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Volume 29 | Issue 2 | Summer 2020

IPEM Institute of Physics and Engineering in Medicine

SCOPE

KEEP BREATHING

The story behind the UK's attempts to secure enough ventilators to cope with the pandemic.

THE BIG DEBATE

How life could change when the pandemic is over

NUCLEAR MEDICINE

Clinical Technologists redeployed as PPE Helpers

HISTORY

The pioneer who established radium and made radiology safe

CLINICAL ENGINEERING

A look at the vital role played in the fight against COVID-19

CHAIR OF IPEM SCOPE EDITORIAL ADVISORY BOARD

The new normal...

Usman Lula introduces the new-look *Scope* magazine, which is published at a time of global uncertainty and change.

Welcome all to a brand spanking new re-design of Summer *Scope* 2020! Even in these uncertain times with unprecedented changes to our daily lives, the *Scope* Editorial Advisory Board (EAB) and the team at Redactive have worked extra-hard to bring this fantastic issue to your doorstep.

It's been more than 100 years since the last pandemic, yet we have all felt the impact of COVID-19 in one way or another. I think what makes us resilient during such challenging times is a global united front and patience - and in doing so, at least in the UK, we have now managed to pass the peak (in COVID-19 deaths) and are hopefully on the road to recovery. The 50-page government plan published last month sets out a phased transition and what life could look like in the new normal. This will, of course, mean we will have to continue to make adjustments, both at home and work.

Whilst mulling over what kind of content we wanted for this summer issue, we thought that perhaps we could include features that are topical whilst also popular at the same time. While our very own editor, Rob Dabrowski, was busy trying to commission some new pieces, I was able to convince some authors to submit relevant features at very short notice! In this issue, we have tried to provide a balance of features, and yet have pieces that captivate all readers. As *Scope* is now available to the public, it is imperative that we have content that also helps others engage. Hopefully, this will be a start to something new!

> I think we have finally started moving (further) in the right direction, in fulfilling our strategic aims for *Scope* magazine.

I think we have finally started moving (further) in the right direction, in fulfilling our strategic aims for *Scope* magazine. First we had the revamp on content and now on the design and, hopefully, next it will be upping engagement with our readers.

A big thank you to all the contributors – without your efforts, we wouldn't be here. I'm also grateful to staff at the IPEM National Office, the trustees and the *Scope* EAB for their input into the new changes to our magazine. Stay safe...

Usman Lula

Usman Lula
Chair of IPEM *Scope* EAB

FEEDBACK

We want to hear your feedback

We really hope that you like the changes in this new-look edition of *Scope* magazine.

We would love to hear your comments and critiques on both the design and content featured in this issue.

So, please send us your feedback using the IPEM *Scope* Communities of Interest (CoI) section on the website.

It is a great place for IPEM members to join in discussions and activities.

The CoI combines the benefits of a mailbase, a networking platform and a resource library, using the latest, up-to-date software – so join us, if you haven't already.

It is also the ideal place to submit articles for publication. So if you are interested in doing so, please do get in touch.

IPEM Institute of Physics and Engineering in Medicine

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Back issues of *Scope* online.
bit.ly/2SRhh0E

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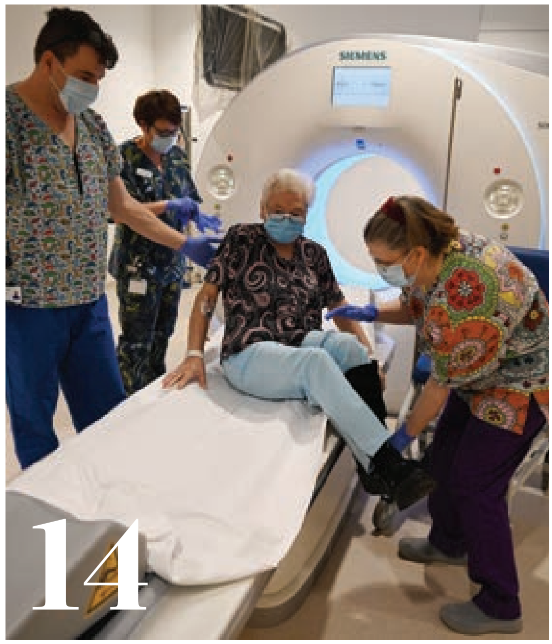


> Now that we have a demonstrable alternative, we can now legitimately ask, "why are we all in this room?" ?

– *Roger Staff* Comment page 14

UPFRONT

COVER FEATURE

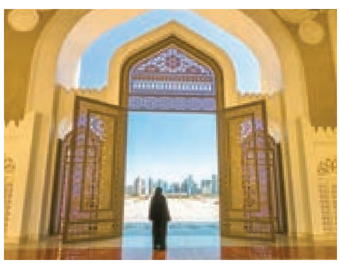
GENERAL FEATURES

UPFRONT

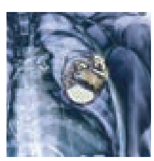
Cover photograph by
GETTY IMAGES

Volume 29 | Issue 2 | Summer 2020

NTENTS



SPECIAL REPORTS



ENDNOTES

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UPFRONT

BREAST CANCER

Larger doses on radiotherapy in the pandemic?

IMAGE: SCIENCEPHOTO

A one-week course of radiotherapy in fewer but larger daily doses was found to be as safe and effective as standard three-week therapy for women following surgery for early stage breast cancer.

The protocol has been implemented by hospitals to help reduce demand on the NHS during the COVID-19 pandemic.

Women with early stage breast cancer can be treated with fewer but larger daily doses of radiotherapy delivered in a shorter overall duration, compared with the current standard, research finds.

> This landmark trial reveals that a one-week schedule promises to become a new international standard

A pioneering study involving more than 4000 patients evaluated the effectiveness of two different radiotherapy doses, each delivered over five days in one week, compared with standard radiotherapy, currently delivered in 15 doses over three weeks.

Researchers found that delivering a shorter course to women who have undergone surgery for early stage breast cancer was as safe and effective as the current standard of three weeks.

The FAST-Forward phase III randomised clinical trial was funded by the National Institute for Health Research (NIHR) – the nation's largest funder of health and social care research – and led by a team at The Institute of Cancer Research, London.

The trial, which recruited patients from 97 NHS hospitals in the UK, shows how treatment times can be reduced for patients while saving healthcare resources.

Professor Murray Brunt, the study's clinical chief investigator, from the University Hospitals of North Midlands and University of Keele, said:

"This landmark trial reveals that a one-week schedule promises to become a new international standard for women with operable breast cancer requiring radiotherapy. This has major benefits in terms of convenience and costs for both patients and healthcare services globally at a time when they face increasing challenges."

bit.ly/2Ys4e9A

STUDY FACTS

4000 PATIENTS with early stage breast cancer

2 DOSES of varying radiotherapy

1 or 3 WEEKS delivered over five days in one week vs 15 doses over three weeks

MRI-GUIDED RADIATION

AI for treatment plans

Artificial intelligence (AI) algorithms can rapidly predict 3D dose distributions for online adaptive MRI-guided radiation therapy plans, it is claimed.

The authors of new research claim this will enable swift optimisation and quality assessment of these treatments.

Using only contouring information, artificial neural networks (ANNs) developed by researchers from Washington University in St Louis produced strong performance for predicting 3D dose distributions for treatment plans.

They identified about 10% of abdominal cancer treatment plans in the study as inferior and requiring further optimisation and refinement.

Lead author Allan Thomas said: "The prediction models will be useful to improve adaptive planning strategies and workflows through more informed plan optimization and evaluation in real time."

The prediction models will be useful to improve adaptive planning strategies and workflows

The researchers trained and validated the models using a dataset of 310 treatment plans from 53 abdominal cancer patients who had been treated with online adaptive, linac-based MRI-guided radiation therapy.

Specifically, the ANN models were designed to predict 3D dose distributions based on the average of prior treatment plans.

"Our models allow a direct, 3D dose comparison between the history of previously treated plans and upcoming plans for future patients without needing to take the time and effort to create an actual treatment plan," the authors wrote. "This is possible because our models are based on inputs that require only target and [organs-at-risk] structure data, not planned beam parameters."

bit.ly/2W2GsiY

INNOVATION

3D PRINTED VENTILATOR

Responding to the global shortage of ventilators, a team from Oregon Health and Science University has come up with a low-cost version that can be widely produced with 3D printing technology. The design is so straightforward that it doesn't require electricity, only the type of standard oxygen tank broadly available at hospitals and clinics worldwide.

bit.ly/3c3HVek

NEWS IN BRIEF

Neuroimaging

A US study has made a major leap forward in the field of functional neuroimaging. The research, lasting several years and examining dozens of patients with epilepsy, has produced a novel source imaging technology that uses high-density EEG recordings to map underlying brain networks. The is a big step towards establishing the ability to dynamically image human brain function and dysfunction.

go.nature.com/2SCVwSe

Cell atlas

A team of Cornell researchers used a new cellular profiling technology to probe and catalogue the activity of almost every kind of cell involved in muscle repair. They compiled their findings into a "cell atlas" of muscle regeneration, which is one of the largest datasets of its kind. This resource provides a comprehensive picture of the many intricate cellular interactions in tissue self-repair.

bit.ly/2z6vDmL

Lab in cartridge

A new lab-in-cartridge test, which requires no lab and significantly reducing waits for results, is beginning evaluation on patients. Imperial College London's Regius Professor of Engineering, Chris Toumazou is working with clinical researchers to trial a rapid, lab-free PCR test that detects COVID-19 and delivers results in just over an hour. The tests have been clinically validated after a successful initial trial on COVID-19 patients and are continuing to validate on larger patient groups.

bit.ly/2YucGoN

COVID-19

Safety in nuclear medicine

In an effort to provide safer working environments for nuclear medicine professionals and their patients, clinics across five continents have shared their approaches to containing the spread of COVID-19.

Clinicians from Africa, Asia, Australia, Europe and North America provided summaries of the steps their individual hospitals and clinics have taken to combat the COVID-19 pandemic.

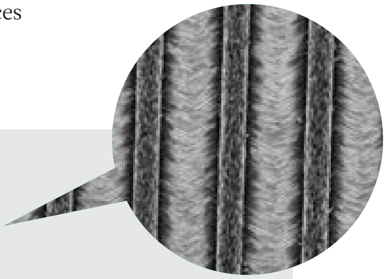
The most common steps taken by clinics have been:

- Triage patients upon arrival
- Reduce elective nuclear medicine studies
- Improve hygiene practices and establish rotations of medical personnel to create back-up teams, should a staff member become infected.

