles had been cause for concern – however, these appear to have alleviated and made way for a new prospect of wider use of molecular radiotherapy, Dr Sosabowski said. ‘There is also some exciting work going on in moving from beta particle emitters to alpha particle emitters, which seem to have some really remarkable therapeutic effects.’ However, she pointed out ongoing availability issues for radionuclides, which threaten to hold back further progress: ‘We cannot do anything unless we have

access to these radionuclides if we want to work with alpha therapies, which is really where most of the research interest is focused at the moment.’

In the UK, the lack of domestic supply sources complicates the issue. Creating radionuclides from nuclear waste is a potential solution, which is currently being explored by the National Nuclear Laboratory, Sosabowski reported. She expressed hope for the industry to find additional ways to increase production, putting an end to this issue and paving the way for further advances in molecular radiotherapies. Beyond this, the expert urged the nuclear medicine community to be ready for upcoming new therapies: ‘We will see some expansion in PET to be able to see if patients are eligible for treatments, but also to follow response to therapy, so these diagnostics and therapeutic radionuclides go hand in hand.’

Due to the critical shortage in the UK, advances associated with alpha particle emitters are mainly seen in the US and Europe, where availability is better. However, there remains an ambition in the UK to expand the field in terms of research, clinical trials, commercial interactions, and patient access and create opportuni-

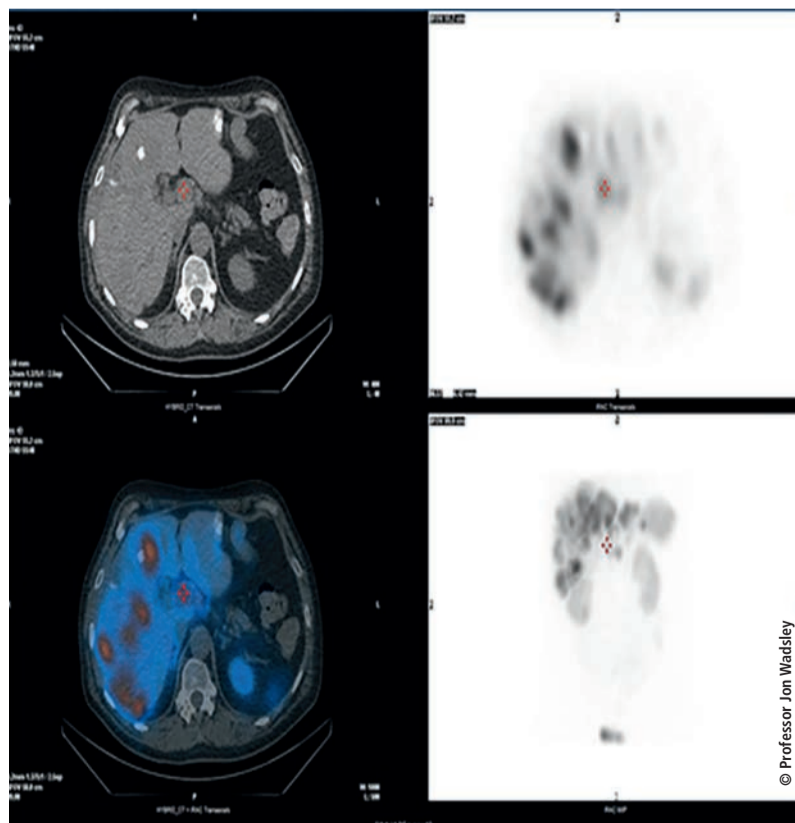
ties in the area of personalised medicine, Dr Sosabowski concluded.

The session also heard from Dr Anna Sundlöv, a senior consultant in oncology at Skåne University Hospital in Lund, Sweden, who discussed dosimetry in clinical trials with molecular radiotherapy, examining “what’s in it for patients?”; and Dr Jonathan Gear, Principal Physicist at the Royal Marsden NHS Foundation Trust, who gave a presentation on the potential for personalised treatment with patient-specific dosimetry.



Jane Sosabowski

Dr Jane Sosabowski is Reader in Molecular Imaging in the Centre for Cancer Biomarkers and Biotherapeutics, Barts Cancer Institute, Queen Mary University of London. She leads the Cancer Imaging Laboratory at BCI, with a team of researchers working on the application of radiolabelled peptides, antibodies, and other carriers for imaging and molecular radiotherapy in pre-clinical models and translation to the clinic, with a particular interest in bringing novel therapy radionuclides into clinical use in the UK.



Molecular radiotherapy with Lutathera



Jon Wadsley

Professor Jon Wadsley is a Consultant Clinical Oncologist at Sheffield Teaching Hospitals NHS Foundation Trust in the UK with clinical interests are in thyroid cancer, neuroendocrine tumours and pancreatic/biliary tract cancers, with a particular emphasis on molecular radiotherapy. His research mirrors these clinical interests, with a particular focus on thyroid cancer and neuroendocrine tumours. He is Clinical Director of the Sheffield Cancer Clinical Trials Centre, Cancer Specialty Lead for the Yorkshire and Humber Clinical Research Network and NIHR National Specialty Lead for Radiotherapy and Imaging.



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Critical infrastructures: targets of cyberattacks

Some ten years ago, it was unthinkable that virtually all company data was stored in the cloud. Now it's what almost every company does. However, the increasing complexity of corporate IT infrastructures also comes at a price.

Report: Madeleine van de Wouw

The sheer size and complexity of the systems makes it difficult to keep track of everything that is going on digitally. And this leads to more and more successful cyberattacks. With all the consequences this entails.

All companies and institutions in Europe have to deal with European regulations such as AVG and GDPR, which must guarantee privacy. Each country may decide for itself what falls under critical infrastructure, but for most that includes healthcare, financial institutions and government. And what counts as critical must comply with all European standards, which are constantly being tightened along the way. The fines for non-compliance are very high and the consequences of a cyberattack can be huge. That is why companies and institutions need to take a preventive approach to secure their IT in order to avoid getting into trouble afterwards. But how do you know exactly what is going on in your company? How can you gain insight into all the systems you have running and what the weak spots are?

Identify and manage

Seamless management of your IT's digital "attack surfaces" is an important step towards cyber-resilience. This attack surface refers to all the possibilities that an unauthorised user can have to bring in or steal information. To manage and control that, Dutch cybersecurity company Cybersprint B.V. developed the Cybersprint Attack Surface Management platform: a SaaS solution with continuous monitoring of all possible attack surfaces. For example, by entering a brand or company name, the system searches for anything related to that brand name and the vulnerabilities and misconfigurations associated with it.

Sebastian Bosman, Product Marketing Manager at Cybersprint, explains: 'Our platform maps the

individual digital components of an organisation. Let me explain the three major developments which make control of the digital attack surface necessary.

1. Digital transformation:

Certainly during Covid, online and cloud working has accelerated and systems have become larger and more complex. And so companies are increasingly outsourcing digitally. You must therefore take stock of what is housed with third parties. Remember, your company is always responsible for your own data, even if you hire a supplier who makes a mistake, has a leak or whether there has been a successful hacking attempt.

2. Increasing threat:

Threats are becoming more frequent and more sophisticated. Ransomware attacks and phishing are a big problem, and they are increasingly starting in the supply chain. A while back this happened, for example, with the Microsoft mail exchange. Criminals were able to get into a large software company and send their own piece of malicious software along with its updates. This gave them access to many more companies at once. In addition to securing your own infrastructure, it is therefore also necessary to know exactly where and which third-party software is running so that you can act immediately in the event of an incident.

3. Rules and laws:

Various authorities such as governments and umbrella bodies within sectors are increasingly prescribing how organisations should run their business, for example in the field of data privacy. Organisations must have control over their own attack surfaces and be able to prove that they know what is going on. If they can not, heavy fines can be issued.

At the end of 2020 an ambulance with a patient had to be diverted because of ransomware. The hackers had gotten in by abusing a Citrix environment (at the end of 2019, a major vulnerability had been discovered in this Citrix product). We were on top of this at the time and advised several customers.

Also, the U.S. Department of Homeland Security has issued advisories to highlight the importance of cybersecurity in healthcare (<https://info.publicintelligence.net/NCCIC-MedicalDevices.pdf>) It might

even be so that people die because of ransomware. For instance, in Alabama, USA, a baby might be the first-ever death caused by a ransomware attack. According to Pandasecurity.com, there is a lawsuit against a hospital where a newborn baby ended up with severe brain injury. The mother did not receive all necessary tests when admitted to a hospital to deliver her

organisation always has the most up-to-date information, fully automated and continuous. Also, the assets found are at once scanned for any risks, allowing a security professional to know what is wrong and to prioritise.'

Shadow IT is a big problem

A major and often unrecognised problem in many companies is

categories. For example, a certificate is not up-to-date, or a patch is required. In our system you can see the software you are using and whether you need to protect it. We indicate the risks on a scale from A to F. 'While an "A" is okay, an "F" means that the issue urgently needs to be addressed by the company's IT department. Step 3 is the management of all data. What should be



baby because of an ongoing cyber-attack. The tests she missed would have shown that the baby's umbilical cord was wrapped around the fetus' neck, with eventually caused brain damage. The baby died nine months later.

What we think is important is the way in which all this information is collected. When you, from within your organisation, start making an inventory of the digital assets you have, you only see what you already knew you had. But what if, for example, created subdomains haven't all been neatly passed on to the IT security team? This creates blind spots which you cannot secure.

That is why our platform works from the outside in, without special access or an imposed IP range in advance – just as an advanced hacker would see it. This way, an

shadow IT. Not only specialists and the IT department can build websites and platforms. A marketing department, for example, can set up a web page for a campaign and link it for instance to a page on Facebook without telling it.

Identifying assets: 4 steps

Bosman: 'Our platform identifies between 30 and 50 percent of assets that companies and institutions did not even know they had. Take for instance a hospital.

Step 1: we start searching on brand name and everything related, such as hosting etc. An overview of all domains and underlying infrastructure automatically follows. Especially in larger organisations, there are tens of thousands of assets, also from suppliers. This means an enormous attack surface. Step 2 is the rating of the risks in

tackled first? If there is a problem, the system can help assign ownership to solve it. Finally, step 4 is reporting. How can you track risks, measure performance, and perhaps adjust processes?

According to Pieter Jansen, founder of Cybersprint, there is a difference with other companies in working methods. 'Our system maps everything continuously. You can hire a company to draw up a report, but these are snapshots and the next day it can all be different. We have automated the process and you only have to log in to see all the information you need. We don't change anything ourselves, we only signal what is wrong, we don't go "deeper" in search. The data from our platform serves as a starting point for other security methods, such as red teaming and penetration tests.

Knowing your critical points is also an advantage if you are audited for NEN certification, for example. Regulations and the need to comply with standards (NEN 7510 for information security) are particularly important in the healthcare sector. Our platform also ensures that, within that framework, both the loose ends and the overall processes and security governance can be examined.

What about our own security? Good question! Yes, we also comply with the highest requirements and standards, and of course we monitor ourselves!'

UPCOMING EVENTS

- **HIMSS Global Health Conference**
14.–18.03.2022
Orlando, USA
www.himss.org/global-conference
- **DMEA 2022**
26.–28.04.2022
Berlin, Germany
www.dmea.de/en/
- **Digital Healthcare Show**
18.–19.05.2022
London, UK
www.digitalhealthcareshow.com
- **e-Health Conference and Tradeshow**
01.–02.06.2022
virtual
<https://www.e-healthconference.com/>
- **MD&M West**
12.–14.04.2022
Anaheim, United States
<https://www.mdmwest.com/en/home.html>
- **Digital Health – World Congress 2022**
17.–18.05.2022
London, UK
<https://digitalhealthcareworldcongress.com/>
- **Medical Informatics Europe conference**
27.–30.05.2022
Nice, France
<https://efmi.org>
- **CARS 2022 Computer Assisted Radiology and Surgery**
07.–11.06.2022
Tokyo, Japan
<https://www.cars-int.org/>

Cybersecurity threat to remote monitoring devices

Remote monitoring devices and pacemakers supporting patients with cardiac conditions such as heart failure could be vulnerable to cyberattacks, according to leading expert Dr Tuvia Ben Gal. While acknowledging the overall therapeutic benefits of such devices, he remains concerned that not enough attention is given to addressing the potential cybersecurity risk.

Report: Mark Nicholls

Major issues are manufacturers often not factoring in cybersecurity, medical guidelines overlooking the matter, and healthcare providers being uninformed about the security risks and unfamiliar with the methods for evaluating those risks, he pointed out during a session at the ESC Digital Summit 2021.

Focusing on telemedicine, monitoring devices, pacemakers, implantable cardioverter-defibrillators (ICDs), cardiac resynchronization therapy (CRT) devices, and left ventricular assist devices (LVADs), he explained that modern communication technologies for the monitoring and management of patients improve outcomes and reduce costs. The devices allow for monitoring and assessment of a patient's condition by both unidirectional data transmission from the patient to the healthcare provider and bidirectional communication features. The latter are designed to facilitate active intervention or electronic manipulation of the device with the aim of improving the clinical condition of the patient. However, bidirectional communication is not yet being applied due to unresolved security issues, since the feature would also open potential gateways for unauthorised access. Dr Ben Gal cautioned: 'While healthcare providers are aware of the clinical benefits and downsides of medical devices, they are frequently uninformed of the security risks and unfamiliar with the methods for evaluating those risks.' As a result, many patients remain uninformed because they rely on information supplied by the medical team.

Gap in guidelines

Expressing concern that cybersecurity is not addressed in guidelines, Ben Gal posed the question of whether the security risk outweighs the clinical benefit of the device. During the ESC presentation, he outlined what is needed for protection against these security risks to ensure safe telemedicine implementation. These included:

- collaboration between all parties using remote technology;
- awareness of cybersecurity issues in telemedicine among the medical team;
- establishment of institution-wide security standards, such as for data encryption;
- frequent software updates and antivirus data scanning;



- using proper authentication
- creating and adopting local cybersecurity regulations.

While he acknowledged the role of public video conferencing platforms, especially during the first phase of the pandemic, the IT expert stressed that going forward, only products specifically assigned for healthcare video conferencing with adequate cybersecurity should be used.

To illustrate his point, Ben Gal expanded on devices used to monitor heart failure patients. Covering a range of parameters, such as

haemodynamic and clinical data, pulmonary artery and left atrial pressure, bodyweight, and lung water content, these devices transmit captured data to a healthcare centre. This data is potentially vital, he explained, as it can initiate a change in therapy, if, for example, a certain threshold in one of the parameters is crossed. Therefore, the data must be protected, not only from transmission-related corruption, but also ransomware attacks encrypting the medical data and demanding payment to unencrypt the information withheld. Any such damage to the data's integrity can

have serious consequences such as interrupting device performance, impacting patient management and potentially causing harm, Dr Ben Gal pointed out. Manufacturers and companies therefore carry a great responsibility to ensure appropriate security of the monitoring device and should be encouraged to publish data on security tools for open review.

Establishing a (safe) remote kill switch for ICDs

Newer pacemaker models, which can transmit data by unidirectional communication for remote follow-up, are equally vulnerable to cyberattack, the expert cautioned – although he noted that fortunately, no cyberattacks have been reported on pacemaker technology so far.

During the Covid-19 pandemic, another issue has emerged: At a certain point, ICDs must be deactivated for increasingly frail cardiac patients or those developing terminal illness, to prevent the implant from automatically administering dangerous shocks. However, most devices require the patient to be transported to a hospital for the deactivation – a considerable risk, especially for terminally-ill patients. Dr Ben Gal said therefore pointed out the need for remote deactivation functionality of the devices, with strict security procedures in place. 'New pacemakers should include enhanced cybersecurity properties, enabling bidi-

rectional communication between the patient and the medical team,' he said.

The benefits outweigh the risks

The expert also stated the need to enhance cybersecurity properties in LVADs, which use bidirectional communication for remote device adjustments to help reduce complications and hospital visits.