The series of editorials has been published by *The Journal of Nuclear Medicine* and is available to access now online.
bit.ly/3b2h5BR

UP CLOSE

NANOWIRES



HOW DO YOU DEFINE A NANOWIRE?

Nanowires are structures with diameters on the order of a nanometer (10-9 meters), in which the length-to-width ratio is usually greater than 1000. They can be made from a variety of conducting and semiconducting materials, such as copper, silver, gold, iron, silicon, zinc oxide and germanium. They can also be made from carbon nanotubes.

WHY ARE WE LOOKING AT THEM ON THE NEWS PAGES?

They have been in the news, thanks to research led by the University of Strathclyde, where a new device made from nanowires could lead to safe imaging technology with far higher resolution than current ultrasound devices that are used to detect small tumours.

WHAT DID THE RESEARCHER DO?

They developed a micro-assembly technique to allow the construction of a 3D lattice of nanowire devices. They then used a "transfer printing" micro-assembly system to print semiconductor nanowire structures, with nanoscale accuracy, in orthogonal patterns onto metal antenna structures.

HOW DOES THE TECHNOLOGY WORK?

The devices use terahertz radiation, which can penetrate through materials such as plastics, wood and skin. The radiation falls between infrared and microwaves in the electromagnetic spectrum and does not damage tissue, as other forms such as X-rays can.

WHERE CAN I READ MORE?

The researchers published a paper in the journal *Science*: **bit.ly/35PNJG9**

IMAGES: SCIENCEPHOTO / ISTOCK

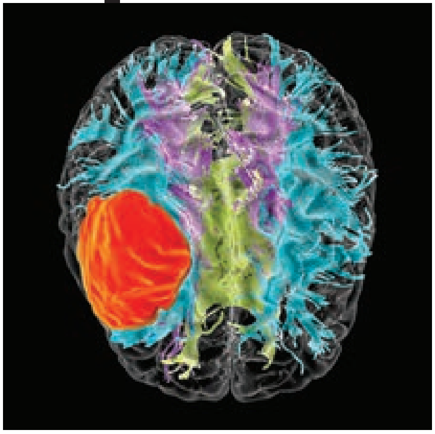
BRAIN TUMOURS

SCHIZOPHRENIA DRUG AND RADIATION

Researchers have found that adding a drug once commonly used to treat schizophrenia to traditional radiation therapy helps improve overall survival in mice with glioblastoma – one of the deadliest and most difficult-to-treat brain tumours.

Their findings show that a combination of radiation and the drug trifluoperazine not only targets glioblastoma cells, but also helps overcome the resistance to treatment so common to this aggressive form of cancer.

The results could prove promising for patients with the disease, for whom the median survival time is only 12 to 18 months, following diagnosis.
bit.ly/2W1o4H1



UF
UPFRONT TECH NEWS

IMPLANTABLE NEUROPROSTHETICS

AN EXPERIMENTAL PROTOCOL FOR TESTING

Advances in materials, microfabrication and medical imaging are accelerating the pace of innovation in implantable neuroprosthetics. These soft, biocompatible devices, which rely on electrical stimulation of the nervous system, have shown potential in improving quality of life for patients with a range of conditions.

But most of the discoveries never make it out of the lab.

Researchers tend to underestimate the amount of engineering and development work needed to get a discovery into clinical use.

Stéphanie Lacour, from the École Polytechnique Fédérale de Lausanne (EPFL) Laboratory for Soft Bioelectronic Interfaces, said: "These discoveries can be so far ahead of the curve that finding an industry partner willing to do the development work is practically impossible."

The EPFL team has developed an experimental protocol for testing, optimising and validating soft, personalized implants.

bit.ly/2yqTZHW

POCT

Portable MRI system

Hyperfine Research has announced its collaboration with the Yale School of Medicine to pioneer the use of the world's first portable, low-cost magnetic resonance imaging (MRI) system for the bedside of patients in the neuro intensive care unit at Yale New Haven Hospital.

Hyperfine's system can move directly to the bedside, plug into a wall outlet, and operate in any healthcare setting.

In inventing point-of-care (POC) MRI, Hyperfine aims to make MRI accessible and available anywhere, anytime, to any patient who needs it.

Yale New Haven Hospital (YNHH) is the first hospital to use the Hyperfine POC MRI system on patients, as part of a two-year study in conjunction with the American Heart Association.

This study aims to overcome barriers that have prevented the routine use of MRI on unstable neurology intensive care unit patients who cannot be transported.

Professor of Neurology and Neurosurgery Kevin N Sheth said: "The MRI systems we currently use around the world require a strict, limited-access environment due to their high-field magnet design.

"The result is that we've taken a very safe technology and made it very difficult for patients and clinicians to access. I'm excited to be part of a project that is finding a way to bring MRI to patients in a feasible, safe and efficient way. The availability and accessibility of a portable MRI scanner has allowed us to test some patients with multiple MRI exams over a time span of hours to days. This could open up a new level of access to the rich data MRI brings, and that could have a significant impact on how we care for patients."

bit.ly/2SzeN6W

This could open up a new level of access to the rich data MRI brings – that could have a significant impact

ULTRASOUND

THE WORLD'S FIRST IN-VIVO BIOSENSOR

Researchers have developed the first biosensor that can be used *in vivo* to emit signals that can be detected by common ultrasound scanners.

The technology has been granted an international provisional patent.

The team from the ARC Centre of Excellence in Bio-Nano Science and Monash University in Australia, has developed a nanoparticle that alters its stiffness in response to pH changes in the body. These changes can be picked up by ultrasound.

Ultrasound imaging uses gas-filled microbubbles, but these only last 10-20 minutes, making long-term tracking within a body impossible.

The new technology can be inserted deep into the tissue and will measure biomarkers, such as pH (as a measure of whether a tumour is shrinking following chemotherapy).In the near future, more complex markers, such as oxygen (as an indicator of stroke injury) or disease-related proteins.

The team behind the innovation claim eventually it will be able to be "read" by "something as simple as a mobile phone", which can currently record ultrasound, making it able to monitor patients in remote areas, without the need for big hospital labs.

bit.ly/2SzmfP

PET IMAGING

Identifying antibodies 30 days after injection

Combining ^{89}Zr-labeled antibodies with total-body positron emission tomography (PET) has extended the utility of novel total-body PET scanners, providing suitable images up to 30 days after the initial injection.

A new study compares four different types of ^{89}Zr-labeled antibodies in preclinical trials, noting excellent consistency for each radiotracer, even at very late time points, as well as differences in antibody behaviour, that are critical to understanding future outcomes of total-body PET in humans.

Monoclonal antibodies have been used in medicine for decades to treat various diseases, such as cancer, rheumatoid arthritis, multiple sclerosis and cardiovascular disease.

Many new engineered monoclonal antibodies have been developed with specific molecular functions in order to achieve a balance between potency and safety in patient treatment.

Excellent image quality was obtained on the initial total-body PET scans for all four types of ^{89}Zr-labeled antibodies. Results from the 30-day scans showed image quality across the four antibody types sufficient to readily identify activity in the liver, kidneys and upper and lower limb joints. But significant differences in uptake between the various chelator-linker combinations were noted in the late time point liver, bone, and in whole-body clearance.

bit.ly/2SCjHQJ

ONCOLOGY

BIOLOGY-GUIDED RADIOTHERAPY

A new technology aims to make tumours their own worst enemy.

The first generation of a machine using this technology harnesses positron emission tomography to track a tumour in real time.

This allows the system to send beams of radiation to destroy cancerous cells with heightened precision.

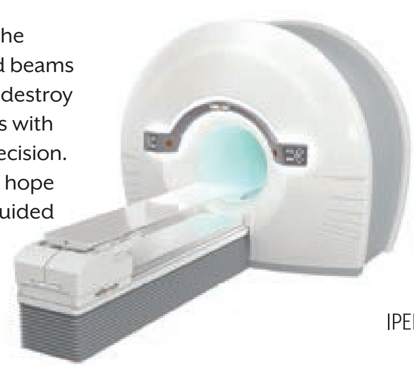
Researchers hope this "biology-guided radiotherapy" will increase accuracy, safety and efficacy.

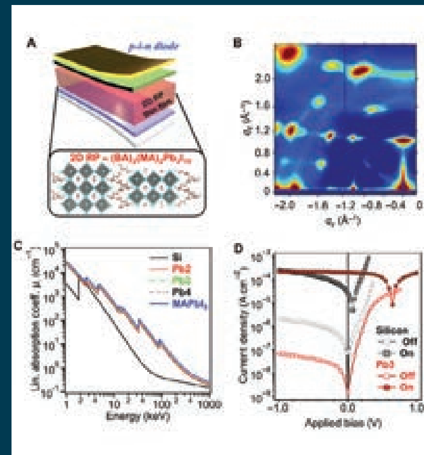
Physicians plan to test the machine later this year in clinical trials.

Daniel Chang, a professor of radiation oncology, who will lead the clinical trial, said: "To my knowledge, this machine is the first of its kind. It combines two technologies – one traditionally used in cancer diagnostics, and one in therapeutics – into a single technology."

The PET scanner provides continuous feedback about the location of a tumour based on emissions, even if the tumour moves as a patient breathes.

stan.md/2zQsQym





MATERIALS

New X-ray detector

Researchers may have discovered a new way to generate precise X-ray images with lower exposure, thanks to an exciting set of materials.

Scientists at the US Department of Energy's Argonne National Laboratory and Los Alamos National Laboratory have identified a new class of X-ray detectors, based on layered perovskites – a semiconducting material used in solar cells and light-emitting diodes. The detector with the new material is 100 times more sensitive than conventional, silicon-based X-ray detectors.

"This new material for detecting X-rays could soon find its way into a variety of different everyday environments, from the doctor's office to airport security lines to research labs," said Argonne X-ray physicist Joseph Strzalka.

The perovskite materials work because they are deposited as a sprayed-on thin film – a production method that helps to reduce cost compared to having to grow a large silicon single crystal.

The new perovskite detectors can also detect X-rays over a broad energy range, especially at higher energies. This is because the perovskite contains heavy elements, such as lead and iodine, which tend to absorb these X-rays more readily than silicon. The potential even exists for the perovskite technology to be used as a gamma-ray detector, provided the films are made a little bit thicker and a small external voltage is applied.

bit.ly/3dcR2te

EXTERNAL RELATIONS MANAGER

A vital role in the pandemic

Sean Edmunds summarises members' involvement in the fight against coronavirus and helping to influence policy across the UK on behalf of IPEM.

As the world fell silent and we became becalmed during the coronavirus pandemic, IPEM members continued to play a vital role during the crisis.