While there was a risk of cyberattack, Dr Ben Gal concluded that the benefits these sophisticated devices bring for heart failure patients still significantly outweigh the drawbacks, greatly helping upgrade the quality of care. However, he added: 'Medical agencies should provide clear regulations for cybersecurity in the manufacturing process of every medical device.'



Tuvia Ben Gal

Dr Tuvia Ben Gal is the director of the Heart Failure Unit of the Cardiology Department at Rabin Medical Center, Petah Tikva, and Tel Aviv University, Israel. He is author of multiple peer-reviewed scientific papers and speaker at many national and international conferences.

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Experience report

AI implementation: Digital pathology switch bears fruit

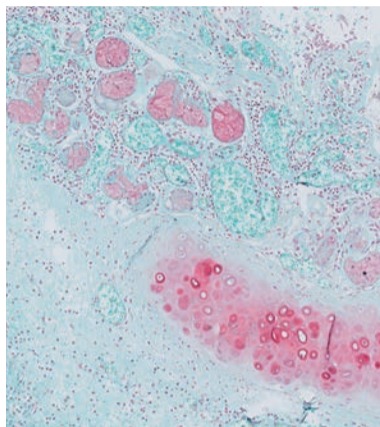
Fully digitising pathology operations has led to greater efficiency, cost savings, and quicker diagnosis for the Laboratory of Pathology East Netherlands (LabPON). The move, made six years ago, is showing measurable benefits and now, the institution is beginning to explore the potential of deep learning computational pathology algorithms, which might push the efficiency gains even further.

Report: Mark Nicholls

Details were outlined to the 8th Digital Pathology and AI Congress in London by Alexi Baidoshvili, Professor of Pathology, who specialises in digital and computational pathology at LabPON. He reported that LabPON had completely digitised its diagnostic routines for clinical cases in July 2015 and has continued to evolve the technology and processes ever since. Additional milestones were the development and introduction of AI software for image analysis in 2018 and a new Image Management System (IMS) in 2021, with further AI development and integration planned for 2022.

In his presentation, the expert discussed the investments neces-

sary to introduce digital pathology. Areas to be considered include flow analysis in the laboratory, storage, scanners, the need for a robust IMS, training of staff, consultation workflows, software and enabling remote working. On average, setting up a laboratory for digital pathology requires at least 1.5 million euros per year, he calculated, with AI systems not included. However, investments might be a bit lower for institutions which already have a robust IT infrastructure in place. 'It is very important to choose the right IMS,' he added, pointing out desirable features such as open architecture, integration with commonly used scanner types, robustness, scalability, support for external consultation and – not least – a user-friendly interface.



Lung tissue with Pas-D staining

Safer, happier, more productive

Despite these initial hurdles, Prof Baidoshvili found the benefits from going digital to be well worth the effort for LabPON, which handles 55,000 histology, 20,000 cytology, 10,000 molecular and 12,000 immunohistochemistry cases per year: 'What we have achieved from our investments is high efficiency and quality improvement,' he said. Working with glass slides is a thing of the past, reducing the burden on logistics, streamlining workflows, and opening new possibilities for external consultations.

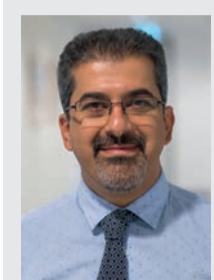
Pathologists' workplaces also saw subsequent improvement, for example in enhanced safety, better service, and more flexibility, continued Baidoshvili. 'In the future, there will be a move from subjective diagnosis to objective with AI applications.' He emphasised how streamlined workflows were important in creating a 'happier workplace', leading to quicker replies to inquiries, faster

and more efficient internal consultations and better support for multidisciplinary teams (MDTs). Digitisation also facilitated remote consultations, improved access to information and images, and better means to organise education and research.

Data from LabPON backs up these perceived improvements: for example, an experienced digital pathologist can diagnose faster via digital methods than with the conventional microscope. Time savings are significant, reported Baidoshvili, reducing the workload of pathologists and releasing time to perform other tasks, such as participation in multidisciplinary meetings. The expert noted that all staff segments benefit from this; lab personnel, technicians, and pathologists. Additionally, the switch from subjective to objective diagnosis led to savings on immunohistochemistry, improved service delivery to the clinic and patient, and yielded financial advantages. 'The digital transition saves on archive time and the work of secretaries and of technicians,' he added.

Current and future AI benefits

After transition to digital diagnosis, and the seamless integration of interoperable AI, Baidoshvili noted an 'impressive' accuracy of the system, for example in cancer detection and Gleason grading of cases. Referencing the lab's experience with prostate AI solutions Concentriq from Proscia and Galen from Ibex, he praised their seamless and intuitive workflows, with initial results showing the potential



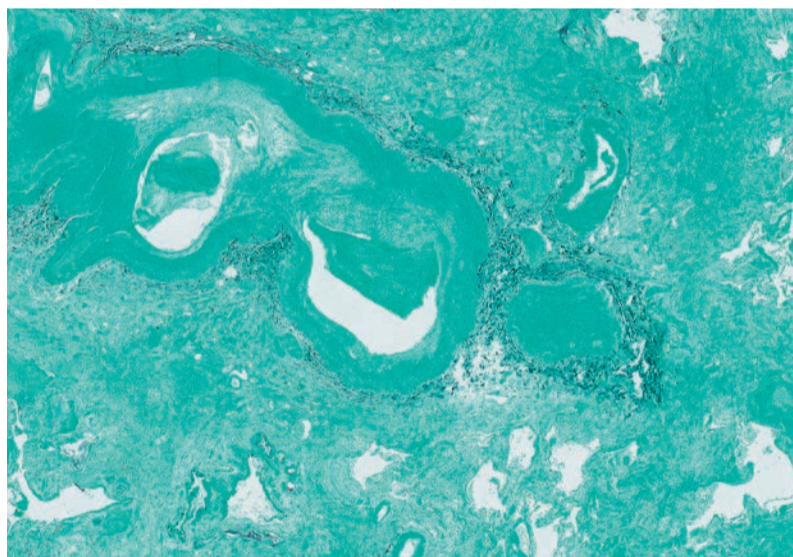
Alexi Baidoshvili

Alexi Baidoshvili is a Professor of Pathology at DT Medical University, Georgia. He specialises in digital and computational pathology at the Laboratory of Pathology East Netherlands (LabPON), an institution with 120 employees, 18 pathologists and 90 lab technicians. Furthermore, Prof Baidoshvili is an active board member of several international organisations and organiser of conferences. At LabPON, he and his team are working on the development of various image recognition programs.

to reduce immunohistochemistry costs, subject to further validation.

The expert also pointed out the potential of automatic report generation with AI assistance. 'Thanks to AI, we can save 1:18 minutes of diagnostic time in every colon diagnosis.' Applying this to the 500+ cases LabPON processed in 2020, Baidoshvili calculated more than 11 hours of saved diagnosis time for pathologists.

Overall, the switch to digitisation had widespread benefits with much improved logistics, handy tools in IMS resulting in high efficiency, flexible and remote working, easy access to computer archives, better and more efficient diagnostic quality and improved diagnostic logistics, leading to a happier pathology workforce.



Lung tissue with special Grocott staining

NPIC network

Pathology in North England goes digital

Reaching out across 15 hospitals and a population of six million people, a network established by the National Pathology Imaging Co-operative (NPIC) is an ambitious move to advance digital pathology in the north of England.

The project, led by the Leeds Teaching Hospitals, will see digital pathology services operate across a network of over 20 NHS trusts and 238 pathologists, scanning over 2.4 million images and generating 3 Petabytes of image data per year. In addition, 48 scanners will feed into a single, scalable, vendor neutral archive (VNA) with DICOM compatibility. Progress on the network was outlined by NPIC operations director, Dr Daljeet Bansal, at the 8th Digital Pathology and AI congress in London.

The aspiration of NPIC is to create a globally leading infrastructure

for digital pathology and AI. The groundwork for this has been laid as far back as September 2018, with the complete switch to digitisation of slides at the Leeds Teaching Hospitals, and the introduction of next generation scanners in 2021. Dr Bansal explained that NPIC's aims are to drive clinical use of digital pathology, create an environment for development and evaluation of AI and support further research and innovation. The project – which involves additional academic and industry partners working with clinicians – includes processing scanners, reporting, storage, data access and research elements and comes with £50 million of investment to fully deploy digital pathology.

Focus on image analysis automation

The network connects the regions of West Yorkshire, Harrogate, York, Hull, and North East England, ena-

bling shared knowledge and procedures as well as research partnerships. Areas of focus are the development and validation of automated image analysis and AI tools for the diagnosis of cancer with existing exemplars in breast cancer, skin, and lung cancer. 'Research partnerships in AI diagnostics and clinical trials will be of benefit for patients and the public,' added Dr Bansal. The scale-up of the NPIC network will also include two national specialist networks; one in paediatric tumours, the other focusing on bone and soft tissue tumours. 'There will be a national knowledge and training centre, customised data sets for AI and research, and research partnerships in AI diagnostics and clinical trials,' the expert went on. 'Training will be a key component with hands-on workshops and training for pathologists and biomedical scientists, a centre for industry/NHS

collaboration, and a multiple scanner platform for research and AI.'

In cooperation with Genomics England, a company of the UK Department of Health and Social Care, NPIC will also create an image library to complement the genomic and clinical data for each patient and develop pathology-genomic correlation. Dr Bansal stressed the importance of the network as the first and largest-scale project in terms of digitisation, calling the project a 'key element of a national digital pathology vision in the UK'. She concluded: 'It will be a platform for many applications: clinical diagnosis, digital pathology and life cycle of AI to establish ourselves as the national digital pathology system platform for use in the NHS and AI research, supporting clinical trials and diagnostic innovation.' (MN)



Daljeet Bansal

Dr Daljeet Bansal is Operations Director of NPIC (National Pathology Imaging Co-operative), overseeing the scale-up of digital pathology across hospitals across the North of England and two national networks. NPIC is a unique collaboration between NHS, Academic and Industry partners, in a network that will also develop artificial intelligence tools to help diagnose cancer and other diseases.



Introducing ATEM Mini Pro

The compact television studio that lets you create presentation videos and live streams!

Blackmagic Design is a leader in video for the medical industry, and now you can create your own streaming videos with ATEM Mini. Simply connect up to 4 HDMI cameras, computers or even technical equipment. Then push the buttons on the panel to switch video sources just like a professional broadcaster! You can even add titles, picture in picture overlays and mix audio! Then live stream to Zoom, Skype or YouTube!

Create Training and Educational Videos

ATEM Mini's includes everything you need. All the buttons are positioned on the front panel so it's very easy to learn. There are 4 HDMI video inputs for connecting cameras and computers, plus a USB output that looks like a webcam so you can connect to Zoom or Skype. ATEM Software Control for Mac and PC is also included, which allows access to more advanced "broadcast" features!

Use Professional Video Effects

ATEM Mini is really a professional broadcast switcher used by television stations. This means it has professional effects such as a DVE for picture in picture effects commonly used for commentating over a computer slide show. There are titles for presenter names, wipe effects for transitioning between sources and a green screen keyer for replacing backgrounds with graphics!

Live Stream Training and Conferences

The ATEM Mini Pro model has a built in hardware streaming engine for live streaming via its ethernet connection. This means you can live stream to YouTube, Facebook and Twitch in much better quality and with perfectly smooth motion. You can even connect a hard disk or flash storage to the USB connection and record your stream for upload later!

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With so many cameras, computers and effects, things can get busy fast! The ATEM Mini Pro model features a "multiview" that lets you see all cameras, titles and program, plus streaming and recording status all on a single TV or monitor. There are even tally indicators to show when a camera is on air! Only ATEM Mini is a true professional television studio in a small compact design!

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The rocky (but worthwhile) road to digital pathology

Close liaison between pathologists and data scientists is pivotal in the successful introduction of digital pathology and artificial intelligence (AI) into clinical workflows, according to one of France's leading pioneers in the field.

Professor Catherine Guettier outlined the advantages of digital pathology to the 8th Digital Pathology and AI Congress in London at the beginning of December, but also highlighted obstacles and difficulties, particularly when coupling AI projects with the transition process. She discussed the experiences of creating a single department of digital pathology for three hospitals in the Saclay University hospital group in Paris – a transition in which it was important to acknowledge the demands placed on data scientists.

For many pathologists, the transition towards digital pathology and AI is marked with mixed feelings, Guettier observed. The Professor of Pathology at Paris-Saclay University and Head of the Department of Pathology at the Hôpitaux Universitaires Paris-Sud illustrated the challenges of this process by example of her department in her presentation 'Artificial Intelligence and the pathologist'. Main topics of the session were the work with data scientists, and the new role of digital slides in healthcare data. 'Pathologists' expectations include screening of lesion patterns in frequent samples, quantification of tumour cells, mitosis count, automated scoring of cancers, quantification of cellular biomarkers and also beyond the usual task of the pathologist, prognosis, therapeutic

or molecular prediction.' Guettier also pointed out the difficulties data scientists face, such as the large dimension of digital slides; difficulties to obtain large enough, balanced and annotated sets; pre-analytic variability; and the issue of interpretability.

The meeting of two worlds

Looking at the practicalities of creating a single department of pathology for the Saclay University hospital group, the expert explained how AI projects have been integrated into the transformation process. 'I am convinced most pathologists will be using AI in their practice,' she said. 'But this is the meeting of the two worlds: of the pathologist and the data scientist.'

The new digital pathology network covers three hospitals in Paris,

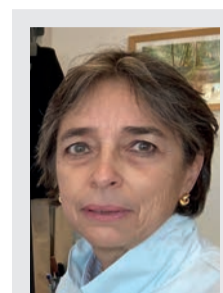
with a shift in focus from teaching to full digital pathology in the workflow. In this constellation, AI has become an important component from the outset. Implementation of the new technology has opened new automation possibilities, for example in quantification of epidermal nerve fibres; screening of prostate and breast cancer foci; and screening of colonic polyps.

Some of the difficulties and obstacles in implementing AI arise from the fact that, currently, very few pathology departments in France are digital. Issues range from lack of compatibility in digital slide sharing between hospitals, different AI companies or academic structures, to regulation issues, medical time for annotation, and GDPR constraints. Prof Guettier said: 'Digital pathology requires the participation of the pathologist – and many pathologists are already participating – but challenges remain in implementation of AI algorithms into routine workflow.'

High investment, high benefits

As the impact of AI in pathology is not yet clear, implementation of the technology is still lacking a viable business model. This means that managers and pathologists need to work closely to find a financially acceptable solution for hospitals, the expert explained.

This aspect should not be underestimated, Guettier pointed out, because the inclusion of AI comes with the need for considerable investments: Solutions to tackle 30,000 cases per year are priced around the million-euro-mark, with an additional 100,000 euros for maintenance, software upgrades and an imaging engineer. However,

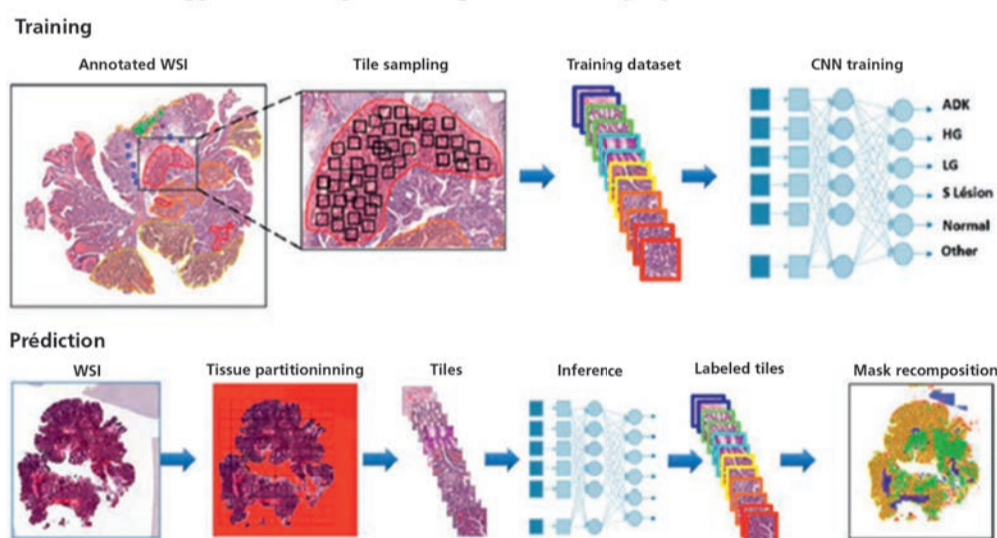


Catherine Guettier

Catherine Guettier is Professor of Pathology at Paris-Saclay University and is also Head of the Department of Pathology Hôpitaux Universitaires Paris-Saclay - Assistance publique – Hôpitaux de Paris (AP-HP). A pioneer of digital pathology in France, her expertise is in liver pathology and her department and team collaborates with several companies and academic structures for the development of AI-based algorithms in pathology.

these expenses must be carefully weighed against the expected benefits of AI in pathology, especially time savings and improved diagnostic quality. 'These benefits include sparing technician time for distribution of glass slides, cost savings on microscopes and glass slide storage, earlier and faster second opinion request, and productivity improvement through organisation of pathology labs and telework,' the expert said. 'The role of the pathologist in this is to guide the choice of algorithms to be deployed, to provide annotated digital slides, to clinically validate algorithms, to test the implementation of AI algorithms in the digital workflow, and to be customers of AI companies,' she concluded. (MN)

Methodology: From image labeling to model deployment (TribunHealth)



Methodology: From image labeling to model deployment (Tribun Health)

Experience report from Portugal

Going digital: no reason to delay

The future of pathology is digital – for many departments, the transformation requires major modifications but promises significant advantages. Speaking to the 8th Digital Pathology and AI Congress in London, Professor Catarina Eloy outlined the vital elements for successful transformation towards full digital pathology implementation.

Report: Mark Nicholls

For her presentation, the expert shared insights from the successful and effective introduction of digital pathology at her own institution; the Institute of Molecular Pathology and Immunology of the University of Porto (IPATIMUP) in Portugal. The efforts, though considerable, had led to a 'new standard for primary histological diagnosis' and 'a relevant improvement in healthcare,' she emphasised.

Highlighting the importance of adopting a new approach, with a

focus on workstations and workflow within the implementation process, Prof Eloy said: 'Digital transformation for primary diagnosis has to be a holistic concept that complements innovative interventions in all areas of the pathology laboratory.' To create optimal pre-analytic conditions of the sample, optimisation, and automation of the lab workflow with strict quality control and validation policies and operations centres on the LIS (Laboratory Information System) are critical, she elaborated.

Getting started

Digital pathology, while being a cost-effective model with significant, direct, and parallel achievements, must be backed by a safe and efficient methodology, Professor Eloy stated, referencing the initial stages of the four-year digital transformation process at IPATIMUP in 2016. First steps involved optimisation of scanners, workstations, and workflows as well as re-design of the lab

layout with an assessment area. 'All areas converge to the scanning area which is located in the heart of the lab,' she said. 'That required some extensive reorganisation of space. The tracking system was probably the most relevant measure we adopted through these first years to have a good digital pathology workflow.'

Once fully digital and paper-free, the laboratory retained the same turnaround times with everything standardised to ensure no errors or lost specimens, Prof Eloy reported. A key ingredient for the successful digitisation of the department was the involvement of the whole team, particularly in the training of technicians and pathologists, along with improvements and automation of the pathologist and technician workstations in terms of equipment, environment, ergonomics, space and workload management. The team at IPATIMUP consists of 14 pathologists (with six not using digital pathology), 11 technicians

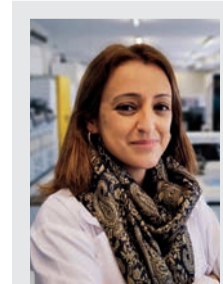
and five administrative staff, working on 38,000 samples a year with a turnaround time of two days and no fall in quality of diagnosis, the expert said.

The road to AI implementation

The next big step for the department is the implementation of artificial intelligence (AI) to assist in routine workflow challenges. Professor Eloy detailed the roadmap of the process, showcasing a paper from her department. Its mission statement reads as follows: 'The model of digital workflow implementation at IPATIMUP demonstrates that careful planning and adoption of simple measures related to time, spaces, and sample management can be adopted by any pathology laboratory to achieve higher quality and easy digital transformation.'

In summary, Professor Eloy told the congress: 'After understanding how simple it may be to increase efficiency, quality, and safety in the laboratory workflow, there is not a

single reason that justifies delaying in the adoption of the digital management of the pathology laboratory, since it represents a relevant improvement in healthcare.'



Catarina Eloy

Professor Catarina Eloy is Head of the Pathology Department and a researcher at IPATIMUP, Porto, Portugal, and Professor at the Faculty of Medicine of Porto University. She is also President of the European Society of Digital and Integrative Pathology and Vice-President of the Portuguese Society of Anatomic Pathology.

ECR 2022

SPECIAL ISSUE FOR THE EUROPEAN CONGRESS OF RADIOLOGY

ONLINE EVENT • MARCH 2-6 2022

VIENNA • AUSTRIA • JULY 13-17 2022

ECR 2022 is building bridges

This year's European Congress of Radiology (ECR 2022) consists of two parts: an online warm-up event on March 2-6 and the actual onsite congress in July. Multidisciplinary and interactivity are cornerstones of both events.

"Building Bridges" will be the theme of this year's ECR. "This represents my vision for the future of radiology", Professor Regina Beets-Tan, president of the congress, explains to Michael Krassnitzer and adds that "In this future, radiologists will embrace a new role, one where we will work more closely with our clinical and diagnostic partners, with scientists and industry in order to deliver the best outcome for the patients." The ECR is supposed to be not only a congress from and for radiologists, but a convention where radiologists can learn from other disciplines. Professor Beets-Tan has

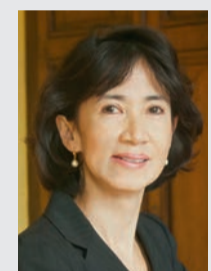
invited over 100 speakers from various disciplines. "I believe if we team up, we can improve our performance and ultimately increase the outcome for the patients", she emphasises.

Multidisciplinary, however, is only one cornerstone of the upcoming ECR 2022. Another priority is interactivity. The number of parallel tracks was reduced and the lectures were shortened to give room for discussions. "Quality above quantity," Professor Beets-Tan summarises. There will be sessions with speakers from several disciplines discussing cases just like in daily practice. "Instead of sitting in a classroom and listening to the teachers, the participants will interact with the speakers," the president explains. Onsite, there will also be low-threshold "open forums" outside the rooms where the audience can listen to speakers

and engage in lively discussions. At ECR 2022, a lot of other new features will be tried out, for example the industry partners will get more space in the congress centre itself in addition to the exhibition hall. "ECR is continuously adapting to the changing world. It is certain that after Covid-19 ECR will not be the same as before; it will be a congress of the modern times, yet not less exciting," Professor Beets-Tan is convinced.

The most obvious change of the annual congress are the two sepa-

rate events: the ECR 2022 on July 13-17 in Vienna and the so-called ECR 2022 Overture online on March 2-6, at ECR's usual pre-Covid-19 date. The warm-up event in March will feature a series of trailer sessions offering a glimpse of some of the major highlights to be held at ECR 2022. In addition, there will be a scientific and educational programme, round table sessions streamed live from a studio with presentations by radiology leaders and industry partners as well a studio dedicated to interventional edu-



Regina Beets-Tan

Professor Regina Beets-Tan is President of the European Society of Radiology (ESR) and Chair Department of Radiology at the Netherlands Cancer Institute, Amsterdam.

The ECR is the annual meeting of the European Society of Radiology (ESR), the European Federation of Radiographer Societies (EFRS) and the European Society for Hybrid, Molecular and Translational Imaging (ESHMIT). The ECR is one of the largest medical congresses in the world, attracting more than 28,000 participants. With 300 companies showcasing their products across more than 25,000 m², ECR hosts one of the largest medical exhibitions in Europe.

cation and technology. The actual ECR 2022 in Vienna in July will heed the calls for a return to the congress format with opportunities for a more personal exchange of knowledge as Professor Beets-Tan says: "Nothing compares to an onsite experience." (MK)

Cancer imaging

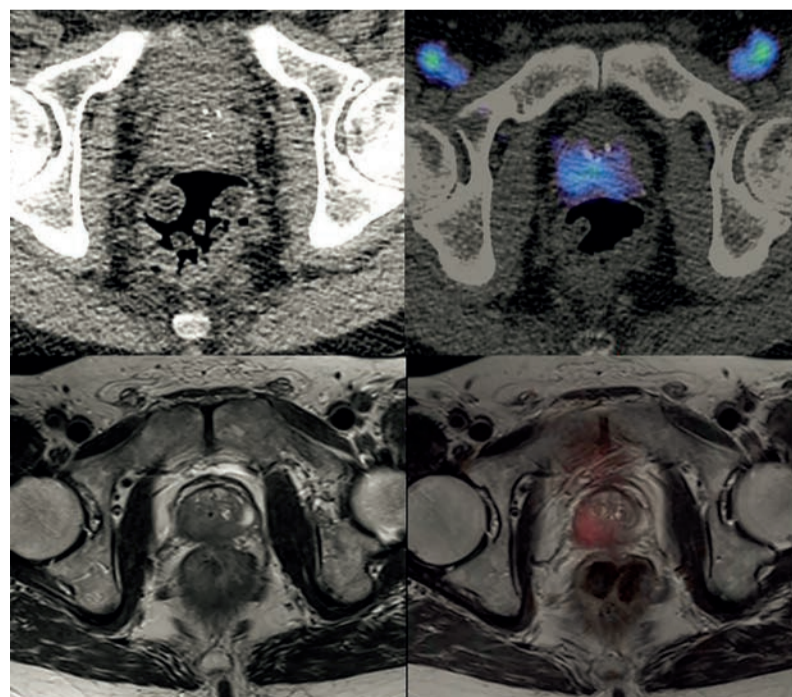
PET/MRI offers significant benefits for cancer patients

PET/MRI is offering new imaging opportunities for cancer patients at various points along the care pathway with its ability to assess different biological processes and its increased specificity.

Report: Mark Nicholls

The growing clinical role of the hybrid modality was discussed by Professor Vicky Goh during the Sir Godfrey Hounsfield lecture at the British Institute of Radiology virtual annual conference in November. In her presentation, Professor Goh highlighted the benefits of the combination, but also acknowledged significant challenges.

Professor Goh outlined how early evidence has established that PET/MRI using the radiotracer 18F-fluoro-deoxy-glucose (FDG) is non-inferior to PET/CT. "Over the last two decades there have been significant strides toward personalised cancer care to improve cancer



Gallium 68-PSMA PET/CT (top row) and PET/MRI (bottom row) images showing the higher contrast and anatomical information that is provided by MRI compared to CT.

outcome," she said. "But in order to ensure that patients receive the best treatment at the right time, imaging has had to evolve to meet these needs. The introduction of clinical PET/MRI in 2010 has been another step change in terms of imaging capabilities for personalised cancer care."

More than the sum of its parts

The imaging expert pointed out the key advantages of integrated PET/MRI systems: the high sensitivity and the ability to provide molecular information from PET; combined with the high contrast-to-noise-ratio and spatial anatomical resolution that MR imaging offers. These strengths, she added, make PET/MRI a comprehensive and powerful tool for tumour phenotyping. "Furthermore, with PET/MRI, physiological imaging such as vascularisation, oxygenation or diffusion can be easily integrated with anatomical sequences."



Vicky Goh

Professor Vicky Goh is Head of Department of Cancer Imaging at the School of Biomedical Engineering and Imaging Sciences of King's College London, and Honorary Consultant Radiologist at Guy's and St Thomas' Hospital. Her translational research focuses on functional and advanced imaging in gastrointestinal, genito-urinary, haematological and lung cancers. She is currently chairing the Academic Committee at the Royal College of Radiologists.

Continued on page 8

NewTom 7G

Multi-Scan Body CBCT: the next level of 3D X-ray imaging

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picture. Compared to conventional procedures, the system optimises analysis of treatment outcomes (by using low X-ray doses, always in proportion to build) and lowers costs. Automatism optimise workflows and avoid the variability and uncertainty inherent in manual examination control, especially during patient positioning and actual exposure.

From in-depth detail to the big picture

With the arrival of 7G, NewTom Cone Beam technology examinations can be carried out on all areas of the body, including the spine, shoulder, and hip. System functions and automatism adapt FOVs and X-ray doses to the patient's build (especially those of paediatric age). From a minimum of 4x4 cm to a maximum diameter of 29 cm, and a length that can be extended up to 62 cm, adaptive

FOVs let users examine the area of interest or a portion of it. A resolution of up to 90 µm means small complex structures such as the inner ear can be analysed with precision.

Select the most suitable FOVs, also for large anatomical areas

NewTom 7G system automatism allow for acquisition of an extended FOV on the horizontal plane. Developed to acquire bilateral hip images, the NewTom 7G can capture a 40x17cm FOV. The horizontally extended FOV allows comparative assessment of hip bones via reconstruction into a single volume. The acquisition will therefore show a single volume on which users can modify the display plane

to better adapt to clinical needs. NewTom 7G allows the acquisition of extended FOVs on the vertical (longitudinal) plane too. The length of the extended FOVs on this plane can be modulated: users can therefore select FOVs with lengths from 22 cm up to 62 cm.

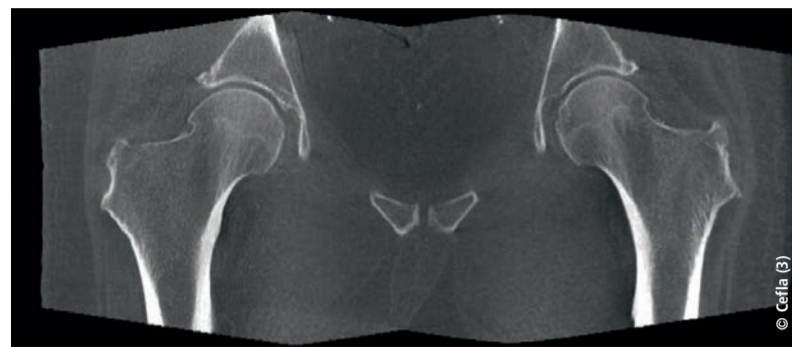
Extended FOVs allow better morphological assessment of long bones and extensive bone structures (e.g. spine).

Wide gantry and motor-driven patient table

In addition to a 77 cm gantry, the 7G can accommodate very heavy patients thanks to a bed with a load-bearing capacity of up to 215 kg. Lying-down patient positioning ensures simple, accurate alignment of the FOVs and makes results more certain by weighting X-ray exposure.