A new COVID-19 page was created on the IPEM website, to share a wealth of information, guidance and advice on the developing situation and the efforts being made to tackle the outbreak. This became an invaluable resource and was updated almost daily with new information from members and also from other organisations and bodies, including the Department of Health, NHS England, the Health and Safety Executive and manufacturers.

One particular area in which members played a crucial role was in developing advice and guidance on ventilators, from converting anaesthesia machines for use in intensive care to considerations that needed to be taken into account when hospitals received an offer of donated equipment. See below for more information.

Many sectors of the healthcare science workforce were asked to volunteer their services during the COVID-19 crisis, especially at the new NHS Nightingale hospitals, and IPEM brought these opportunities to the attention of members.

The Institute also wrote to recently retired members after the Health and Care Professions Council created a temporary Covid-19 register for those who had deregistered within the last three years and who wanted to return to work. This also applied to third year STP students who had completed their clinical practice placements.

IPEM also produced and shared guidance for members to help protect their mental health during the pandemic, which offered information, support and advice. The Institute's Trustees made themselves available as a resource to be used in this regard as well.

At the same time, IPEM took

Members played a crucial role in developing advice and guidance on ventilators

VENTILATOR INITIATIVES

IPEM members played an important role in responding to the crisis.

The clinical engineering community really came to the fore on the various ventilator initiatives. Many members were involved in this, with Professor Stephen O'Connor, IPEM's President, Professor Mark Tooley, Immediate Past President, Dr George Dempsey, Vice President Engineering, and Dr Keith Ison OBE, IPEM Past President, leading on the response to this call.

Member Chris Ramsden, as co-lead for healthcare of the Chartered Institute of Ergonomics and Human Factors, was involved in producing a guide for human factors issues to help the engineering companies pressed into action to develop ventilators for the first time.

IPEM also hosted a video call for the Heads of Medical Physics and Radiation Protection Advisers for them to share experiences and knowledge gained of the radiation protection issues around expansion of intensive care unit capacity and field hospitals.

IMAGE: GETTY

the decision to open up the Communities of Interest (CoI) to non-members to help share best practice in response to the crisis and to help provide professional, expert advice to those that needed it.

The CoIs came into their own, with a wealth of information, advice and guidance being shared and many conversations and discussions taking place.

Just one example of this was Fellow Justin McCarthy, who wrote about the possible postponement of the full application of the EU Medical Devices Regulation EU 2017/745 from May 2020 to May 2021 due to the coronavirus pandemic. This was posted on the Clinical Engineering CoI to stimulate discussions about the implications of this happening.

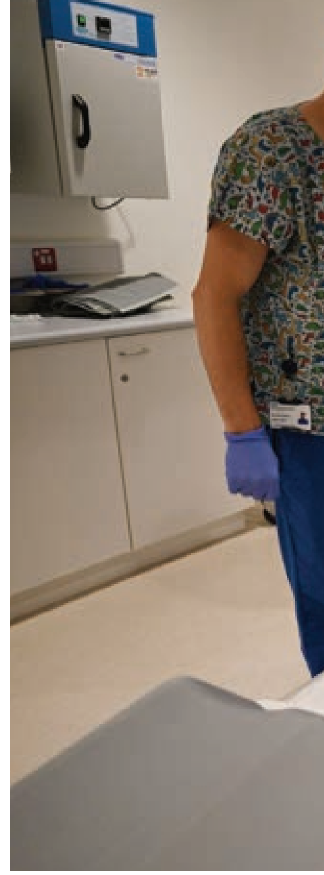
Staying with clinical engineering, Dr Dempsey and Professor O'Connor, together with members of IPEM's Engineering Policy and Standards Panel, submitted written evidence to the House of Commons Public Bill Committee's scrutiny of the Medicines and Medical Devices Bill, which is currently passing through Parliament.

> **"THE COIS CAME INTO THEIR OWN, WITH A WEALTH OF INFORMATION AND ADVICE BEING SHARED**

The bill seeks to address a regulatory gap in updating EU regulations by introducing regulation-making, delegated powers covering the fields of human medicines, clinical trials of human medicines, veterinary medicines and medical devices to enable the existing regulatory frameworks to be updated at the end of the transition period.

Earlier in the year, Professor O'Connor orchestrated a letter to Home Secretary Priti Patel MP about the proposed NHS visa scheme. The letter was written by Professor O'Connor and was endorsed by several other learned societies, professional bodies and Royal Colleges. It sought clarification that allied healthcare professionals within the scheme would include medical physicists, clinical and biomedical engineers as well as diagnostic and therapeutic radiographers.

Finally, before normal life was turned on its head, Nicky Whilde, Head of Radiotherapy Physics at Northampton General Hospital, represented IPEM at a Radiotherapy4Life event at the House of Commons – a drop-in session for MPs to understand more about the campaign to increase funding and better organisation of radiotherapy.



THE BIG DEBATE

Life after the pandemic

We asked six experts three questions about how life could change when the COVID-19 pandemic is over. Here's what they said.

Q *Following delayed treatments and cancelled appointments, will the NHS be able to cope with the inevitable spike in demand that will follow the pandemic?*

DR. ROBERT FARLEY [RF]

At the time of writing, the country is still in lockdown, awaiting news as to when and how restrictions will be eased, which makes this a very difficult question to answer. The demands that will be placed on the NHS will likely vary according to population demographic, geography and the clinical setting. Furthermore, factors, such as how the government lifts restrictions; the effect that any restrictions have on other communicable diseases, such as seasonal flu; and the timing and magnitude of any subsequent pandemic waves, will all affect the overall demand on the NHS. Nevertheless, it is very clear from the drop in presentations across primary care, the reduction in capacity and routine work in the acute sector to support the COVID-19 response and the considerable reduction in A&E attendances, that we should expect an increase in demand for these services as restrictions are lifted.

We might also expect to see considerable pressure on services such as mental health, social care and sexual health, as normal activities resume. As regards medical physics services, there is considerable variability in these services, both by specialism and on a department-by-department basis. In our department, the nuclear medicine section is running a very reduced service and contributing to the trust's COVID-19 response, whereas the radiotherapy physics section is almost "business as usual". Sadly, however, I fear that in the months to come patients will be presenting with more later-stage tumours than we might normally see.

The good news is that, certainly in my own trust, careful thought is being given to how clinical services are resumed and capacity increased to mitigate against any predicted surge and in a way that enables them to be quickly suspended should further COVID-19 pandemic support be required. I expect that very similar discussions are being held in every trust across the country. Nevertheless, I think that those of us working in the NHS should be prepared for a sustained, very busy period ahead.

NICKY WHILDE [NW]

It will, because it has to, and it always does – no matter what we face. Fortunately, for patients, NHS staff always go above and beyond to provide our services. We all believe in what we are doing and will move mountains to succeed.

MEET THE EXPERTS

ROBERT FARLEY
Head of Medical Physics and Lead Healthcare Scientist
Medical Physics Department, South Tees Hospitals NHS Foundation Trust

IMAGE: GETTY

GEORGE DEMPSEY [GD]

The NHS will cope with the inevitable demand for the return to normal clinical services that follows the pandemic, as services are developing restoration plans. However, spikes in demand due to delayed treatments will require the same high-level planning and resourcing as the crisis produced. It should not be expected that rapid upskilling in delivering healthcare science specialist support during a crisis is the way forward for delivering the service after the crisis, as this will compromise safety and quality in the long term. Whilst the COVID-19 surge thankfully was not as expected, it demonstrated the ingenuity and rapid multidisciplinary team working expected of our healthcare professions during such a crisis. Hopefully, lessons are learnt and the needed investment in NHS specialist services and equipment supply is considered if the next pandemic crisis is to be avoided.

DR ROGER STAFF [RS]

The NHS will, as it has always done, employ "best endeavours" to address the inevitable spike in demand. Being seen to cope is a relative term and of course depends on the size of the spike. If not coping, for example, means waiting times doubling or trebling, then the public should be made aware these are the knock-on consequences of the pandemic. It will be impossible for the service to magic-up large amounts of extra capacity in the short term to get the service back to its pre-pandemic state quickly. We are all acutely aware that addressing this demand is the most important challenge of our working lives and careers. In the future, statisticians will calculate the cost (in lives and well-being) of not having a comprehensive health service during this time. The aim of the post-pandemic "great catch-up" is to minimise this cost. We should be aware that the first "unlock" act will mark the end of the beginning, not the beginning of the end.

> **"BEING SEEN TO COPE IS A RELATIVE TERM AND OF COURSE DEPENDS ON THE SIZE OF THE SPIKE**

STUART GREEN [SG]

Yes – but it will be difficult. There will be a significant backlog in treating patients with many conditions, but I am confident that the teams we have in place will rise to any

NICKY WHILDE
Head of Radiotherapy Physics
Northampton General Hospital NHS Trust

GEORGE DEMPSEY
Head of Clinical Engineering
Belfast Health and Social Care Trust

ROGER STAFF
Head of Imaging Physics
Aberdeen Royal Infirmary

STUART GREEN
Director of Medical Physics
University Hospitals Birmingham NHS Foundation Trust

HEATHER A WILLIAMS
Consultant Medical Physicist
The Christie, Manchester

challenges that come. The arrangements to expand capacity and run NHS services from private hospitals are promising in this regard. However, to be honest, I struggle with a question that talks about the NHS "coping" in the same way as I have struggled with the government mantra of "protect the NHS" during this whole pandemic. The NHS exists to protect people, and any suggestion that it should be the other way around really misses the point and reflects an acceptance that the NHS is funded to a level which is too low so has no real headroom to cope with spikes in demand and so "needs protection". Of course a system can never have the level of headroom required to fully cover this kind of crises and some adjustments are inevitable, but the fact we have had to scale back to such a large degree on routine care is an illustration that the NHS does not have any headroom at all (and of course that the government was too slow on lockdown, so the epidemic has been much bigger than it could have been).

HEATHER A WILLIAMS [HW]

We can't say for sure, but healthcare practitioners are already planning the return to "service as usual" in stages so that those patients who need medical attention most urgently are seen first. A timely but gradual stepping-up of service provision will also make it less disruptive to step back down again if there is a second, or even third, peak of COVID-19 cases in the UK.

IMAGES: GETTY / ALAMY

Q How do you think public attitudes towards health and well-being will change after the pandemic is over?

[RF] I would like to think that there is a far better public awareness of the importance of good hand hygiene and other simple measures in limiting the spread of contagious diseases and that this understanding continues long into the future. It important that the message is communicated that these measures work for many other communicable diseases. I am also hoping that, as and when a COVID-19 vaccine is developed, there will be a better public understanding of the importance of vaccination in maintaining public health and saving lives, which results in an improved uptake of vaccines such as MMR.