Broader diagnostic range

The NewTom 7G can perform numerous types of investigation, including those with intra-articular contrast agents (e.g. arthrograms with Cine-Scout positioning). A broad series of exams with



Bilateral hip

dedicated protocols is available for all disciplines:

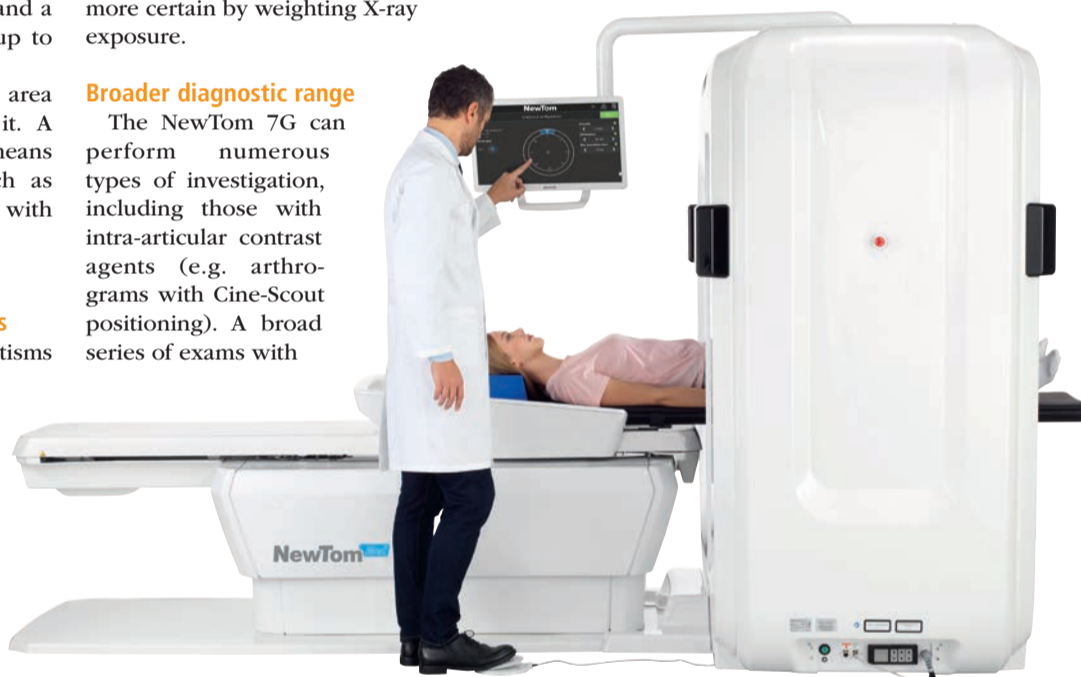
- Orthopaedics – osteo-articular study with multiplanar view

- Otorhinolaryngology – ear and airways volume analysis
- Dentistry, implant and orthognathic surgery – dental-maxillo-facial and bilateral TMJ analysis-For further information:

www.newtom.it/en/medicale/



Intramedullary PIN knee



NewTom7G

PET/MRI offers significant patient benefits

Continued from page 7

Benefits in staging and restaging

Professor Goh emphasised the clear benefits of lower radiation dose by replacing CT with MRI, particularly in paediatric or young

adult populations, where reductions of 50–80% can be achieved. MRI can also outperform CT in localising the PET signal, and the integration of PET and MRI results in

increased specificity and improved quantitation. Due to these benefits, PET/MRI has become increasingly established across the clinical pathway in oncology in terms of detection, characterisation, stage and risk stratification, therapy planning and therapy assessment over the last decade. In particular, the use of PET/MRI in detection and characterisation for prostate cancer has been a success story, the expert reported.

The hybrid modality has also proven its worth in staging or restaging for several tumour types, including gynaecological cancers, resulting in greater accuracy and diagnostic confidence. This versatility has been certified in five studies, which assessed the performance of FDG for primary staging and found that PET/MRI enhances local regional staging and therapy planning. Professor Goh added: 'For suspected recurrence, PET/MRI has been shown to offer greater diagnostic accuracy and diagnostic confidence,

particularly for nodal disease.'

Further studies have highlighted the superiority of PET/MRI in detecting, localising and characterising bone and liver metastases. Additionally, the technique can improve patient selection for therapy, such as for neuroendocrine tumours. 'A number of studies have also shown the added value for PET/MRI in terms of sensitivity for disease and better characterisation of lesions,' said Professor Goh.

With respect to therapy assessment, she suggested PET/MRI may have a role in clinical trials, while its advantages also apply in some clinical scenarios, for example in the evaluation of myeloma patients undergoing induction chemotherapy and stem cell transplantation. The expert attested to the emerging clinical impact of PET/MRI, referencing two recent prospective studies with different tracers, which demonstrated higher accuracies as well as a change in management due to additional findings. Beyond oncology, PET/MRI

has also made its way into the clinical routines in neurology and cardiology, Professor Goh reported.

A more expensive option (that still pays off in the end)

While PET/MRI may be more expensive than PET/CT, the imaging expert believes that the benefits outweigh the increased costs: higher overall image quality may obviate the need for additional scans and lead to faster management decisions. Regarding the financial impact, treatment costs may even be reduced due to better patient selection for therapies.

Professor Goh concluded: 'With increasing personalisation of care, PET/MRI offers the opportunity to transform care delivery for patients and, in particular, to improve patient experience.'

More than just MRI accessories



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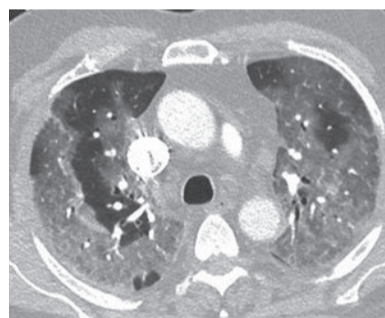


CT severity score predicts Covid-19 death risk

Radiologists at the Hôpital Européen Georges-Pompidou in Paris have developed a standardised simple visual lung damage CT severity score for Covid-19 patients who do not have symptoms of severe acute respiratory syndrome (SARS) at the time of initial treatment.

Report: Cynthia E. Keen

This visual score of lung alveolar opacity aids in decision-making to admit a patient into the hospital rather than treating them and sending them home to recover, and to admit inpatients to an intensive care unit (ICU) directly or upgrade them to ICU treatment.



Diffuse lung infection with a very poor prognosis

The severity score is based on the presence and extent of ground-glass opacities (GGO), consolidation opacities, or both, seen on the CT images of lung lobes. Each lung lobe extent is classified with a numeric score as mild, moderate, or severe, ranging from 0 (not present in any lung lobe) to 20 (> 75% in all five lung lobes). The number of lung lobes involved

per patient by GGO or consolidation opacities is also estimated as a first visual CT score to assess the extent of the damage.

A score of 7 or higher is the threshold indicating greater risk of death within 30 days from Covid-19, independent of other commonly accepted risk factors, including patient age, respiratory rate, oxygen saturation levels, comorbidities, and hs-troponin I level at admission. The score also helps predict discharge rates among inpatients.

The study to develop the severity score

Principal investigator Professor Elie Mousseaux, MD, PhD, and colleagues developed the score by assessing the initial chest CT exam of 210 consecutive patients hospitalised for at least 24 hours who were not directly admitted to an ICU between March 13 and April 8, 2020.

CT images of all patients were assessed by pairs of radiologists working independently who were blinded from all clinical data, biology, and initial chest CT analysis. In cases of differing assessments, a cardiothoracic imaging specialist would provide a consensus reading used for the final analysis of the relationship between the visual lung CT scores, 30-day mortality, and other outcomes.

The researchers analysed rates of all-cause mortality at 30 days according to the number of affected lung lobes by either GGO, consolidation, or both, and according to the visual lung damage CT score. All of the patients were initially admitted to Covid-19 wards, but 72 patients were transferred to an ICU

during their hospital stay. As of May 8, 2020, when follow-up ended, 147 had been discharged, 15 remained hospitalised, and 48 died.

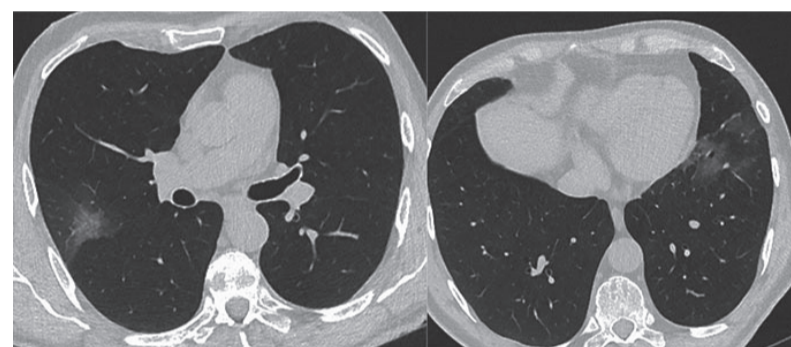
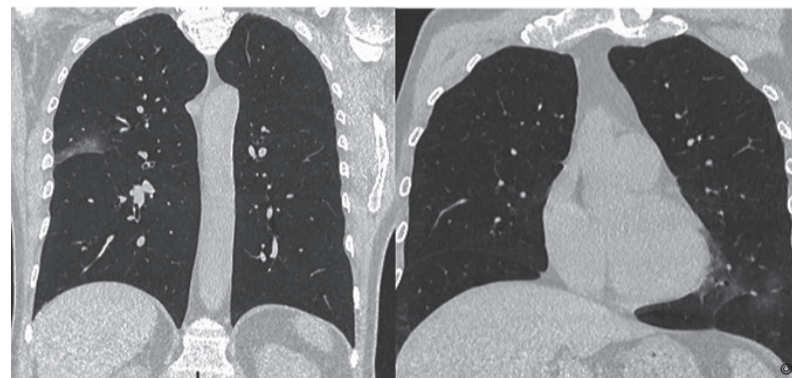
The total CT severity score combining GGO and consolidation was a mean of 6.3 in survivors and 9.5 in non-survivors. The 30-day mortality increased threefold if the visual lung damage CT score was 7 or greater. The more frequent and significant features in non-survivor patients were dyspnoea (shortness of breath), higher respiratory rate, and lower oxygen saturation.

The researchers reported that there also was a significant increase in creatinine levels, in cardiac biomarkers and in inflammation biomarkers in non-survivors compared to survivors. Additionally, the presence of pleural effusion and of peripheral distribution of lesions was more frequent in non-survivors.

Patients with a CT severity score of 7 or higher were also twice as likely to be transferred to an ICU during hospitalisation. Survivors with high scores also had longer hospital stays.

Scoring system aids hospital clinicians

'The scoring system has helped the hospital staff in their decision about admitting a patient whose Covid-19 symptoms might not be considered severe enough for an inpatient stay,' Mousseaux explained during our European Hospital interview. 'If a patient has a CT score greater than 7, we keep that patient in the hospital to be sure their clinical condition will not change during the next few days. In this situation, the CT is essential.'



CT detected lung lesions in Covid-19 infection: the form is limited to only 2 lobes

The researchers explained that 'to evaluate prognosis, the short-term mortality seems to us as a more objective criterion than a composite endpoint including mortality. Given the magnitude of the epidemic from one location to another, at near-peak the number of patients transferred to intensive care and conversely sent home were more complex to analyse because of the obvious lack of available space in many institutions, particularly regarding ICUs.'

'We have confirmed here that the proportion of patients discharged was lower and that transfers to the

ICUs were greater when the lung severity CT score on admission was 7 or greater,' they added.

Writing in *European Radiology*, the authors recommend that their score should be incorporated into risk stratification algorithms and in structured chest CT reports requiring a standardised reading by radiologists. Mousseaux also advises that the severity score also accurately predicts Covid-19-related deaths six months following initial treatment.

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Subscription rate
4 issues: 32 Euro, Single copy: 8 Euro.

Printed by: mgo360 GmbH & Co. KG,
Bamberg, Germany

Publication frequency: quarterly

Representatives

China & Hongkong: Gavin Hua, Sun
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Mediengruppe Oberfranken –
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Experts discuss gender issues

Women in interventional radiology take center stage

Gender-specific benefits of women should have a greater impact in interventional radiology (IR). But also, the field should see more women practicing the craft.

These were among the main take-home messages of the annual meeting of the French Society of Radiology (JFR). Speakers focused on the benefits brought by IR to women's health and the global shortage of women interventional radiologists.

Interventional radiology offers significant benefits in the treatment of infertility, post-partum issues and symptomatic uterine fibroids, reported Professor Maureen Kohi, chair of the radiology department at the University of North Carolina in Chapel Hill, USA.

According to recent figures, infertility is a global problem that affects 15% of couples trying to conceive. Roughly a third of cases are caused by diseases concerning the fallopian tube. IR can help many of these couples procreate, Kohi explained: '10 to 25% of tubal disease are due to proximal tubal inclusion,' she said. 'Fallopian tube recanalisation is an effective treatment that can be provided in a minimally invasive fashion to address this problem.' Recanalisation is less aggressive than surgery and may help women avoid potential emotional turmoil caused by other options like in vitro fertilisation, adoption, or surrogacy, Kohi noted.

Saving a woman's life

Another important issue is the high number of women who die while giving birth, often caused by post-partum haemorrhage. Here, uterine artery embolisation (UAE) has proven an effective treatment option. 'When you see a pseudoaneurysm or some sort of uterine artery anomaly, going ahead and performing a uterine angiography and embolisation can be an amazing way of saving a woman's uterus and her potential for getting pregnant in the future,' the expert said. Success rate with UAE in post-partum bleeding is well above the 90% threshold, Kohi reported, with delayed treatment being the most common cause for failure. 'The key is having better communication with the obstetrics haemorrhage team and tell the obstetricians to call as soon as possible to improve patient prog-

nosis.' Morbidly adherent placenta, another abnormal condition after birth, has increased over the last decade. Patients quickly lose a lot of blood, with 40% requiring more than ten units of packed blood cells – a quantity that many hospitals are not able to provide. Different solutions exist to manage the condition, but most recommendations point to a caesarean, followed by hysterectomy. Catheterisation helps reduce blood loss during those complex interventions, Kohi explained. 'We can place occlusion balloon catheters before or after delivery to minimise blood loss during hysterectomy,' she said. However, the procedure exposes the foetus to radiation and is subject to controversial discussion. Kohi performed a registry study to assess the outcomes of balloon occlusion. She found the procedure was associated with decreased estimated blood loss (EBL), transfusions, ICU admissions and adverse events compared to internal artery ligation or no adjunctive interventions.

Bilateral uterine embolisation can also be performed after caesarean delivery and before hysterectomy whenever a hybrid OR is available. Embolisation is also highly recommended in the treatment of symptomatic uterine fibroids, the most common reason for hysterectomy in the US. 'It's a great treatment and it's been tested with excellent level of evidence and over time,' she concluded.

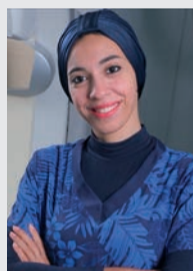
Underrepresentation of women

Tackling another aspect, Rana Tarek Khafagy, an IR consultant at Ain Shams University Hospital in Cairo, Egypt, highlighted the global shortage of female interventional radiologists. 'Although the prevalence of women in radiology has increased over the past few decades, there's still a remarkable lack of women interventional radiologists all over the world,' said Khafagy. She also described the situation in Egypt, where female physicians have traditionally been underrepresented, at a current 5.9% of IR consultants. 'Interest has been growing for the past few years,' said the



Maureen P. Kohi

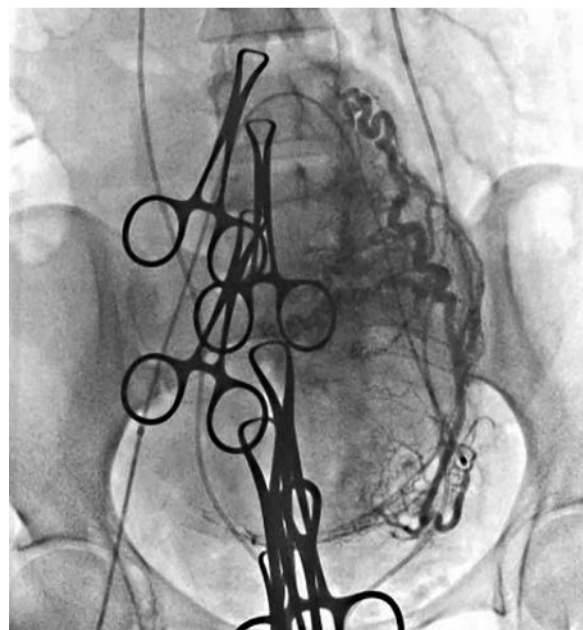
Dr. Maureen P. Kohi is professor of radiology and chair of the radiology department at the University of North Carolina in Chapel Hill, USA. Dr. Kohi is a well-known leader in Vascular and Interventional Radiology in clinical care, education, and research, as well as a nationally recognised women's health advocate. She has received many honours recognising her commitment and service to academic radiology and major areas of advocacy in medicine.



Rana Tarek M. Khafagy

Dr. Rana Tarek M. Khafagy is an interventional radiology consultant at Ain Shams University Hospitals, Cairo, Egypt. She currently heads the Residents Fellows and Students (RFS) Committee of the Pan Arab Interventional Radiology Society (PAIRS). Dr. Khafagy is also an editorial board member of the Arab Journal of Interventional Radiology (AJIR) and the main author and co-author in several peer reviewed publications. Her main areas of interest include women's health, embolisation and oncological interventions.

expert. Radiation exposure and its potential consequences on pregnancy were identified among the main impediments to a career in IR, along with the nature of the profession and its associated stress, she said. 'We should now address those concerns and insist that interventional radiology can be practiced safely,' she concluded. (MR)



Left picture: uterine embolisation being performed on the left side following caesarean delivery of the foetus. Right picture: successful bilateral embolisation with no blood flow to the uterus. This results in minimal blood loss during the hysterectomy.



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Watch your back! Spinal imaging in

Spinal trauma imaging is considered one of the most challenging areas radiologists face as they seek to assess the extent of injuries to patients under high pressure. The issue was tackled in detail at the British Institute of Radiology virtual congress by Professor Elizabeth Dick.

Report: Mark Nicholls

The spinal imaging specialist focused on different approaches and protocols for a range of levels of spinal injury and discussed how best to assess and image them, which modalities to use, and the key factors to consider.

In her presentation "Watch your back! – an approach to spinal imaging in trauma," Professor Dick explored imaging of thoracolumbar and cervical spine injuries. One of the major challenges, she said, was assessment of the spine's stability, a crucial prerequisite for safe removal of the cervical collar. Misjudging stability can result in severe consequences, such as progression of skeletal deformation or neurological

deficits. Generally, spinal imaging should be performed on patients who have undergone a relatively high-energy mechanism of injury, Professor Dick said. 'But there is also a need to be cautious if there is another injury or altered level of consciousness. It is important to get the patient to CT as quickly as possible, ideally within half an hour of arriving in the emergency department.' She stressed the importance of this timeframe since delays often result in a higher risk of neurological injury.

Number of affected columns as a predictor of stability

To determine spinal stability in thoracolumbar injuries, several classification systems may be applied.

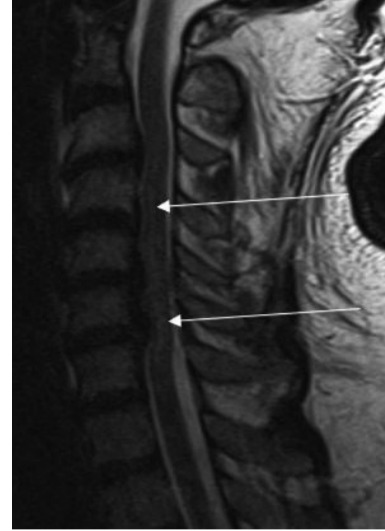
For many clinicians, the Denis system is the preferred option, based on its division of the vertebral body into anterior, middle, and posterior columns. 'Put simply, if two columns are injured, it is quite likely the patient has an unstable spine,' Professor Dick said.

Another aspect that has gained relevance in recent years is the posterior ligamentous complex. Consisting of the posterior bony ring and adjacent soft tissues, the structure acts like a tension band which holds the whole spine together, the expert explained. For this reason, injury to the ligamentous complex is associated with a high risk of spinal instability.

The four thoracolumbar spinal injury patterns are:

1. compression fracture
2. burst fracture, which may be a 2 or 3 column injury, with or without retropulsion and neurological damage
3. flexion-distraction or Chance injury, an unstable three-column injury which may have an associated abdominal injury, and usually needs intervention
4. fracture dislocation, such as from someone falling from height, with unstable spine and a high likelihood of neurological deficit

Professor Dick added: 'Burst fractures can be stable or unstable. If a patient has a neurological deficit, that would indicate the need for surgery. The radiologist can help



Central Cord syndrome

by identifying various signs on CT, such as severe loss of height of the vertebral body, retropulsion, kyphosis and rotational malalignment.'

The 'golden rules' of spinal MRI

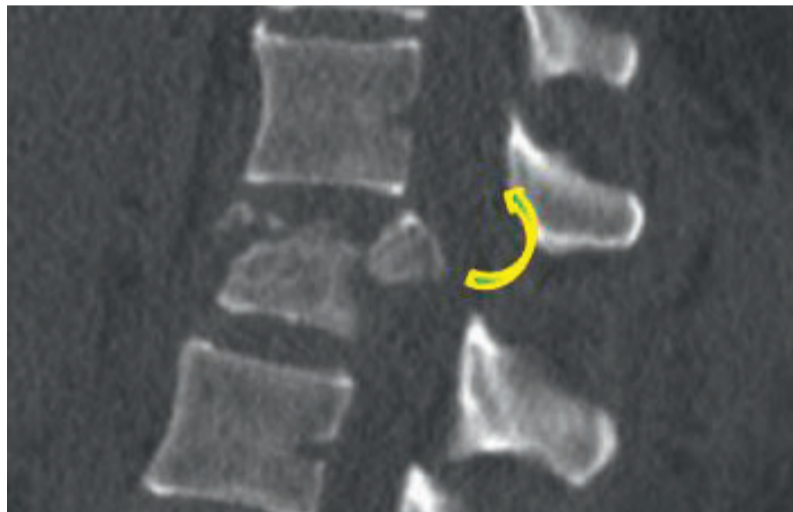
For MR imaging, the expert also gave two "golden rules": the importance of a T2 fat saturated imaging sequence, and imaging of the whole spine; 'because if someone has one spinal fracture, they are likely to have a second one as well, so it is important to make sure all of the injuries are detected,' she stressed. These rules are especially important since patients with severe injuries are difficult to get into the scanner in the first place, so any scan

should be performed properly the first time.

Professor Dick also outlined the TLICS (Thoracolumbar Injury Classification and Severity) score for determinants of injury covering fracture morphology, integrity of posterior ligamentous complex and the neurological status of the patient. 'It is useful to be aware of this as two out of the three components are based on radiology,' she added. Furthermore, she stressed the importance of early imaging for patients with thoracolumbar spine injuries, with CT being the primary modality, followed by MR whole spine imaging.

For children, different rules apply

For patients with cervical spine injuries, Professor Dick advised moving from the anterior to posterior during the examination. Additionally, routine CT in major trauma should be chosen over plain film, with imaging of the entire cervical spine in all planes being of great importance as well. 'In major trauma in general, a routine whole-body protocol should be performed to image the entire patient each time,' she said. 'That way, all the injuries will be included, and the image can be reviewed in a very structured and disciplined fashion, to maximise chances of picking up every injury.' She concluded that promptly and thoroughly executed whole-body CT has an important role in improving patient survival.



Burst fracture retropulsed fragment

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In the second year of the pandemic, JVCKenwood draws a positive conclusion despite all difficulties. 'We were able to welcome some highlights in 2021, both on the part of new monitors and new customers,' says Marcel Herrmann, Marketing Manager Medical Imaging. 'Nevertheless, the situation remains tense here and there.'

The two new displays CL-S600 and CL-S1200 have received consistently positive reactions from users. Both can display medical images of different modalities such as CT, CR/DR, MR, ultrasound and pathology side by side, the 12-megapixel monitor additionally displaying images of mammography. The two large screens without a centre bar create a comfortable environment for radiological diagnostics. For this purpose, they are equipped with the latest technology. 'The patented Dynamic Gamma function, for example, analyses the entire screen content and selects the correct gamma curve for each individual pixel in real time. This applies to all images – whether ultrasound, endoscopy, pathology or nuclear medicine – and always results in an optimal display,' explains Herrmann. This succeeds without problems even with moving images, although millions of opera-



CL-S600 monitor

tions per second are necessary here. Another important feature: luminance and colour temperature are adjusted automatically and in real time. 'The built-in colour front sensor on the screen constantly measures the colour temperature and adjusts changes over a long period of time,' says Herrmann. This is easy on the eyes of the person making the

findings – as is the built-in lighting on the back of the monitor and the indirect lighting of the keyboard and mouse.

JVCKenwood has installed the first CL-S1200s in a hospital in Switzerland. Spain also reports a large project: Here, the Japanese company has equipped all clinics in the Asturias region around Gijón

trauma

Stroke: The benefits of multimodality imaging



Elizabeth Dick

Professor **Elizabeth Dick** is a consultant radiologist and Professor of Practice at Imperial College NHS Healthcare Trust with expertise in body MRI, emergency, trauma, and musculoskeletal radiology. At Imperial College Healthcare she was Head of Trauma radiology and is Associate Director of Medical Education. She is past-President of the European Society of Emergency Radiology and of the British Society of Emergency Radiology. Her research interests include trauma imaging, medical education, and digital learning.

The use of CT angiograms may also be considered to identify injury of the vertebral artery early, so patients can be anticoagulated to decrease the risk of stroke.

However, the aforementioned guidelines only apply for adult patients, Professor Dick cautioned, as the rules on imaging the spine in children are very different: if possible, CT imaging should be avoided because of the long-term radiation risk and should only be considered if there is a strong suspicion of injury.

with more than 400 different displays.

Innovations for 2022

2022 will be marked by functional expansions of the i3 monitors. They will also be equipped with a turboluminance function as well as the so-called Visual Point Mode, which users of our 6 and 12 MP displays are already familiar with,' says Herrmann.

The turbo luminance function can increase the brightness and contrast of the screen for a maximum of 30 seconds to magnify recognisable greyscales. This enables the radiologist to reliably assess even the finest calcifications. The effect is further enhanced by the Visual Point mode. This increases the contrast in certain areas controlled by the mouse pointer. With both technologies, the DICOM characteristic curve is maintained or dynamically adjusted.

In addition, the launch of an 8-megapixel monitor is planned for the summer. 'However, due to the pandemic, we are still facing challenges that also affect the supply situation. Therefore, we unfortunately cannot exclude the possibility of delays. However, we will do everything we can to be ready in time. After all, the European Congress of Radiology ECR is planned as a presence event in July – with us as an exhibitor,' says Marcel Herrmann, looking forward to a relaxed summer.

When a patient suffers a stroke, speed in treatment can mean the difference between successful recovery, permanent disability, or death. Often encapsulated in the phrase 'time equals brain', the ability to act quickly and with greater certainty enables physicians to bring a higher quality of life for those who survive. For Christopher Hess, MD, PhD, success in stroke diagnosis and impactful treatment therefore is a question of workflow and efficient care delivery.

Report: Sascha Keutel

'Effective treatment of stroke depends critically on workflow and the overall strategy for how patients are evaluated and treated,' the Chairman of the Department of Radiology and Biomedical Imaging at the University of California, San Francisco (UCSF), said.

For Hess, new and emerging multimodality angiography suites that include MRI and cone-beam CT hold significant promise for stroke patients. 'We have a closely located MRI and angiography suite at Zuckerberg San Francisco General Hospital that we use to decide in real-time how to proceed with embolectomy. Our other imaging resources like effective hub-and-spoke imaging transfer tools, fast emergency department CT and cone-beam CT in the angiography suite are essential to rapidly make sure the patient doesn't have a hemorrhage before embolectomy proceeds,' he reported.

This technological advantage directly affects workflow at UCSF, because it can allow patients with large vessel occlusion to avoid going through the ER, the expert explained. 'Patients are transferred directly into the hands of our neurointerventionalists to start the procedure. This is important, because the clock is always ticking in stroke therapy.'

Time is also of the essence when thrombolysis is performed using tissue plasminogen activate (tPA) in patients with large-vessel occlusion. The tPA protein, which is used to dissolve the clot, must be given intravenously within a four-and-a-half hour window from the onset of symptoms to ensure treatment success.

Mobile Stroke Units

Deployment of Mobile Stroke Units (MSUs) is another approach to shorten stroke-to-embolectomy time. Equipped with compact CT scanners, point-of-care laboratories, and real-time bidirectional audio-video communications, these ambulances allow for initial diagnostics and even treatment while the patient is on the way to the hospital. Clinical staff onboard typically include a paramedic, CT technician, and physician plus a registered nurse trained in stroke medicine. Researchers at the Medical University of South Carolina recently tested an ultra-low field portable MRI machine that would not only cost a fraction of the CT scanner but would also bring the advantages of MRI scanning to the MSUs.

'Mobile Stroke Units offer significant promise. Studies show that they improve patients' outcomes by decreasing the time to treatment,' Hess said. 'However, with costs often exceeding \$1 million per unit,

MSUs are a very expensive resource to deploy and their overall effectiveness remains to be determined. It is critical that these resources are directed to actual stroke patients, and not in circumstances where other neurological disorders like seizures, headaches or drug overdoses cause stroke-like symptoms.'

Embolectomy is available at only a few centres, so the distinction between stroke and stroke-like syndromes impacts where the MSU should drive. 'We have to see how effective it is at triage, but I expect that for large vessel strokes, MRI in MSUs will be very effective and cost-efficient,' Hess said.

'Especially with late-onset strokes, the question often is how much tissue is still viable. The extent of whether an MRI scanner could answer that question prior to the arrival at the hospital would allow a more precise targeting of therapy,' he explained.

Outlook

Envisioning the future of stroke imaging, for Hess, it all boils down to workflow. 'The future lies with multimodality systems. At UCSF, we are very excited about our combined angiography-MRI units and using them to make real-time decisions about how to best treat patients,' Hess said. 'We need to



Christopher Hess

Christopher Hess, MD, PhD, is Alexander R. Margulis Professor and Chairman of the Department of Radiology and Biomedical Imaging at the University of California, San Francisco. Hess earned his medical degree at the University of Illinois College of Medicine. He obtained a master's and a doctorate in electrical engineering at the University of Illinois at Urbana-Champaign working in the field of MRI. His primary research interests lie in brain degeneration, epilepsy, and neurovascular disease.

push for more multimodality imaging.' Furthermore, he envisions new software will help the diagnosis and treatment of stroke. 'There will be advances in numerical quantification of a stroke's effect on the brain, some of which use MRI, and these will increase our ability to more effectively select patients who will benefit from treatment,' he predicted.

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Endoculus

Robotic 'mini-tank' to enhance

A miniature colonoscopy robot developed to collect images and biopsies could have clear benefits for both patients and endoscopists. The device, which carries a camera and uses other small surgical tools, uses tank-like treads to proceed along the patient's colon under the control of a gastroenterologist, instead of the current 'pushing' technique to propel the endoscope manually through the colon. This means advantages for the patient in terms of less friction and discomfort, as well as having ergonomic benefits for surgeons.

Report: Mark Nicholls

The device, called the Endoculus, has been designed by a team at the Advanced Medical Technologies Laboratory (AMTL) at the University of Colorado in the United States.

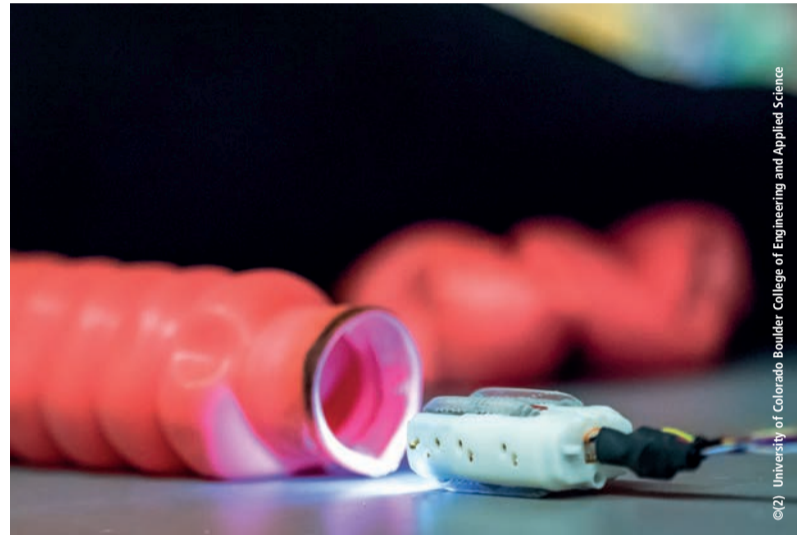
Professor Mark Rentschler, director of the AMTL, who leads the project, explained the current version of the device began in earnest in 2016 with PhD students Greg Formosa and Micah Prendergast advancing the mechanical and electronic

design. It has now reached the stage of adding more autonomous capabilities and features to further the understanding of its capabilities as the team look to transition the project into a commercial product that is affordable and tested clinically.

can focus on diagnostics and treatments, not just access.' With chronic shoulder and elbow problems being a well-known strain on endoscopists related to this heavy manual work over long periods of time in theatre, this is not just a matter of enhanced convenience.