The support that those working in key services, including the NHS, have received during the pandemic has been overwhelming and I really hope that the public realises how important it is to ensure that these services are well supported all the time to ensure that they can respond rapidly and effectively in times of national crisis. I also hope that, after a period in which the boundaries between opinion and fact have become somewhat blurred, and experts viewed with suspicion, society has a greater appreciation of the importance of scientific evidence.

[NW] My gut feeling – pessimistic as it is – is that public attitudes will go back to how they were. I don't think the unquestioning support and appreciation of healthcare workers will survive either. Some national newspapers are already openly criticising frontline workers.

[GD] The public now appreciates the importance of a well-resourced NHS service when faced with such a sudden health crisis. People also appreciate the fragility of life and the need to care for others as much as they care for themselves. The publicity around lack of medical equipment, and the eagerness to develop a range of devices may provide a needed boost and enthusiasm in our younger people to consider future careers in the health service and, in particular, for clinical engineering, which has played a significant role in the rapid set-up of the Nightingale hospitals, and development of novel ventilators. This is much needed, as we need to develop our future workforce to support the ever-increasing need for the management and maintenance of complex healthcare technology, as well as supporting engineering solutions to healthcare problems.

[RS] It is inevitable that the public's attitude to health, the health service and their own well-being will change. At a national level, when the dust settles and a measured review of events has taken place, I believe the public will want a health service better suited to cope with a crisis of this type; one with more resilience and greater flexibility. At a personal level we have taken more responsibility for ourselves and others during this time. If this increase in responsibility shifts health behaviours so as to reduce the risk of chronic diseases, such as heart disease, cancer and diabetes, that would be good, but it is too soon to tell at this stage.

[SG] I really hope there will be positives from this

experience. People may understand how important it is to be healthy and to be able to withstand illness (and the consequences of treatment).

I also hope people will have some greater clarity in their views of what is really important and that we can develop an understanding that we truly are inter-connected and inter-dependent on this planet and that there is no escape from global crises.

If enough people learned that acting early is a great way to minimise impacts in the long term, and if we could apply this to climate change, then there is some hope for our children. Globally, this lesson may have some traction, but I'm afraid that in the UK our government will do and say almost anything to deflect criticism that it acted too slowly.

[HW] Some people have had the opportunity during lockdown to reconsider their lifestyle and plan adjustments for the better. Others have found it really challenging, financially and psychologically. I'm also concerned that some of the reporting of the staggering number of COVID-19-related deaths has been callously dismissive of the elderly, the obese, and those with pre-existing health conditions. I think it remains to be seen how "healthy" we are as a nation after this, in the broadest sense of the word. I expect we will see some positive responses, and some that are much more problematic.

Q *Will the increase in remote and flexible working have a lasting impact?*

[RF] Once we start to resume normal life, we should have a good, objective look at this. Certain activities that we are undertaking now are only sustainable in the short term or because other activities have been suspended. Equally, there have been aspects of the revised ways of working that have been of great benefit and should be continued. Many of these ways of working were already in existence and the recent need for social distancing and isolation has simply accelerated their implementation; however, they are important in widening participation. I think attitudes to remote and flexible working are changing and it will be very interesting to see in five years' time what we have retained with respect to this and the effect that it has had on society.

> **"ATTITUDES TO REMOTE AND FLEXIBLE WORKING ARE CHANGING**

[NW] For a long time, we have been trying to push paper-light working here at Northampton General Hospital; but engagement was proving difficult from all staff groups. We are now almost at a place where we could be a paper-free service. Meetings will change. Remote meetings have become the norm and there is no need for many of them to go back to face-to-face meetings – for which I, personally, am hugely grateful! Working from home in my own department won't become standard practise – we need that face-to-face contact; but we will now have the option for completing audits and project work in a quiet space.

[GD] Flexible and remote working has been a requirement of clinical engineering services adapting to environments, due to the complexity and connectivity of healthcare technology, for instance – accessing clinical equipment out of hours or remotely via computer networks for offsite work. As we come out of this period, the emphasis that clinical engineers place on the need for decontamination of equipment will have a lasting effect on the way equipment users adapt to ensuring that such equipment and environments are maintained in a clean state.

[RS] Hopefully the advantages of productivity, efficiency and access of remote working will be a revelation. Now that we have a demonstrable alternative, we can now legitimately ask, "why are we all in this room?" In the future, I hope meetings will be better defined, shorted and more productive. Flexible working has been an ethereal desire for NHS redesign for many years. The "great catch up" will have to exploit the fixed assets, building and equipment, better – the nine-to-five will not cut it. Flexible working patterns have been proposed and partly implemented in the past and the coming challenge is an opportunity to demonstrate that flexible, "smart" working can work.

[SG] In my day-job in the hospital, I'll continue to try to work flexibly and maybe a little more remotely – even after the need to maintain distance has lessened. I hope that, in our radiotherapy service, the ability of staff to work effectively from home will improve staff lives and give us a more flexible and responsive service for patients. I will be nervous of travelling as much as I have in the past on trains and planes. But the opportunity to meet and work with people from all around the world is one of the great joys of working in science, so this will be something to wrestle with.

[HW] We already work flexibly and have several members of the team working part-time. The main change in the last two months has been the shift to having as many people working at home as possible. Whilst there is always work we need to do in person, I expect that in general it will be feasible for most medical physicists to work remotely, at least some of the time. This could have the benefit of opening up the career to those who aren't able to be in the department five days a week.

Cf

COVER FEATURE

KEEP BREATHING

The story behind the UK's attempts to secure enough ventilators to cope with the pandemic.

❶ Patients who displayed mild symptoms of the COVID-19 coronavirus at an exhibition centre converted into a hospital in Wuhan in China's central Hubei province. ❷ Medical workers check the information at the Huoshenshan (Fire God Mountain) makeshift hospital.

On 31 December 2019, as crowds gathered around the world to greet the arrival of the New Year, the Wuhan Municipal Health Committee in China alerted the World Health Organization (WHO) that it had encountered an "unknown" pneumonia. Wuhan's hospitals had 27 cases: mostly stallholders from a local wet market, of whom 18 were stable, but seven were critical. That same day the city's population was warned to avoid gatherings and enclosed public places. By the end of the day, Chinese state television had broadcast news of the virus, soon to be designated as COVID-19.

By the end of January 2020, WHO had recorded 9720 confirmed cases of COVID-19 in China (with a further 15,000 suspected cases, though other models estimated the number could have been as high as 100,000) and 213 deaths. Outside China, 106 cases had been confirmed in nearby countries, such as Japan, South Korea and Australia, and further afield, in the US, France, Germany and Italy. On 2 February, WHO recorded the first two cases in the UK.

At this point, little was known about the virus, how it spread from person to person and how it attacked the respiratory system, except that it was wreaking havoc on the lungs of a small percentage of patients, leaving them struggling for their lives – many needed ventilators to feed them oxygen and take over their breathing. On 11 March, WHO declared a pandemic, and as the virus spread further around the world – particularly as the scenes of devastation began to emerge from the hard-hit hospitals of northern Italy – ventilator numbers were all of a sudden a pressing concern for governments and health authorities everywhere.

"THE VIRUS WAS WREAKING HAVOC ON THE LUNGS OF A SMALL PERCENTAGE OF PATIENTS

Ventilator numbers

At the start of the pandemic, the NHS had access to around 5,000 ventilators, rising to 8,000 when machines from private hospitals and other sources were factored in. On 18 March, *The New York Times* ran an article looking at the potential shortage of ventilators, warning the 160,000 machines available in US hospitals might need increasing, and that the Germans had ordered an extra 10,000 ventilators from the domestic manufacturer Dräger to add to the 25,000 capacity in its hospitals. Set against those numbers, the feeling was that the UK total would not be nearly enough.

Why did the UK not keep more ventilators in reserve in the event of a pandemic-like crises, which epidemiologists had warned was bound to happen sooner or later? A stockpile would have been a sensible precaution, says Professor Peter Ogrodnik at Keele University's School of Pharmacy and Bioengineering: "As an engineer, I would always err on the side of caution and have much more in stock than you'd normally need. If in an average year you need 4,000,

FAST FACTS

VENTILATOR AVAILABILITY AT THE END OF APRIL 2020:

10,900

The NHS had 10,900 mechanical invasive ventilators at the end of April

4,300

It also had 4,300 non-invasive devices

18,000

The initial ventilator target that Health Secretary Matt Hancock set on 5 April.

IMAGES: GETTY

I'd want 8,000 as a contingency. You might need them only once every 10 years, but there are ways of not having them standing idle."

With that contingency in place the subsequent scramble for ventilators might not have looked quite so frantic. The situation looked even worse when, as Dr Keith Ison, former IPEM President, says, modelling suggested well over 18,000 intensive care beds and associated equipment would be needed as the wave of COVID-19 cases hit the country. "We would have to quickly rack-up capacity, including repurposing anaesthetic machines as ICU ventilators and using CPAP devices as intermediate patient support. This is what was behind the drive to get hold of ventilators."

In mid-March, the government launched the Ventilator Challenge. "We're calling on the manufacturing industry and all those with relevant expertise who might be able to help to come together to help the country tackle this national crisis," said Downing Street. "We need to step up production of vital equipment such as ventilators so that we can all help the most vulnerable, and we need businesses to come to us and help in this national effort." It asked companies across industry to mobilise their technological know-how and manufacturing capacity in support of the effort.

Ramping up production

The drive to acquire more ventilators immediately ran into two big problems. The first was that COVID-19 crisis had become global, so the international competition for machines, components and other equipment had intensified. The UK would have to buy equipment wherever it could find it. The second was that the specialist nature of ventilator manufacturing meant that existing UK firms would not be able to scale-up production quick enough; even less likely was the possibility that companies unskilled and unequipped to build complex medical devices could do so from a standing start.

" IT'S HARD TO START FROM SCRATCH

If the engineering challenges were tough, so too were the regulatory obstacles. In the UK any company that makes medical devices has to be registered with the Medicines and Healthcare Products Regulatory Agency (MHRA) and any product used in a clinical setting must have a CE mark. Ventilators are class IIb devices, meaning their manufacture must be done under strict conditions (for example, using carefully controlled materials in sterile rooms). None of this, or the required CE mark, can be achieved overnight.