The 'Endoculus' miniature robot



The robot with a model of an intestine

Reducing the strain on endoscopists and patients

The robot is the size of a small film cannister and can be used on patients without causing discomfort, but the team is looking to make it smaller still.

'The idea was originally to make a capsule device that can be tethered and can propel itself around to enable remote endoscopy,' explained Professor Rentschler. 'There are a few things tied to that: one is just capability and ease, but also a lot of the mental energy and effort from surgeons are focused on getting to where they need to go with the scope, rather than just focusing on visualisation. So, if you can have less of a manual approach, the upside for the physician is that they

Familiar, yet different

As a motorised colonoscope, the Endoculus has all the standard capabilities of an endoscope, with an onboard camera and lighting, channels for irrigation, inflation and suction, and a port for conventional tools. 'Our device needed to have visualisation and tool access, but we want the device to focus on mobility, traction, and manoeuvrability,' Rentschler added. 'Ultimately, we wanted to approach this as a remote device that the physician can control and get to where they want it to go.'

The group is looking at options to design portions of the device for single use, with motors off board and the power transfer through its tether. 'We are trying to add new capa-

bilities to the physician suite but not radically change their approach from an operational standpoint,' the robotic expert added.

From push to pull

The device offers benefits to surgeons and patients. 'The patient benefit is more comfort and less pain,' Rentschler said. 'With endoscopy, distension of the wall from endoscope pushing is where discomfort occurs for the patient. The key for us is to transition away from

Greater precision, reduced exposure to radiation

Robotic surgery procedures bring great benefits to cardiac interventional

Interventional cardiology is entering a new era with the wider introduction of robotic procedures which bring significant benefits to the medical team and the patient. The benefits for interventional cardiology were outlined to the ESC 2021 Digital Summit by consultant cardiologist Professor Dariusz Dudek, while cardiac surgeon Professor Nikolaos Bonaros discussed the advances in robotic cardiac surgery.

Relying on robotic assistance benefits precision and brings additional options for remote procedures. This, in turn, results in less direct contact with the patient, and reduced exposure to radiation for interventional cardiologists.

While interventional cardiology and percutaneous coronary interventions (PCI) had seen significant progress in recent years, Professor Dudek, from the Department of Clinical Cardiology and Cardiovascular Interventions at the University Hospital and the

Jagiellonian University in Krakow, Poland, expressed his confidence that robotic techniques would take these fields even further, ushering in a new era. Having adopted the technique for patients at his centre in March 2021, he outlined the benefits for the cardiologist, medical team, and the patient.

More precision, less fatigue

The robotic instruments are controlled via a cockpit console in the operating theatre, the cath lab or a separate control area. Only one assistant is needed close to

the patient to change devices and wires with headset communication between the two areas.

For aspects such as wire manipulation and balloon or stent delivery, robotics also allow for a degree of automation, Professor Dudek explained. 'The benefits we see is that there is almost no radiation exposure, and a dramatic reduction of operator fatigue due to not having to wear heavy aprons.'

There is also precise evaluation of coronary artery lesion length, which is much more precise than colleague assessment, and precise positioning



Dariusz Dudek at the robotic console



The robotic system in the cath lab

of stents, especially for ostial lesions and for long lesions with minimal overlap.'

Precision is also increased in comparison with the manual technique, the expert continued, particularly with guidewire navigation. 'With this technology, it is time to change the traditional cardiology era and make the next step,' he said. Professor Dudek envisions the 'cath lab of the 21st century,' as he put it, with a greater focus on image-based pre-procedural planning via CT, robotic-assistance, and the ability for remote procedures.

'We are going towards a new era that is a paradigm shift in interventional cardiology, with less radiation exposure, artificial intelligence and more precision.' Professor Bonaros

from Innsbruck Medical University, Austria, reflected on advances in robotic cardiac surgery, and developments in techniques, equipment, and instrumentation, over the last two decades. Available systems range from fully human-controlled procedures through partial automation with human back-up, to fully-automated smart vehicles capable of operating in any circumstances, he explained.

The expert showcased the benefits of automation with examples of cases, demonstrating the degrees of manipulation of the instrumentation, particularly with the flexibility of the endowrist technology, and levels of 3D visualisation. However, while robotic assistance brings benefits in cardiac surgery procedures

colonoscopy techniques

push endoscopy where the physician is pushing, to pull endoscopy, where device at the end of the tether is pulling it softly through the colon.'

With the surgeon, the reduced physical effort helps avoid common injuries associated with the task.

For populations with a tortuous, or strange, colon pattern, it can be challenging for physicians to reach the cecum at the beginning of the colon to get a full colonoscopy, so consistently getting a complete procedure is also a strong upside for the device, he said.

From testing to clinical practice

The device is a few years away from use in clinical practice but has been tested on animal tissue laid out in the form of human anatomy. The plan is to launch a company to establish the product, with a view to procedures in humans within

three years. 'We have focused long and hard on the clinical aspect, but we really need to make sure of the commercialisation aspects of it to keep it moving forward,' said Professor Rentschler.

The team believes the Endoculus could eventually replace traditional

endoscopes used in colonoscopies and endoscopies and lead to earlier detection of cancers enabling better outcomes. ■



Mark Rentschler

Mark Rentschler is Professor of Biomedical, Mechanics of Materials, Robotics and Systems Design and director of the Advanced Medical Technologies Laboratory (AMTL) at the University of Colorado in the United States. His research is focused on intelligent medical devices and surgical robotics for patient-specific medical care and includes design of novel surgical tools, devices, and robotics, and characterization and modelling of how these interact with the patient.

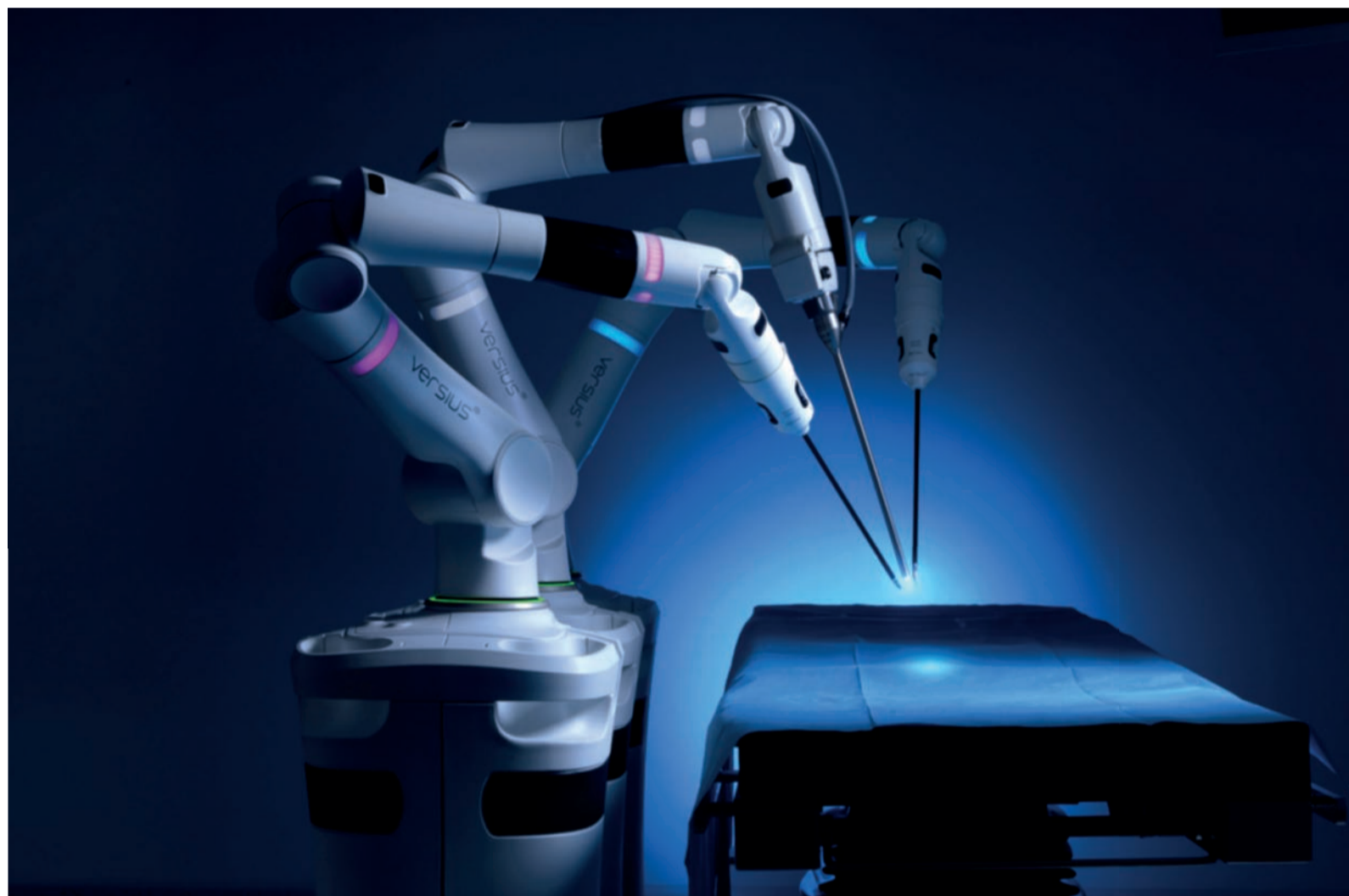
g ntions

such as coronary surgery, mitral valve surgery and procedures for congenital conditions, human participation remains a necessity, for example a perfusionist operating the heart-lung machine. Professor Bonaros concluded: 'I think the future of robotic cardiac surgery is very interesting, but it is important to support it with training, with simulators. There are difficulties in implementation, such as costs, and this is the reason why robotic cardiac surgery has not boomed until now, but I think it is an opening market.' (MN) ■



Dariusz Dudek

Dariusz Dudek is President of the European Association of Percutaneous Cardiovascular Interventions (EAPCI) of the European Society of Cardiology (ESC). He heads the second Department of Clinical Cardiology and Cardiovascular Interventions at the University Hospital in Krakow, Poland, and is a Professor of the Institute of Cardiology at the Jagiellonian University in Krakow. His key areas of research are acute myocardial infarction, antiplatelet and antithrombotic drugs and complex PCI.



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Bringing liquid profiling to the

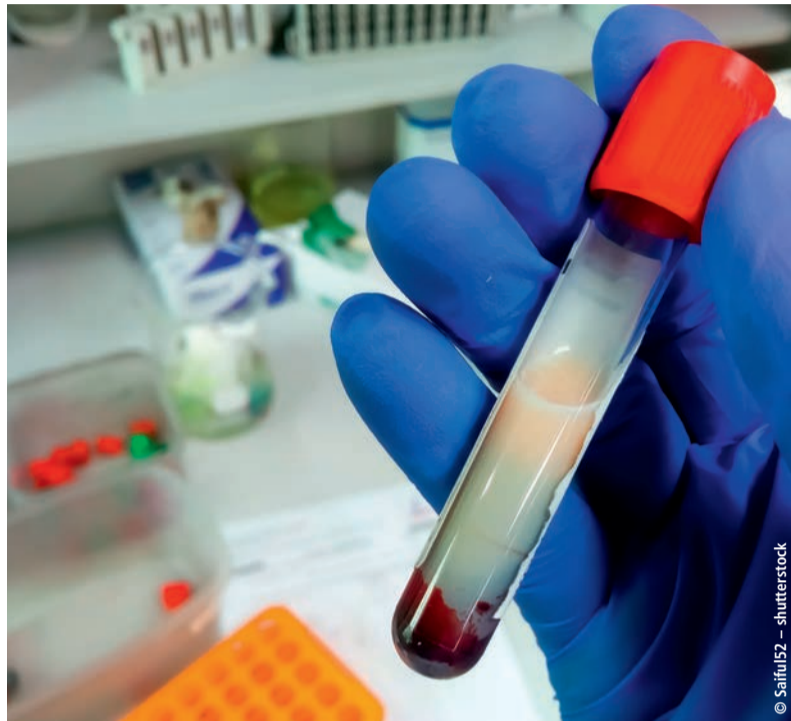
Liquid profiling is offering clear benefits in terms of cancer diagnostics and targeted therapy, but challenges remain in bringing it into the clinic. During the LabMed oncology sessions at the 2021 Medica/Compamed conference, Dr Verena Haselmann talked about the gaps between the possibilities of liquid profiling and the status quo in standard of care.

The expert from the Institute of Clinical Chemistry of the University Medical Centre Mannheim, Germany, also outlined the challenges with implementing the technique into standard care and routine diagnostics in management of cancer patients.

Liquid profiling, she said, brings a number of benefits; it can be used as a companion diagnostic for appropriate drug selection, provide therapeutic monitoring to detect upcoming resistance mechanisms and recurrence, and prognosis assessment for guidance of therapeutic/diagnostic decisions. On the other hand, she conceded that it was a challenging type of diagnostics with a need for highly sensitive techniques. Its unwieldy nature made it hard to convince clinicians to integrate it into their clinical routine workflows, despite the benefits, the expert summarised.

'At the end of the day, the clinicians will decide'

Her unit was the first to introduce an external quality assess-



ment scheme in 2017, which now sees 40 laboratories participating. Compared with standard-of-care molecular genetic tests, liquid

profiling is prone to high error rates, often depending on the methods used by individual labs. Prof Haselmann identified further chal-

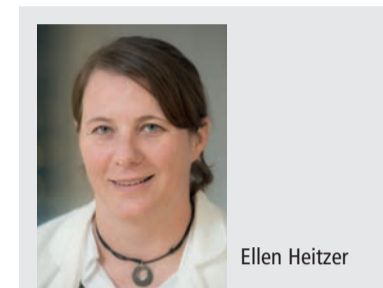
lenges in a lack of harmonisation of preanalytical and analytical workflows and reimbursement issues for most targets. Most important, however, is the incorporation into clinical guidelines for different cancers, because 'at the end of the day, the clinicians will decide whether this will be successfully translated into standard of care.'

Liquid profiling, the expert maintained, is still not fully implemented into standard of care. 'But we do see a nice correlation between the frequency we observe in liquid profiling and the clinical course of the disease of the patients.' She noted that more clinicians become aware of these benefits and it is increasingly being integrated into workflows. If this trend were to continue, liquid profiling should have 'a really great future' to match its diagnostic potential, Prof Haselmann concluded.

Different strategies for different scenarios

Dr Ellen Heitzer from the Institute of Human Genetics at the Medical

University of Graz, Austria, discussed the application of liquid profiling diagnostics in oncology and its unique challenges. One of these, she said, was the highly fragmented nature of circulating tumour



Ellen Heitzer

Dr Ellen Heitzer is Associate Professor at the Diagnostic and Research Institute of Human Genetics and heads the Research Unit for Liquid biopsies for personalized medicine in cancer at the University of Graz, Austria. A pioneer of liquid biopsy in Europe, her scientific expertise and research focus is in cancer biomarkers, cell-free circulating DNA, tumour heterogeneity, hereditary cancer syndromes, next generation sequencing, and circulating tumour cells.

Considerable advances

Emerging technologies in POCT

Considerable advances in point-of-care testing (POCT) devices are emerging from lab-on-a-chip platforms, innovations in smartphone-based technology and wearable technology. Cloud-based deep learning systems herald a future revolution, writes Bernard Banga, MD.

The World Health Organization (WHO) has endorsed bedside diagnostics as the top research priority in response to the so-far 2-year long epidemic without let-up. The aim is to improve turnaround time and ease of use compared to the gold standard lab-based PCR test. These have included rapid antigen tests, alternate nucleic amplification methods and novel sensors in proximity to the patients.