"It's hard to start from scratch," says Ogrodnik. "It's easier for those people who already have all the processes in place. They don't have the learning curve. They can trim down or change the manufacturing process, and they are already working to the regulatory processes. They can take a basic

THE VENTILATOR CHALLENGE

THE DEVICES THAT THAT MADE THE CUT

PENLON PRIMA ESO2 – the medical manufacturer Penlon has been working with a consortium of firms, including Siemens, Airbus and Ford, to adapt its ventilator for mass production – it normally makes around 50 a week but hopes to escalate that to 1,500 to meet an order of 15,000. The ESO2 machine can be switched on and off easily, allowing liquid to be regularly drained from the lungs.

SMITHS PARAPAC – with an order of 10,000 units, the Smiths Group is ramping up production, from hundreds of ventilators a month to thousands, with a close focus on its supply chain, in collaboration with companies from the auto, aerospace and industrial sectors. The portable paraPAC plus ventilator is especially useful during emergencies, or when patients are being moved.

BREAS MEDICAL NIPPY 4+ AND VIVO 65 – Breas has expanded its production capacity and shored-up its supply chain in order to concentrate on its versatile Vivo 65 model, which is capable of life-support, and the smaller, more mobile Nippy 4+.

Two other models that are subject to ongoing review to ensure they meet the needs of the NHS are the Zephyr Plus, made by Babcock/Dräger, and the Gemini, made by OES Medical.

❸ Lead ICU Nurse at Nightingale North East prepares equipment for a ventilator in ICU ward.
❹ A man wearing protective gear, sprays disinfectant on Piazza Duomo in Milan.

IMAGES: GETTY

ventilator and make a design modification far quicker than say Dyson or JCB could take an existing design and do something with it."

Even so, existing manufacturers would still find it hard to ramp up production to an extent that would make up the shortfall in quick time. Foremost, they would need time to identify and solve production bottlenecks. But, argues Ogrodnik, one big bottleneck would not be solved easily: "The main problem is that since the late seventies our manufacturing industry has been in decline, and our supply chain is now spread across the globe. We rely on overseas suppliers. Globalisation is good in one respect, but it has also left us exposed. There's a big difference between a supply chain that involves lorries driving through the Channel Tunnel compared to one that leaves us waiting for stuff to arrive on a 747 or on a container ship. Look at the problems with the equipment that's supposed to have come from Turkey and China."

Other questions and issues also abounded, not least the suitability of certain machines. "CPAP and BiPAP machines have a place in treating patients in the early stages of pneumonia, but are not able to cope with full-blown lung infections," says Ison. "Initial thoughts were that CPAP would not be that useful, then information from Italy suggested they could be, then clinical experience in the UK with seriously ill patients suggested their role was limited. This illustrates the truism that there are no simple answers and you need engineers to work with clinicians on everything from consumables supply to oxygen availability."

At the end of March, recognising that manufacturers needed help to meet the challenges of making ventilators, the MHRA eased the regulatory regime and promised to fast-track approval of promising devices. "I understand the intention is to allow them to be used during the pandemic with exemptions, with a view to achieving CE marking at a later stage," says Ison. "Validation is being carried out via clinical trials in major hospitals and an evaluation centre in Nottingham. It won't be until these items are in full clinical use for a while that all the limitations and issues will become apparent. There are reasons why it takes years to get items developed and accepted."

Training and utilising

Even once the ventilators are built and approved, that's not the end of the matter. Training healthcare workers how to use them is another hard task. "Manuals and quick training guides are being produced, both for the challenge ventilators and for the newly procured ventilators," says Ison. "But that isn't the same as individuals undergoing hands-on training. In practice, it takes weeks for clinicians to become confident using

5 Member of staff holds an absorber, a part of a medical ventilator, at AMRC Cymru in North Wales as the UK ramps up production of equipment.
6 Staff at Penlon in Abingdon, Oxfordshire, test ventilators ahead of them being shipped out to the NHS.

new models of ventilator from a manufacturer they are used to, let alone learning how a different make of machine works in detail. Ventilators are complex items that have to be mastered. If you make basic mistakes, you will put the lives of patients at risk."

Looking ahead, a tailor-made strategy will be needed for training and recording competency, not least to reduce liability insurance costs for hospitals. This will become a key issue if a second wave hits and hospitals start treating COVID and non-COVID patients side by side, says Ison. "If a stockpile of ventilators is ready to be rushed out to infection hotspots, how will the local clinical teams get trained quickly? It is unlikely that everyone can be trained in every model that they might be asked to use."

Ultimately, the Ventilator Challenge attracted more interest than the government could feasibly handle. Responses came from specialist medical manufacturers, high-tech engineering firms, industry and academia consortia, and even Formula One teams. The proposals ranged from brand new designs to re-engineered old models.

On 28 April, the government announced that an additional 2,400 mechanical ventilators had been made available to the NHS since the start of the pandemic. Some 250 of these had come via the Ventilator Challenger, which doesn't sound overly impressive. But as Ogrodnik says: "We should actually be impressed that they made any quite so quickly."

Tip of the iceberg

By the end of April, the NHS had access to 10,900 mechanical invasive ventilators and 4,300 non-invasive devices. But the government also said that during the coronavirus pandemic "everyone who has required a ventilator has had access to one". This hints that the clinical demand for machines has not been as great as feared, and not even close to the 18,000 target that health secretary Matt Hancock set on 5 April. Quite why remains to be seen, particularly when the COVID-19 death rate in the UK became the highest in Europe. The availability of non-invasive CPAP devices may be a factor, but there is a feeling that the UK has nevertheless been lucky and may have dodged a far worse bullet, though we may not be alone in that. "Other countries in Europe have faced similar problems," says Ison. "It is particularly acute where hospitals are limited to one or two different ventilator models. In the UK we are used to more diversity. In Germany, their high initial capacity meant that they could cope."

For now the government strategy for ventilators remains in place: buy more machines from overseas, scale-up the production of existing or modified designs, and design new devices. It's a catch-all approach, though one that need not really have been necessary, which is also the case for all sorts of far simpler items such as face masks. "Ventilators are just the tip of the iceberg," says Ogrodnik.

IMAGES: SHUTTERSTOCK / PA

"EVERYONE WHO HAS REQUIRED A VENTILATOR HAS HAD ACCESS TO ONE

IUPESM 40TH ANNIVERSARY

As IUPESM celebrates its 40th anniversary, we look back over the union's history.

The International Union for Physical and Engineering Sciences in Medicine (IUPESM) was established in 1980 as an union linking the International Organization for Medical Physics (IOMP) with the International Federation for Medical and Biological Engineering (IFMBE).

The principal objective of IUPESM is to contribute to the advancement of physical and engineering sciences in medicine for the benefit and wellbeing of humanity. The union is managed by both IOMP and IFMBE and its President and Vice-President are the past-Presidents of these Organisations, while the IUPESM Administrative Council is also elected by IOMP and IFMBE. The IUPESM now represents more than 150,000 professionals in over 100 countries. In spite of the difference in membership numbers between IFMBE (c.120,000) and IOMP (c.30,000), the union operates based on the principle that there should be equitable sharing between the two organisations.

The need for a union covering both professions was recognised back in the late 1970s. The first Joint Committee meeting for the creation of IUPESM was in Ottawa in 1977. The Union started its activities in January 1980, its first President being Prof. John Mallard, OBE, FIPEM (at that time President of IOMP). Four years ago, IOMP recognised the contribution of Prof. Mallard to the global development of the profession by establishing an International Award in his name.

The first steps of IUPESM were towards global recognition of our professions. To achieve this, IUPESM applied for membership of the International Council of Scientific Unions (ICSU) – one of the oldest non-governmental organisations in the world. The long process was completed in 1999 when IUPESM was accepted as a member. In 2018 ICSU merged with the International Social Science Council (ISSC) to form the International Science Council (ISC). IUPESM is the 27th member of the ISC, which has 32 full members. Membership is very significant in terms of international recognition of our professions.

The next steps of IUPESM were directed toward the inclusion of both medical physicists and biomedical engineers in the list of the internationally recognised professional occupations. This activity was of particular importance for colleagues in low-and-middle income countries (LMICs), many of whom were not able to be employed as medical physicists or biomedical engineers because these occupations were not listed in the International Standard Classification of Occupations (ISCO) of the International Labour Organization (ILO). Following complex negotiations, in 2012 IUPESM achieved inclusion of the occupation of "Medical Physicist" and the occupation of "Biomedical Engineer" in ISCO-08. Medical physicists are listed under Unit Group 2111, and biomedical engineers under Unit Group 2149. This further important international official recognition of both professions has benefited thousands of colleagues from LMICs.

IUPESM activities are handled by a number of committees, including: Education and Training, ISC Liaison, Union Journal, Public and International Relations, Awards, Data, and the Women in Medical Physics and Biomedical Engineering Task Group. In 2012 IUPESM set up a Health Technology Task Group (HTTG) intended to assist countries in defining their health technology needs, and identifying and rectifying health system constraints for adequate management and utilisation of health technology, particularly through training, capacity building and the development and application of appropriate technology.

IUPESM sponsors and coordinates the triennial "World Congress on Medical Physics and Biomedical Engineering". The union has organised all World Congresses since 1979 (Jerusalem) and is currently preparing for the World Congress 2021 in Singapore. The main IUPESM publication is the journal *Health and Technology* (Springer). To mark its 40th Anniversary, last year IUPESM approved a Fellowship scheme. The official office of IUPESM is at the IPEM Headquarters. Currently IUPESM is investigating the possibilities of acquiring a specific legal status in the UK, following the successful incorporation of IOMP in the UK. At present, three IPEM members are part of IUPESM's Administrative Council.

IPEM members *of the IUPESM Administrative Council: Slavik Tabakov, Stephen Keevil and Leandro Pecchia*

FAST FACTS

40
IUPESM is the 27th member of the ISC.

150K
IUPESM represents more than 150,000 professionals in over 100 countries.

2021
Currently preparing for the World Congress on Medical Physics and Biomedical Engineering in 2021.

A CHANGE OF ROLES

Nuclear medicine to personal protective equipment

At Imperial College Healthcare NHS Trust (ICHT), nuclear medicine Clinical Technologists have been redeployed as PPE Helpers. Clinical Technologist **Robert Konstandelos** asks if this is a blessing in disguise.

The coronavirus (COVID-19) pandemic that arrived in the UK a few months ago has radically changed the way we live and work. The viral pneumonia originated from Wuhan, Hubei Province in China and transfers from person to person. Consequently, this has affected operations of nuclear medicine (NM) departments nationwide. The majority of NM investigations and therapies are outpatient and elective. Non-urgent tests have been put on hold and some patients have cancelled appointments due to fear of visiting the hospital. There has been a drastic reduction in NM procedures performed, meaning some technologists and radiographers at ICHT have been redeployed to infection and prevention control (IPC) to work as personal protective equipment helpers, as a pilot scheme. The initial thought was that this role was to help supply staff with the right PPE equipment. However, the expectations for the role were entirely different.