POCT deployed in multiple clinical contexts in 2021

POCT is being rolled out in various healthcare settings in 2021. The most obvious applications are blood-glucose monitoring and pregnancy testing. 'Widespread POC testing and diagnostic devices are avail-

able, including, but not limited to, glucose monitoring, pregnancy and infertility testing, infectious disease testing, cholesterol testing and cardiac markers,' said Amit Saha, from the Stanford Genome Technology Center in California, USA. Today, blood gas analysis along with haemoglobin, prothrombin time and infectious disease testing are the dominant applications in the POCT market.

Looking to the future, tumour markers, flow cytometry (mainly for chemotherapy monitoring), endocrine function tests and therapeutic drug monitoring will all benefit from recent technology advances in the POCT field.

Technology advances change POCT applications

Miniaturisation in chip technology, microfluidics and new biosensors have heralded the design of new systems for POCT. Lab-on-a-chip technology is one of the main drivers of POCT, especially in infectious disease diagnosis. This technology means various bioassays, such as microbiological culture,



polymerase chain reaction (PCR) and enzyme-linked immunosorbent assays (ELISA), can now be used at the point of care.

Similarly, emerging microfluidic technologies include a set of miniaturised components allowing chem-

ical or biological samples to be analysed at the microscopic level. Microfluidic-based POCT devices are widely used in molecular biology as well as in chemical and biochemical analysis. They enable detection and fluid regulation in a single unit. 'Greater sensitivity and specificity when detecting target analytes in small volumes overcome several challenges encountered when using traditional POCT techniques,' Saha said. POCT currently centres around two technologies: lateral flow assay (LFA) and nucleic acid amplification. The first is used in pregnancy testing; testing for HIV, herpes simplex virus, hepatitis, infectious diseases (Ebola, dengue, malaria, Zika virus) and respiratory infections; and for diag-

nosis and prognosis in conditions such as cancer, by identifying specific biomarkers. The second, much more sensitive and specific, is based on PCR on a chip and isothermal amplification. Nucleic acid amplification can be used to detect a whole array of infectious diseases, such as Mycoplasma pneumoniae, Bordetella pertussis, Legionella pneumoniae, Influenza A virus, SARS, Legionella, Aspergillus, West Nile Virus and, now, SARS-CoV-2.

A seventh format joins POCT

POC device manufacturers are continually looking for ways to design products that deliver greater user comfort in a cost-effective manner. POCT relies on six main formats: bench-top, monitoring, transportable, portable, handheld and disposable. In recent years, the latest advances have seen the launch of a seventh: smart devices with smartphones and wearable devices. Mobile POCT uses sensors to detect signals from samples in vitro, whereas wearable POCT detects signals directly on the body. Both systems then send quantified results to the clinic via wireless communication. Various body fluids such as tears, urine, blood, sweat and saliva can be used to analyse metabolites, hormones, proteins, viruses and bacteria.

Smartphones act as minicomputers for sensitive and specific data quantification with built-in sensors, high resolution cameras, rapid wireless connectivity and the ability to use various software and apps. This means they can function as standalone sensors and detectors in mobile POCT,' Saha pointed out.

POCT and Covid-19

Most promising SARS-CoV-2 POCT methods: immunoassays for antibody and antigen detection, RT-PCR as the gold standard, isothermal amplification and CRISPR-Cas9 genome editing technology as an emerging technique. Due to growing confirmed Covid-19 cases globally, rapid and reliable POCT is needed urgently for early detection. A reliable POCT device could reduce transportation, risk of spreading infection, strain on healthcare, and cost of care. Despite outbreaks caused by infectious viral diseases such as MERS, SARS, and Ebola, existing POCT platforms were not sufficiently ready to address the Covid-19 viral threat. However, in 2020, great efforts were made in POCT to improve Covid-19 detection.

clinic

DNA (ctDNA), making it hard to discriminate between normal cell-free DNA (cfDNA) and its malignant counterpart.

She also pointed out the necessity of adapting analysis strategies to different clinical scenarios; while at the time of diagnosis, testing of clinically actionable targets might be sufficient to tailor the patients' treatment, the detection of MRD (minimal residual disease) after surgery or a

molecular relapse requires screening for patient-specific alterations to achieve the necessary sensitivity. To analyse disease progression, larger gene panels and genome-wide analysis of copy number alterations may identify resistance mechanisms or novel actionable targets.

Potential alternative to tissue biopsy

To illustrate this further, Dr Heitzer applied this approach to non-small cell lung cancer (NSCLC), where hard-to-access tumours are present in 31% of patients and up to one fifth of biopsies yield insufficient

tissue quantity or quality for molecular testing. With respect to MRD, she noted that ctDNA could detect disease recurrence earlier than imaging in 72% of patients, adding that 'ctDNA recurrence opens a window of opportunity to treat patients while tumour burden and heterogeneity are at their lowest'.

She also pointed out the role of ctDNA as a marker of treatment response in ICI (immune-checkpoint-inhibitor) in NSCLC, with molecular ctDNA being predictive of long-term outcome. 'Liquid biopsy is a rapidly evolving and promis-

ing diagnostic tool that may be an adjunct or an alternative to tissue biopsy and can be applied in many clinical scenarios.' In addition, ctDNA testing has entered clinical routine in cases where no evidence-based treatment option is left and clinicians look to plasma for clinically-actionable mutations. 'However, due to the high variability of ctDNA, we still need to work on sensitivity,' the expert cautioned. 'Implementation of ctDNA mutation testing in routine clinical practice is envisioned in the near future, but it is necessary to standardise workflow because many

steps are involved in a liquid biopsy test so it is really important to do this in a proper way.' The session was hosted by Professor Stefan Holdenrieder from the German Heart Centre (DHM) in Munich, and also heard presentations on monitoring of conventional and immune therapies by molecular biomarkers from Professor Michel van den Heuvel of Radboud University Medical Center in the Netherlands; and on Exosome-associated miRNA and lncRNA diagnostics by Professor Michael Pfaffl from the Technical University of Munich. (MN)



Verena Haselmann

Dr Verena Haselmann is Deputy Director of the Institute of Clinical Chemistry at the University Hospital Mannheim and heads the Next Generation Sequencing (NGS) Core Facility of the Medical Faculty Mannheim at the University of Heidelberg, Germany. Her research focuses on molecular genetics, ctDNA/liquid profiling, integrative diagnostics and quality assurance.

Similarly, wearable POCT devices can be physical sensors used to acquire samples from the skin, eye or mouth with minimal invasion. They come in various forms, such as tattoos, patches, bands, watches, spectacles and contact lenses, and can be integrated with smartphones for data capture. This type of testing is especially important for patients suffering from critical conditions, as they can monitor their health constantly without the need to go to hospital, or for trained personnel.

Artificial intelligence and machine learning

Artificial intelligence (AI), machine learning (ML) and neural networks are now starting to be integrated into POCT. These AI modules have demonstrated their value in diagnostics studies. However, the accuracy of test apps varies greatly and relying on these apps is cautioned against. The future is bright. Since samples can be digitised directly at the point of care (POC), advanced digital diagnostic techniques, such as sample analysis using medical AI algorithms, can be deployed outside high-end laboratories. 'Hence POC digital microscopy, supported by automated digital image analysis and AI, might be deployed for routine microscopy diagnostics on samples harvested during cancer surgery, or on parasitology samples with an emphasis on potential areas of application in low-resource settings,' added Oscar Holmström from the Faculty of Medicine at the University of Helsinki.



From Sample to Result



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PUREPREP TL+

The PurePrep TL+ buffer allows the combination of safe transfer of viruses and lysis in one tube for research (including diagnostic tests and molecular biology techniques). The lysis component is optimized for further processing steps like nucleic acid extraction. The PurePrep TL+ buffer breaks down mucus-like substances in the tube to decrease prepping time and improve liquid handling.



Eco-friendly power source

'Greener' mini-batteries to power medical devices

More than 15 billion batteries are sent to landfill sites every year – technology that converts glucose and oxygen into electricity has the potential to reduce this waste and serve as a sustainable alternative power source for medical devices such as pacemakers, glucose monitors and pregnancy kits.

Report: Mark Nicholls

Visitors at the recent Medica/Compamed conference were introduced to the innovative approach and its possibilities by French-based company BeFC at the "Powering the future – Energy generation with papers and enzymes" session.

Dr Jules Hammond, CEO of BeFC, described the technology as part of a new wave of smart and connected devices for patient monitoring, glucose monitoring, fertility testing and connected packaging. With an estimate of 50 billion connected units in 2020, this is expected to be a growing market within the industry.

Many of these devices can operate with low power consumption. Dr Hammond proposed that sustainable and clean energy alternatives can be used to power these machines, replacing conventional miniature batteries that often contain toxic materials.

The eco-friendly paper-based fuel cells are ultra-thin, lightweight and flexible. Energy is generated via enzymatic reactions and stored using glucose and oxygen, avoiding the use of toxic materials and environmental pollution long after the batteries have been discarded. The



BeFC sustainable power source batteries

sustainable power cells developed by BeFC are flexible, lightweight and appropriate for wearable and implantable devices, the company's CEO pointed out. 'We use enzymes to convert glucose and oxygen into electricity, very much a bioinspired solution.' The glucose and oxygen can be harvested from the bloodstream and power items such as pacemakers and insulin pumps, with the biofuel cells being activated by biological fluids such as blood, sweat, or urine. Dr Hammond also presented a "blister reservoir" as an alternative mode of activation, with

the technology able to last for days or even months, depending on use case. The power source can also be sterilised with no obvious signs of degradation, he pointed out.

The fuel cells are constructed as a stack of cellulose and carbon layers. Its function is based on the use of different enzymes immobilised on the electrodes. One enzyme is used to oxidise glucose, liberating electrons, which are harvested through the electrode.

A different enzyme then reduces oxygen into water, which pulls electrons through the electrical circuit

with the combination of the two half-cell reactions creating the bio-fuel cell.

Reliable even when the lights go out

The shape and size of the paper biofuel cell can be adjusted or enlarged as necessary. Current models are 600 microns in thickness, with plans to reduce to 250 microns in 2022. Dr Hammond reported that his company is working with partners to scale up their production from a robotic sheet-to-sheet process to a roll-to-roll process.

A major obstacle that prevents many green and flexible energy sources from use in wearables is their tendency to produce only unreliable power output. As an example, photovoltaics require exposure to direct light to achieve useful power densities – this makes the technology unsuitable for devices worn underneath garments. Due to their structure, the batteries developed by BeFC are not limited in this way, the CEO pointed out.

He expressed confidence in the technology developed by his team at BeFC of engineers, scientists and problem-solvers, with academic backgrounds in biosensors, printed batteries and paper microfluids. 'What we are looking to do is provide smart and connected devices that represent the minimal environmental amount of impact.' Dr

Hammond expressed his belief that medical application will become a major market for these low-cost, green platforms, which will combine metal-free and plastic-free energy solutions with printed electronics.



Dr Jules Hammond

Dr Jules Hammond is CEO and cofounder of BeFC. Having completed his BEng and MEng degrees in electronic engineering, he continued his studies, completing a PhD in nanofabricated biosensors and then joined the group of Dr Serge Cosnier at Grenoble to develop novel biofuel cells. As a CEO, Hammond is focused on hiring talent to build an interdisciplinary team of problem-solvers. He develops the strategy to guide the company towards its mission of replacing conventional miniature batteries with eco-friendly technology, to provide a sustainable energy solution for low-power electronics.

Wearable technology

Smart textiles to help detect heart conditions

Serious heart conditions such as Atrial Fibrillation (AF) are among the major causes for strokes in patients, if undetected. However, AF can be difficult to pinpoint as symptoms – irregular or rapid heart rhythms – may occur at unpredictable intervals. So, long-term monitoring of a patient's heartbeat is required to effectively identify AF. Smart textiles with built-in sensors and transmitters present themselves as a diagnostic solution as they can monitor heart rhythm over long periods and thus pick up on potential AF.

Risk of stroke is increased 3–5 times for AF patients, but because the condition can occur at irregular intervals, it may remain unnoticed by the affected person, explained Markus Sonderegger, from Austrian start-up company 24sens. Globally, 45 million people have AF, a quarter of 40-year-olds will develop it in their lifetime, and the prevalence increases rapidly with age, with 10% of people over 65 affected.

With more than five million new cases a year,

global prevalence of AF has doubled in the past decade, with the World Health Organization classifying it as a global problem. 'The challenge is to detect AF because it occurs at irregular intervals,' explained Sonderegger. 'This requires a long-term recording of the patient's heart activity and subsequent analysis of the data.'

Wearable device designed for all-day use

24sens has devised a mobile solution for long-term 24/7 recording and visualisation of heart rates and certain heart diseases, par-

ticularly AF. The system, called SmartcorCONTROL, consists of a smart textile patch, which is fastened via a chest strap, and sensor technology-based software. A sensor located at the front of the strap and an onboard ECG monitor are used to gather data on heart activity over several days. The device is connected to a mobile app, which records and documents health status, and transfers collected data to a web portal, where it is evaluated by a healthcare professional and an AI-powered software for visualisation.

The cable-free design of the smart textile facilitates use during normal daily activities, Sonderegger added. Its recording unit can store a week's worth of collected data. A rechargeable battery and washable textile component further cater to the all-day application of the device.

Control and feedback options for patients

Using the mobile app, patients can pause and resume the recording as well as give feedback on health status and activities during the recording. 'The application visualises the heart activities and the detection of areas possibly affected by AF, and they can be seen through the doctor's dashboard,' Mr Sonderegger said. 'The healthcare professional can access important data without reviewing the whole data stream and can provide an earlier, faster and reliable diagnosis. The dashboard integrates individual feedback by the patients about their activity, health status and health feeling during the recording and the patient management process.' The physician can also contact the patient by sending a message through the dashboard onto the patient's mobile app.



Markus Sonderegger

Markus Sonderegger is Chief Technology Officer with 24sens, a start-up company based in Austria which was launched at the beginning of 2021.

For the development of the new product, the company has consulted with a medical advisory board and established a cooperation with the University of Vienna. With the product verification and usability process under way, 24sens is currently preparing the market launch in line with the new Medical Device Regulations. (MN)



The SmartcorCONTROL system combines smart textiles with intelligent software.

Antibiotic resistance: a global problem in urgent need of intelligent solutions

Antibiotics have been at the heart of modern healthcare since the 1950s. They are prescribed prior to an operation to minimise the risk of infection after the operation. Or antibiotics are prescribed to fight an infection. This practice, which might seem straightforward at first glance, has proven to cause a number of problems itself.

Report: Madeleine van de Wouw

Over the last twenty years, it has become increasingly clear that pathogenic and sometimes even life-threatening bacteria are becoming resistant to these antibiotics.

This results in persisting infections in humans and animals which cannot be controlled. Because of this, various types of medical interventions such as surgery, chemotherapy and stem cell therapy may become impossible.

The development of new antibiotics might seem the obvious solution. However, most pharmaceutical industries do not see that a priority, because it is expensive and lengthy, often yields little to no profits – and more likely than not, a newly developed antibiotic will never even reach the market. ‘We are therefore waiting for a huge crisis to happen,’ says researcher Nathaniel Martin, PhD, and head of the Biological Chemistry department at Leiden University, the Netherlands.

‘That’s why as academic researchers we need to be proactive in addressing the issue of antibiotic resistance (AMR). We know that some bacteria become resistant because they can produce enzymes that break down antibiotics. We are trying to tackle that problem by developing enzyme inhibitors that prevent bacteria from destroying the antibiotics and thus maintaining their antibacterial activity. Another approach our research team is using to overcome resistance is by structurally modifying antibiotics. In this way, the bacteria are exposed to a “new” antibiotic to which they are not resistant. Now, several years into the research, we are testing how well these modified antibiotics cure infections in animals. This is still the preclinical phase, but the results so far are very encouraging. If we can show that these new antibiotics are safe and effective in animals, the next step is to test them on humans.’