IMAGE: GETTY

Self-contamination

There was a requirement for staff to demonstrate consistent and optimal PPE practice, as per Public Health England's guidance. Staff protection, minimising the risk of infecting others and ensuring the right PPE is available are essential to good PPE practice, so the role of PPE Helper was devised.

The objectives were: to support and help staff don (put on) and doff (take off) their PPE safely, provide and signpost PPE information and support staff who may be unsure of PPE practice. Sub-optimal use of PPE was a concern and could result in self-contamination.

Despite using PPE safely throughout a procedure, there is a possibility that a healthcare worker can self-contaminate – rates can be as high as 46-90% across types of PPE (i.e. gowns and gloves). This is a result of how PPE is worn and doffed, which is one of the most critical factors in minimising risk to individuals and colleagues. The effectiveness of PPE is determined by how healthcare workers wear and doff PPE, which was shown in the outbreak of a different infectious disease – Ebola. Similar principles can be applied to self-contamination of COVID-19.

Self-contamination is a term common to NM technologists and radiographers. Dealing with unsealed radioactive medicine that is used for patients is risky. Spillages can occur, leading to contamination on surfaces, including skin. Unknowing self-contamination of a radioactive substance has the potential to spread across an entire NM department, if a staff member does not monitor themselves after handling an unsealed source. This can result in spreading contamination across different surfaces and areas of the body. The worst case is possibly ingesting the radioactive substance.

" EFFECTIVENESS OF PPE IS DETERMINED BY HOW HEALTHCARE WORKERS WEAR AND DOFF PPE

In addition, patients administered with NM are a potential source of contamination. Most, if not all, radiopharmaceuticals are excreted from the body by some process. Typically, they are flushed from the body via urinary tract, but can also be excreted in other forms, such as saliva, sweat and tears. This can lead to many areas being contaminated. For instance, a radioactive iodine therapy patient during their inpatient procedure inside their shielded room. A variety of surfaces can become contaminated, such as pillowcases, worktop surfaces, tables, chairs and floors.

Also, NM staff have knowledge of minimising exposure to radiation. Applying the concept of time, distance and shielding is crucial to minimising the radiation dose received. It is key to minimise time exposed to an unsealed radioactive source and our walk-in patients. Increasing the distance between those sources is inversely proportional to the square of the distance. Meaning that a greater distance reduces the radiation dose significantly. Finally, lead shields and appropriate PPE can work effectively to minimise dose and potential skin contamination.

Resolving contamination

There is a possibility that radionuclide contamination can be compared to COVID-19 contamination. The teaching from the IPC team stated that COVID-19 spreads through droplets produced by the person infected, if they are not undergoing an aerosol generating procedure (AGP). Therefore, the way COVID-19 spreads can be similar to NM contamination, assuming a non-AGP. A sneeze or cough can produce droplets that can spread the disease across different surfaces in an infected bay. The major downside with this comparison is it is not possible to use a monitor to detect the virus.

The method of time, distance and shielding can be used in a similar way when dealing with a COVID-19 patient in a bed bay – minimising the time spent with the patient can minimise the potential exposure. Applying two-metre social distancing, where possible, from the infected patient reduces chances of collecting the virus on patient visits. Subsequently, using PPE appropriately can work effectively as a shield between the healthcare worker and the virus. These are examples clinical technologists can apply when giving reassurance and guidance to staff.

A fortunate aspect of NM is the ability to detect radiation using a variety of monitors. A handheld mini-scintillation radiation detection monitor can pick up the tiniest specks of radionuclide contamination. On the other hand, how that contamination is removed can

PPE COLLABORATIONS

In May, the government said NHS and social care staff in the UK are set to receive millions PPE items over the coming months, thanks to new collaborations with a number of organisations.

Companies including Amazon, the Royal Mint, Jaguar Land Rover and eBay are supporting the government's ongoing efforts to get PPE to the hardworking frontline staff.

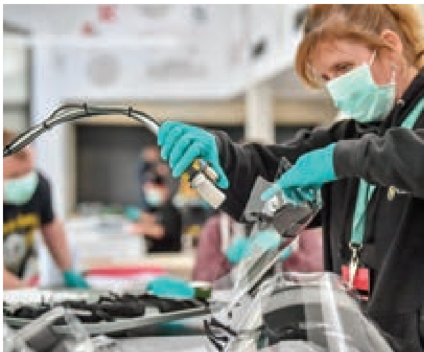
This follows a call-to-action from the government for UK businesses to use their existing manufacturing power and expertise to meet the growing demand for protective equipment.

More than 200 potential manufacturers have been identified and many have been contracted to make over 25 million items of PPE and deliver 12 million square metres of PPE fabric to produce items like gowns, gloves and aprons (see Fast Facts for examples).

Deliveries have started, including contracts for 2.5 million aprons and 50,000 bottles of hand sanitiser a week.

Firms will be supported through the regulatory, testing and procurement process in less than a month to get PPE to the frontline as quickly as possible.

IMAGES: GETTY / PA



be difficult! Technetium-99m contamination can be exceptionally hard. Cleaning is done to reduce the radionuclide count rate to as low as reasonably practicable. The surface is covered to prevent further possible spread and is removed once the radioactive substance has decayed to background levels. Skin contamination can be problematic to remove too! Handwashing multiple times may not remove all the contamination. Hair contamination means that one must wash their hair. Further drastic measures may be required, such as cutting the hair.

Thankfully, COVID-19 contamination is easier to remove. Using chlorine solution on surfaces where a suspected patient has been should remove the virus. Contamination on the skin can be cleared with an adequate hand hygiene technique. Using and doffing PPE optimally should limit the prospect of self-contamination. Ultimately, this should protect staff and reduce the chance of spreading the infection to others.

A new environment

Being on the wards has been a new experience. Technologists are familiar with control rooms, scanners, injection rooms, labs and hot waiting rooms, but the ward is completely different. The IPC team has been incredibly supportive when offering advice and most healthcare staff have been welcoming the PPE helpers onto their wards. There has been a great amount of appreciation for our input and advice, but, unfortunately, a small minority have not been as receptive. Recently, PPE has become a contentious issue, which has increased the challenges of working collaboratively.

Healthcare staff have been interested in talking about the roles we have left for our redeployment. Subsequently, this has led to a talk about radionuclide contamination and comparing it to COVID-19. The response has been interesting. Nurses are more horrified at the prospect of encountering radioactive substances than deadly infections. So telling the healthcare worker to imagine they are helping a radioactive patient may help get the message of using the PPE and doffing safely.

NM technologists have a deep understanding of contamination and its implications, and there is great care taken when handling radioactive substances and patients, as they are dangerous when handled inappropriately. For example, removing PPE sub-optimally can lead to greater radiation doses to hands via contamination. This can also be applied to infectious diseases. Radionuclide contamination in a clinical setting may not provide immediate repercussions, unlike infectious diseases. But it can be applied in the same manner – a single droplet produced from an infectious patient that enters the eyes, nose and mouth can infect another individual with devastating consequences.

" OUR INPUT AND ADVICE HAVE BEEN APPRECIATED

To conclude, the redeployment of NM technologists to IPC has been a blessing in disguise. As healthcare scientists, it is possible to analyse the processes and techniques in using PPE in a methodical manner. Basically, to constructively criticise decisions made by the healthcare worker and provide guidance in a similar fashion to a radionuclide contamination event. This redeployment has the potential to protect individuals, colleagues and patients. Most importantly, it has the potential to save lives!

Robert Konstandelos *is a Clinical Technologist at Imperial College Healthcare NHS Trust Nuclear Medicine*

FAST FACTS

1.9M
VISORS

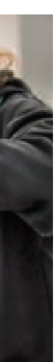
The Royal Mint will be providing over 1.9 million face visors over the next six months, with 54,000 being delivered a week.

12M
METRES OF FABRIC

Don & Low will be manufacturing 12 million metres squared of fabric for gowns over the next six months, with the first delivery expected at the end of May.

174,000
SANITISER BOTTLES

Ineos is delivering around 174,000 bottles of hand sanitiser a week to NHS hospitals.



BRICK BY BRICK

The Little Linac journey

IPEM's Little Linac project aims to give every UK child undergoing radiotherapy a free toy model of the machine used to treat them. **Sean Edmunds**, IPEM's External Relations Manager, tells the story of how some of the kits ended up in South Africa.

From York to Cape Town via Santiago is a bit of a circuitous route, but that is how some of IPEM's Little Linacs ended up at a children's cancer charity in South Africa.

Wayne and Cheryl Flowers, of Flowbiomed, a company based in Sandton just outside of Johannesburg (1), were attending the International Conference on Medical Physics in Santiago, Chile, when they spotted the Little Linac on the IPEM stand there.

They got chatting to Professor Stephen O'Connor, IPEM's President, who told them all about the Little Linac initiative and the aim of giving every child in the UK undergoing radiotherapy a free Little Linac model to help ease their stress and anxiety.

A wonderful opportunity

Cheryl says: "This really caught our eye and resonated with us, not only because of our business in the oncology sector, but also due to the large number of children suffering with cancer in South Africa.

"Our own medical physics congress, the South African Association of Physicists in Medicine and Biology (SAAPMB), was taking place in Cape Town the following month and we thought it would be a wonderful opportunity to launch this initiative locally.

"Fortunately, Chris Trauernicht, the current Chair of SAAPMB, was also attending the congress in Chile and he was very excited about the prospect."

Cheryl and Wayne's idea was simple: Flowbiomed would buy enough Little Linacs to provide each delegate attending SAAPMB with one to take back to their department and, at the same time, IPEM agreed to donate the same number of models to their company to give to a local cancer charity.

"The obvious choice was the Childhood Cancer Foundation South Africa (CHOC), which provides free, comprehensive support to families of children with cancer and life-threatening blood disorders," says Cheryl.

"CHOC is mainly active in government hospitals, where children are often from rural backgrounds and families have little concept of what cancer treatment involves.

"We approached them and they were overwhelmed with the offer and the opportunities it would give them to benefit the children. They have a number of social workers in all the main hospitals and centres, including a few private clinics. They have some resources for explaining chemotherapy, but nothing to prepare the children or educate the parents about what radiation therapy is all about. The Little Linac could be used to show them what a treatment machine looks like, as well as being a tool for therapy in helping to reduce the anxiety being experienced."

(1) CHOC Head Office, Johannesburg, Cheryl Flowers, Adri Ludick, Programme Development Manager, CHOC, Alta Bence, Psychosocial Support Services, CHOC, Wayne Flowers, of Flowbiomed.