Educating professionals worldwide

However, Martin is convinced that there are more ways to prevent an increasing number of bacteria from developing resistance. For example, educating every prescriber of antibiotics is high on the agenda. In fact, education and communication were the motivations for Molecular/Medical Microbiologist Maarten van Dongen, PhD, in coordination with twelve Dutch public and private organisations, to found AMR Insights in 2017. The information platform focuses entirely on combating the issue of antimicrobial resistance worldwide.

‘The subject already had my attention, but when my neighbour died of an infectious disease, and there

was no antibiotic that could save him, AMR came awfully close,’ he said. There is a lot of research and information being generated on antimicrobial resistance worldwide. And that amount of information makes it difficult to determine relevancy and to keep abreast of the latest developments.’ While staying on top of current events might be possible with some effort in the Western world, the expert says that this is much more difficult or even impossible in developing countries.

As a major cause of preventable deaths, AMR must be tackled now, Van Dongen stresses. ‘Already each day around 800,000 people worldwide die, and according to the World Bank, AMR leads to extreme poverty in many places.’ To reduce the prevalence of resistant bacteria in countries such as Belgium and Germany, but also in southern Europe, he advises to look to the Netherlands, where AMR is much less common. ‘This is because in the Netherlands, we are cautious about prescribing and using antibiotics in humans and animals,’ the microbiologist says. He also compliments the Dutch open-mindedness for new technologies, citing a type 1 diabetes app as a major inspiration for the AMR Insights platform: ‘When I became involved with the app, I thought that a collection platform with information on antibiotic resistance should also be feasible,’ Van Dongen recalls.

About the platform

The online expertise platform AMR Insights informs, educates and connects experts from different disciplines worldwide. Symposia and innovation missions are organised, and people can subscribe to the free newsletters. These contain information for people from different

sectors; professionals in the human, animal, food, and environmental sectors can draw on the collected and tailored information to help them in their daily work. Updates on current research, such as the modification of antibiotics, which Martin’s team is working on, are also available on the platform. In addition, more than 300 ambassadors including researchers, doctors, veterinarians and entrepreneurs in some 60 countries work together to represent AMR Insights in the workplace. They are united under the project’s aim of maintaining antibiotic availability and effectiveness as well as preventing AMR from further threatening health and food safety.

Martin sees current antibiotic management in emergency consultations as a main driver of AMR: ‘Here, a broad-spectrum antibiotic is often used until it is determined whether an infection is viral or bacterial and, in the latter case, what type of bacteria it is.’ To put an end to this practice, solutions are needed to view and sequence the genome of bacteria more quickly, determining resistance profiles before medication is applied. ‘As progress is made in diagnostics, this should also allow a more targeted approach to the use of antibiotics,’ he says.

Another cause of resistance development is the widespread use of antibiotics in animals – to prevent disease or just to promote growth, the expert continues. As a result, antibiotics accumulate in humans through the consumption of meat



Maarten van Dongen

Maarten van Dongen is a Molecular and Medical Microbiologist. After attaining his PhD in Biochemistry at the University of Amsterdam, the Netherlands, he has worked for the international Pharma and Biopharma industry in the Netherlands, Switzerland, Finland and Belgium. He has gained extensive experience as a (project) manager of complex, international projects. As an advisor, Van Dongen is increasingly involved in projects in the field of antimicrobial resistance. In 2020, he founded the global AMR Insights Ambassador Network.



Nathaniel Martin

Nathaniel Martin obtained his PhD degree in 2004 from the University of Alberta, Canada, after which he performed postdoctoral studies at the University of California, Berkeley, USA. In 2007, Martin moved to the Netherlands, where he started an independent research career at Utrecht University. In 2018, Martin accepted a professorship at Leiden University where he currently holds a chair in Biological Chemistry. In Leiden, the Martin group works on developing new molecular strategies to address antibiotic resistance. With a firm foundation in bioorganic chemistry, the approaches used by the Martin lab include the design and synthesis of new antibiotics as well as developing small molecule inhibitors of different resistance mechanisms.

and animal products. Furthermore, antibiotics-laden wastewater from institutions like animal farms and hospitals ends up in the ground water. Van Dongen: ‘Good systems are needed to filter antibiotics and resistant bacteria from wastewater.’ To this end, AMR Insights, together with medical industry association VIG and water treatment company EWS, established the Dutch Consortium Antibiotics and Medicinal Residues from Water in 2020.

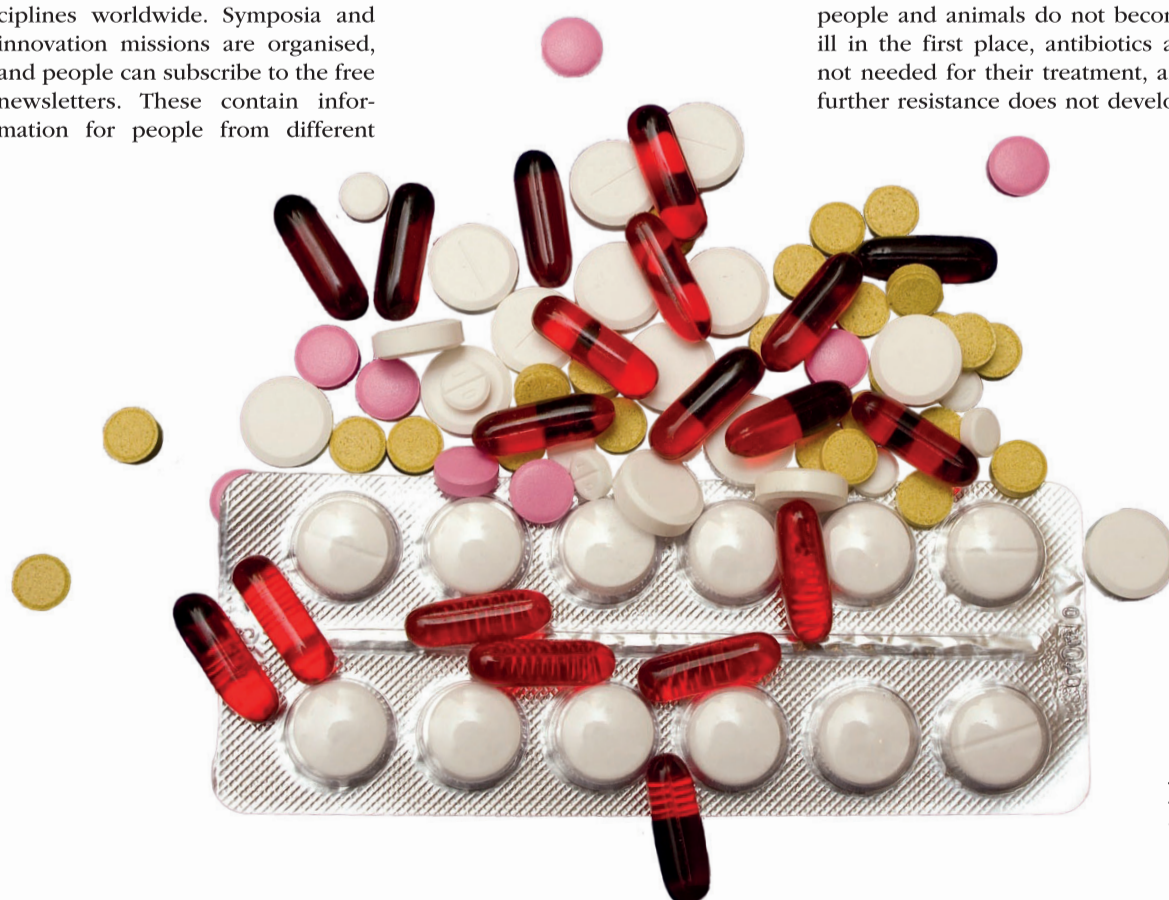
Spearheads in the fight against AMR

Both Martin and Van Dongen believe that prevention of infectious diseases is one of the most important ways to prevent many antibiotics from working at all in the near future. They argue that, if people and animals do not become ill in the first place, antibiotics are not needed for their treatment, and further resistance does not develop.

To this end, they point to the importance of good hygiene standards and Antibiotic Stewardship, which is crucial in monitoring the use of antibiotics in humans and animals, and the reduction of unnecessary antibiotic use through better and quicker diagnostics and tests.

Besides the development of new antibiotics and modification of existing types, the experts see the search for alternatives such as phages as another vital strategy. These are viruses that selectively attack bacteria and render them harmless. To fully exploit the potential of these solutions, Van Dongen says that this information must be made available worldwide to effectively tackle the antibiotic resistance problem. The platform aims to provide this information in a targeted manner, as relevant aspects are different for a veterinarian than, for example, for a general practitioner.

Even though there is much to be done, Van Dongen remains optimistic about the future of AMR Insights: ‘Now, our income consists of project income, contributions for participating in events and from sponsors. The objective is to change from short-term, project-related funding to long-term, programme-related funding. Then we will be able to set and realise our own objectives. With sustainable funding, AMR Insights can go one step further to become a global information and knowledge platform with even more searchable information.’ Martin adds: ‘A lot of money is needed for further research and clinical studies.’ But while a current focus area is on the modification of antibiotics, it is certainly not the only way to tackle AMR, he concludes.



New sepsis marker speeds up detection and therapy

Sepsis is the cause of one in five deaths worldwide, killing nearly 11 million people each year, many of them children. It is also a major cause of disability, affecting millions more. To combat the condition, many hospitals have implemented sepsis performance improvement programmes. A meta-analysis of 50 observational studies showed that these programmes are associated with better compliance with sepsis resuscitation and management bundles as well as a reduction in mortality* in patients with sepsis and septic shock.

Report: Dr Jean Patel

Rapid and accurate profiling of infection-causing pathogens remains a significant challenge in modern healthcare. Most hospitals use blood cultures and other microbiological tests to detect sepsis, while blood culture analysis remains the diagnostic gold standard. However, this method is too slow and cumbersome to significantly influence the initial management of patients. In addition, antibiotic resistance – one of the greatest global challenges of modern time – has become worse with the advent of Covid-19 because it increases the challenge for doctors to differentiate patients who need antibiotics from those who don't. It is estimated that 72% of Covid-19 patients receive antibiotics when only 8% of patients have co-infection.

Time is of the essence

Blood culture is the most common laboratory method used to identify pathogens responsible for an infection. Cultures obtained with-



Illustration of sepsis in the blood

in three hours and other diagnostic tools such as PCT and lactate can help identify the risk for sepsis. However, physicians, especially in emergency departments, cannot wait for the results of a microbial culture before pursuing treatment for a potentially septic patient. In fact, delaying intervention is known to increase mortality.

Laboratorians recognise that shortening the time at which pathogens are identified will result in improved patient outcomes in cases of sepsis. Over the last decade, MALDI-TOF (matrix-assisted laser desorption ionisation time-of-flight)

mass spectrometry has emerged as an important tool in the quest to speed up microorganism identification. Whereas traditional biochemical microbial identification methods may require days to complete, MALDI-TOF mass spectrometry can provide answers in minutes. These results, integrated with an Antibiotic Stewardship Programme, significantly improve time to optimal therapy while decreasing the length of stay and total costs. A rapid identification combined with accurate antimicrobial susceptibility testing ensures patients get the right antibiotic to treat a life-threatening infection.

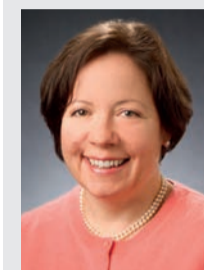
A new sepsis marker

In addition to diagnostic tools such as blood culture, PCT and lactate, monocyte distribution width (MDW), a novel sepsis biomarker, is emerging as a valuable resource enabling physicians to make decisions regarding their patients who may be at risk for severe infection. New analysis from a study confirms that abnormal MDW at presenta-

tion consistently increased sepsis probability. Used early in emergency department patients, MDW enhances the odds of early sepsis detection approximately 6-fold utilising Sepsis-2 and ~4-fold based on Sepsis-3 criteria.

The FDA-cleared MDW in-vitro diagnostic (IVD) parameter is intended for use with adult patients presenting to the emergency department. A complete blood count (CBC) with differential has been ordered to aid in the early detection of patients with or developing sepsis. Together with other laboratory findings and clinical assessments, it provides a qualitative assessment of sepsis from whole blood venous samples. Moreover, the results are automatically available as part of CBC-Diff results for adult patients entering the emergency department with no impact on laboratory or emergency department workflow and no additional tests to order.

*OR: 0.66; 95% CI 0.61-0.72



Dr Jean Patel

Dr Jean Patel currently serves as the principal scientist, scientific affairs, at Beckman Coulter. Prior to her role at the company, Patel served as the science team lead, antibiotic resistance coordination and strategy unit, at the Centers for Disease Control (CDC), where she led implementation of its Antibiotic Resistance Laboratory Network and the CDC and FDA Antibiotic Resistance Isolate Bank. Patel has served as chair and vice chair of the Clinical and Laboratory Standards Institute Subcommittee for Antimicrobial Susceptibility Testing and worked with the World Health Organization (WHO) to develop technical guidance for detecting resistance and strengthening global surveillance of antimicrobial resistance.

Cutting-edge study

Stay sharp, surgeons – your patients depend on it

Researchers at Auckland University of Technology's BioDesign Lab and the University of Auckland's Department of Surgery have uncovered a link between the sharpness of surgical implements and the risk of post-surgery infection.

The study, published in PLOS ONE, determines that keeping tools sharp is essential to avoiding cross-contamination. 'Bone surgeries are some of the most common surgeries, with approximately 9,000 hip replacements and more than 8,000 knee replacements happen-

ing in New Zealand every year,' says Lecturer Lorenzo Garcia. 'Post-surgery infection not only reduces the patient's quality of life; it also significantly increases healthcare costs. Reducing cross-contamination and possible infection will improve patient outcomes.'

The osteotome is a surgical tool commonly used to chip, cut, and sculpt bone during various surgical procedures such as orthopaedic, plastic, and dental surgeries. This tool resembles a chisel, beveled on both sides of the cutting edge and is like many bone-cutting surgical tools usually manufactured

from either heat-treated Martensite, Austenite, or Martensitic Stainless Steel.

These materials allow surgical tools to withstand impact forces without fracturing. They also possess excellent properties of corrosion resistance, biocompatibility, and cost-effectiveness. Osteotomes are re-used in surgical procedures however lack of regular maintenance can lead to a dull or damaged cutting edge being used.

Three different osteotomes

The research performed at AUT showed that dull osteotomes, used in surgical procedures including common operations like knee or hip replacements, retain bone contaminants even after sterilisation. The BioDesign Lab's study tested three different commercially available osteotomes with different surface coatings. After four cutting and sterilisation cycles, contaminants including calcium and phosphorous (evidence of bone contaminants), chromium, magnesium, silicon, aluminium, carbon, and nickel (base material of stainless steel) and traces of chlorine (used in autoclave sterilisation water) were found.

'Thanks to our commercial partner Sheffmed we were able to test a

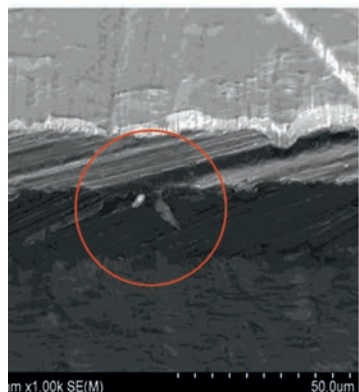


An osteome used for bone cutting

range of different commercially available osteotomes with different coating treatments, to measure what affect the different coatings had on reducing cross-contamination. Our testing detected bone contaminants in each osteotome,' says Dr Garcia. 'However, the PVD (physical vapor deposition) coated osteotome demonstrated significantly less bone contamination than either the as-supplied or electroless nickel coated tool. According to the results,

there is an association between blade sharpness and post-sterilisation bone contamination, so if hospitals can maintain sharp tools, it follows the risk of cross-contamination will be reduced. Or alternatively, the use of disposable osteotomes could be recommended.'

Source: Auckland University of Technology



As-supplied osteotome cutting edge at x1000 magnification (left). Energy-dispersive x-ray spectroscopy (EDS) points for as-supplied osteotome (right). Mechanical wear and damage can be seen across cutting edge.