Incredible passion

During the SAAPMB congress, there was a handover of some Little Linacs to Lynette

❷ Oliver Chillmaid (far left), aged four, at the Northern Centre for Cancer Care in Newcastle and ❸ Aaron Pilcher (left), aged 10, at Nottingham University Hospitals NHS Trust, were among the first children in the UK to receive Little Linac kits.

Muthuray, the Western Cape CHOC Director, who spoke about what a tremendous difference the models would make in the lives of children living with cancer.

Whilst in Cape Town, Cheryl and Wayne also met Professor Alan Davidson, Head of Paediatric Oncology at the Red Cross Children's Hospital, the largest children's hospital in Africa. Around 140 children are treated there each year for cancer and Cheryl and Wayne donated a few Little Linacs to the hospital.

Once they were back in Johannesburg, Cheryl and Wayne met up with Adri Ludick, Programme Development Manager, and Alta Bence, Psychosocial Support Services Manager, at the CHOC head office, to hand over the balance of Little Linacs.

"We were struck by their incredible passion, commitment and enthusiasm," says Cheryl. "They were thrilled with the donation and see this initiative as something that will develop into a major project.

" THIS REALLY CAUGHT OUR EYE AND RESONATED WITH US

"They know Professor Davidson very well, and with him on board, the dream of every child in South Africa undergoing radiation therapy having their own toy has a great chance of being realised.

"CHOC has received 130 toys in total, a long way off the ultimate goal, but a great start to realising the dream."

THE LITTLE LINAC MACHINE PROJECT

The Little Linac machine (Linac being short for linear accelerator) project was started by Professor David Brettle (left) when he was President of IPEM. The idea was to use the toy bricks to educate young patients about their treatment in a way that is designed to reduce their stress and anxiety, and so contribute to successful treatment sessions. As well as the linac, the kit also makes three other imaging or treatment machines the child may encounter during their time in hospital – an MRI scanner, a gamma camera and a CT scanner. After their treatment is over, David's challenge to the children is to use the bricks to make something different: a rocket, a rabbit or robot, as part of their transition back to a more normal life.

For more information on the project, visit ipem.ac.uk/AboutIPEM/Campaigns/LittleLinac.aspx

A WIDER PERSPECTIVE

Andy Rogers, Lead Interventional Medical Physics Expert at Nottingham University Hospitals NHS Trust, maps his journey from silo to multi-disciplinary thinking.

IMAGE: GETTY

"WORKING MULTI-DISCIPLINARILY WITHIN PROFESSIONAL BODIES ALSO OPENS UP MANY OPPORTUNITIES TO INFLUENCE BOTH PRACTICE AND POLICY

When I started in medical physics at King's College Hospital back in 1985 at the age of 28, I was an experienced research physicist, but a very raw clinical scientist. I was employed as a basic grade physicist in the radiation protection section and spent the next few years driving around south east London testing X-ray equipment, giving talks to nurses at their induction about radiation safety and incrementally starting a network of other medical physicists from around south London.

It was very intensive on-the-job training and I had excellent mentor colleagues who were international experts in their fields. It soon became evident to me that, watching these more experienced, senior colleagues at work, the things I was lacking were a clinical context for my work and clinical colleagues to discuss issues with. I had joined IPEM immediately upon employment and was already active as a basic grade rep – IPEM was fulfilling my immediate medical physics needs, but something was missing.

"THE REAL GOAL WAS TO ACTUALLY WORK COLLABORATIVELY WITH CLINICAL COLLEAGUES

Collaborative working

I was lucky enough to meet other physicists from around London who introduced me to the British Institute of Radiology (BIR) and its journal *The British Journal of Radiology (BJR)*. In those days (the late 1980s), the *BJR* was full of medical physics papers, as well as clinical papers, and I found this mix compelling, so I joined the BIR.

Being a shy and retiring type I soon realised that, although access to multi-disciplinary material widened my horizons, the real goal was to actually work collaboratively with clinical colleagues and so, to be honest, I bullied the BIR until they let me join their Radiation Protection Committee.

This enabled multi-disciplinary working within a subject area that I felt confident in, namely radiation protection as applied to radiology. Meeting and discussing issues with radiologists and regulators gave me a wider perspective on solutions and, I genuinely believe, made me a better clinical scientist.

I also discovered that, once working and communicating effectively with clinical colleagues within their clinical areas, they appreciated the different skills that a scientist brings. The whole experience may be summed up as "pushing at an open door". Working multi-disciplinarily within professional bodies also opens up many opportunities to influence both practice and policy at a national level and I would recommend this whole-heartedly to all young clinical physicists and engineers who are just starting out on their careers.

Wide interaction

My career will soon come to a close, but the mixture of my "home" professional body providing both support and interesting debates within my core scientific area and the ability, via bodies, such as the BIR (but there are others depending upon your areas of interest), to interact more widely professionally, has provided me with the most satisfying career and I only hope that my contribution has in some small way rebalanced the equation of giving/taking. So, don't just engage with your local clinical colleagues – go take it to the next level.

THE RADIUM BOSS

The life and times of Sidney Russ (1879-1963)

❶ Centre. Middlesex Hospital, Mortimer Street, London (circa 1910).

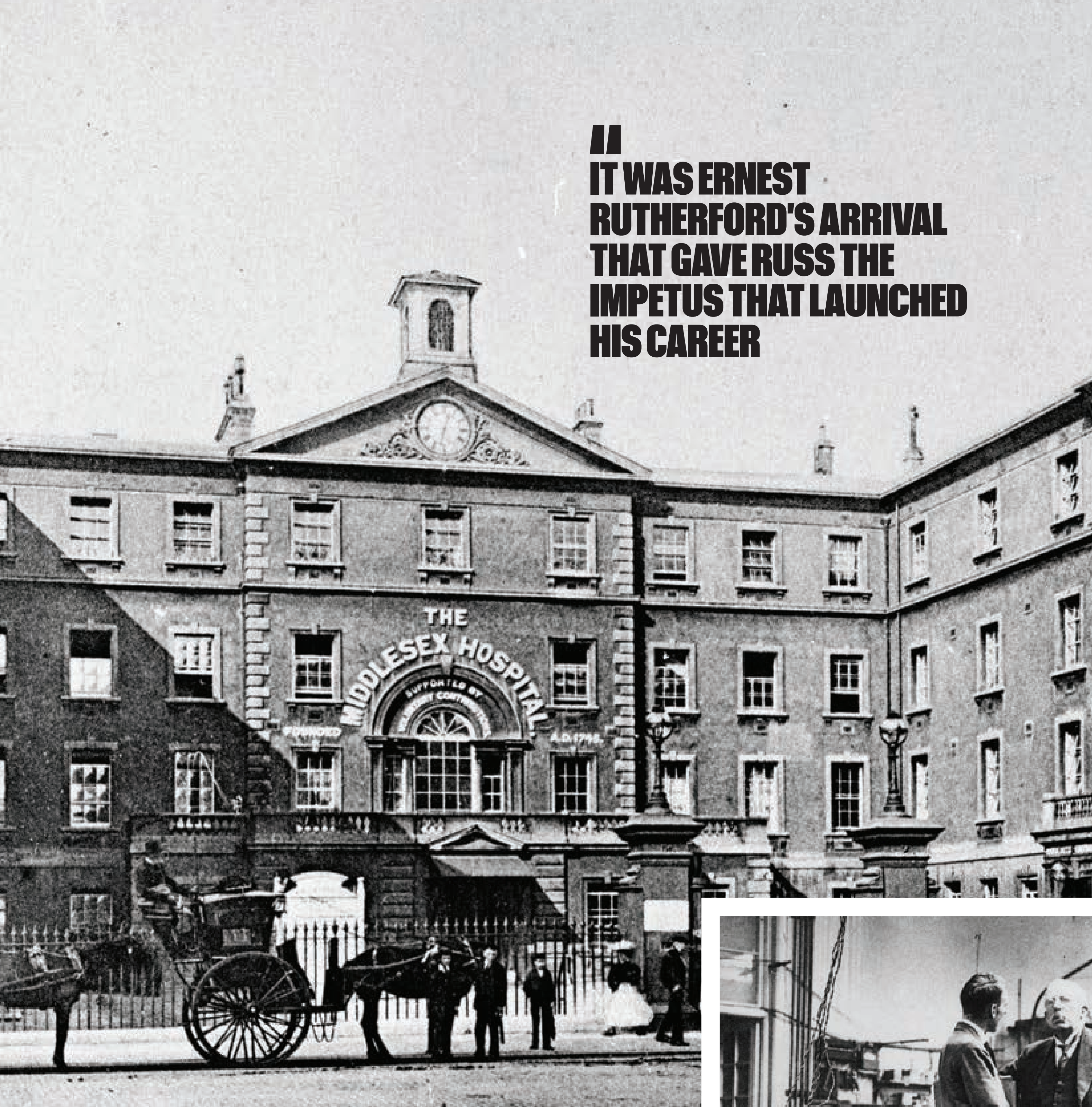
❷ Right. Ernest Rutherford (right) in the Cavendish Laboratory at the University of Cambridge.

Medical physicist **Francis Duck** describes the life of **Sidney Russ**, whose pioneering work established radium and made radiology safe.

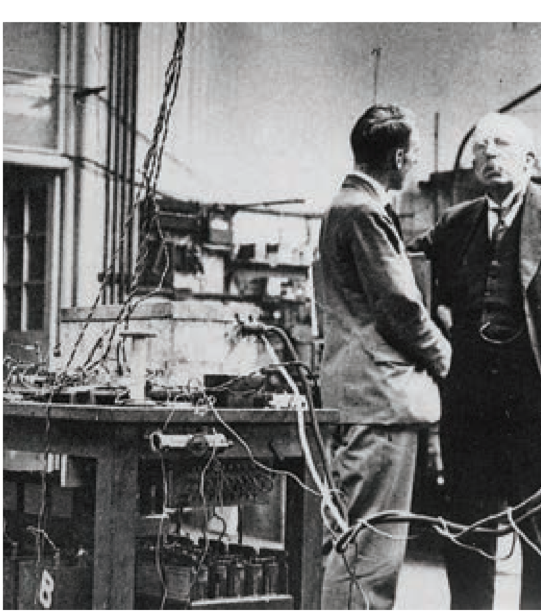
Sidney Russ grew up in London in a large middle-class family. His father, Charles, was a naturalised German immigrant and a successful fur trader. All seven Russ brothers attended a small Christian boarding school in Cornwall. His father had died by the time he matriculated in 1897, but he was still apprenticed to follow him as a furrier in London.

Early years

The release of Russ' inheritance of £3500 left him free to enter university. He studied physics at University College London, travelled a bit (to Egypt and to Paris), and graduated with a first in 1905. He was then appointed as demonstrator in Arthur Schuster's physics department in Manchester. Schuster also had German origins, and was one of only two British recipients of Röntgen's first paper, describing his discovery of x-rays. One family story even suggests that Russ visited Röntgen, which is possible, given Schuster's link and Russ' fluency in German. A short flirtation with Schuster's daughter, Nora, is more believable, his family remembering him having "a great way with women using his charm and knowledge without a hint of superiority". Schuster had already procured 60-70mg of radium, and this enabled Russ



"IT WAS ERNEST RUTHERFORD'S ARRIVAL THAT GAVE RUSS THE IMPETUS THAT LAUNCHED HIS CAREER



to carry out his first experiments with this rare and expensive element. However, it was Ernest Rutherford's arrival in Manchester in May 1907 that gave Russ the impetus that launched his career. Russ worked with Walter Makower, recruited from the Cavendish Laboratory, publishing studies of radioactive recoil and, in 1909, submitted his DSc thesis to London University.

Lifetime pattern

Sidney could have looked forward to becoming a senior academic physicist. But instead, in December 1909, he applied for one of the new Beit Memorial Fellowships, established "to promote the advancement by research of medicine and the allied sciences in their relations to medicine". These Fellowships, valued at £250 per annum for three years, were restricted to "any person of European descent by both parents". Maybe his brother Charles, who had been trained at the Middlesex Hospital ❶, told Sidney about the Cancer Research Laboratory there. However he identified this laboratory, his application was accepted and he commenced his new appointment on 1 March 1910, one of 10 successful candidates appointed nationally in this first batch. Russ was described as an "author of papers and researches on radium, thorium and actinium". His research was to be concerned with the association of radioactivity and cancer, a specific interest of Walter Lazarus-Barlow, the Director of the Cancer Laboratory, who believed that cancerous cells were so because of the radium they contained.

The Beit Fellowship established a lifetime pattern of research across discipline boundaries. During the next three years, he published with several medical colleagues: with Hector Colwell, Assistant Director of Cancer Research, on radiation chemistry; with Cecil Lyster, Radiologist Head of the Electrical Department, on the clinical use of radon; with the bacteriologist Bernard Wedd on the vitality of irradiated cancer cells; with Albert Morson on cancer immunity; with the pathologist Helen Chalmers on the bactericidal action of radium radiation and the effect of radiation on blood cells – the start of a long-standing professional relationship between them. His work with Colwell culminated in *Radium, X-rays and the Living Cell* (1915), a complete evaluation of knowledge in this rapidly developing discipline of

"THEIR WYNDHAM LEWIS ENCOUNTER RESULTED IN A PORTRAIT OF SIDNEY RUSS

❸ Sidney Russ. Portrait by Wyndham Lewis. 1933.

radiobiology. In the preface he thanked Makower for reading the manuscript, retaining his physics contacts. He published individually, too: a comparison of the radiation from radium with x-rays; secondary radiation from animal tissues; radiation from radium mounted as supplied for clinical use ❹. A visit with Morson to Paris to study radium treatment of cancer resulted in the purchase of 150 mg RaBr from the Société Française du Radium.

As the end of his three-year fellowship approached, Lazarus-Barlow convinced the Middlesex Board that the hospital should retain Russ' services for another six months. Thus, in January 1913, Russ became the first physicist to gain full-time employment in a British hospital.

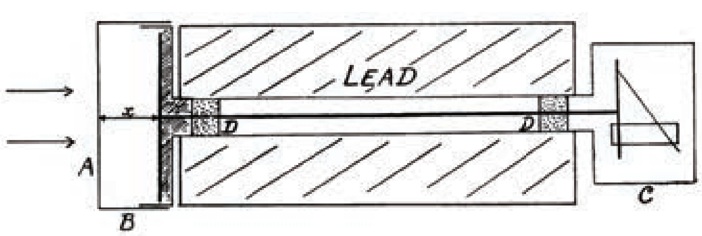
His appointment was made permanent later in the year, with an eventual salary £500 per annum.

Radiation protection

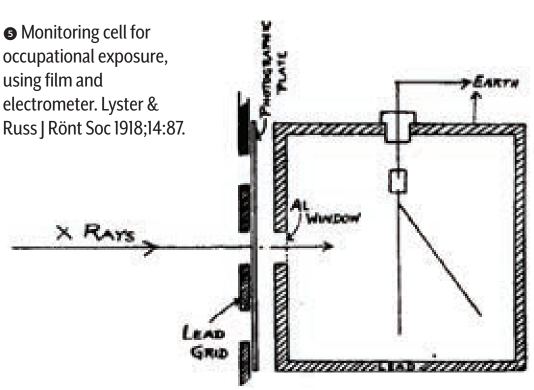
The outbreak of war redirected Russ's work. In his 1909 Croonian Lecture, Lazarus-Barlow had reported "the undoubted fact that workers with x-rays are liable to suffer from carcinoma of the hand". The war, with its widespread use of radiography, brought increasing evidence of this risk. In June 1915, Russ was asked by the MRC to "draw up detailed rules to be observed by x-ray operators at military hospitals". The death in 1916 of Reginald Mann, a Middlesex radiographer, from radiation-induced disseminated cancer increased Russ's concern and he initiated further action on radiation protection in the Röntgen Society. He carried out his first room survey using film in the same year and, in 1918, designed an energy-sensitive means to monitor occupational exposure ❺. After the war ended, and with the deaths of several radiologists from the metastatic spread of skin cancer, including his colleague Cecil Lyster in 1920, Russ started the British X-ray and Radium Protection Committee, becoming its Joint Secretary and writing guidelines that would set international standards for protection.

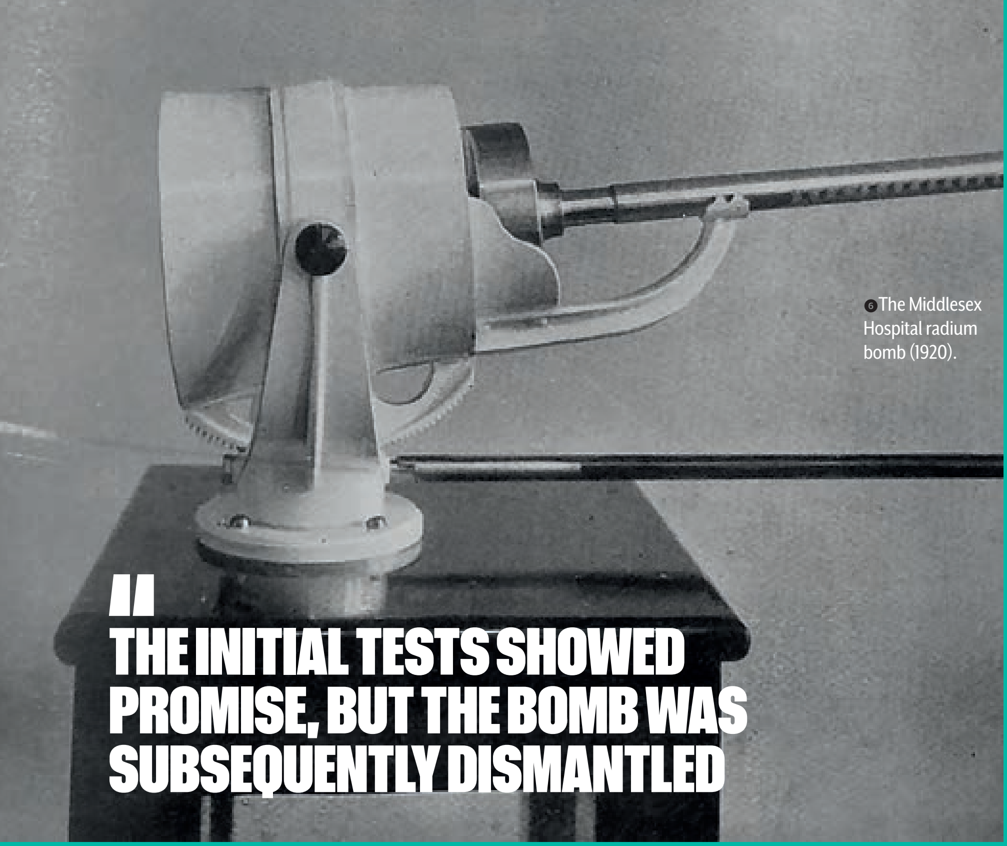
Sidney Russ married Mary Priestly on 19 August 1917. It was a marriage of opposites: Sidney was "precise and autocratic, but genuinely kind" and Mary, "supercharged" according to one family member, who suffered from TB for much of her life. They had three children, including one son tragically lost at sea during WW2. They lived first in London, moved to Kent, then back to London in 1930 when Mary returned from another extended period in a

❹ Variable volume ionisation chamber for radium measurements, connected to electrometer C through amber plugs DD. Russ. Proc Roy Soc Med 1914;7:92-102.



❺ Monitoring cell for occupational exposure, using film and electrometer. Lyster & Russ J Rönt Soc 1918;14:87.





6 The Middlesex Hospital radium bomb (1920).

"THE INITIAL TESTS SHOWED PROMISE, BUT THE BOMB WAS SUBSEQUENTLY DISMANTLED

convalescent home. Their encounter with the charismatic artist and novelist Wyndham Lewis left the marriage with shock-waves that took time to heal. It resulted, however, in a portrait of Sidney Russ, uncharacteristically realistic for an artist known for his avant-garde "vorticist" style 3. A more supportive friendship developed with the Duchess of Bedford. Mary spent some time in the Duchess' cottage hospital at Woburn where Sidney provides advice and tuition in radiology.

Radium and radiobiology

Peacetime saw a return to research. He worked with Helen Chalmers, returned from Endell Street Military Hospital, investigating radiation effects on lymphocytes. Together they set up and tested the first radium bomb in Britain, using 5g of radium bromide given to the MRC by the Ministry of Munitions in 1919, recovered from war-time gun-sights and instruments. The sources, in eighteen glass tubes, were mounted in a 20mm thick lead and brass box 6. The initial tests showed promise, but radium was expensive and scarce and the bomb was subsequently dismantled and the radium was reused in other centres, apart from about 0.5g that was retained in the Middlesex as a radon source. Chalmers was the first doctor to state clearly that the physicist was an essential part of the radiotherapy team, alongside the surgeon, radiologist and pathologist, certainly influenced by her experience working with Russ. His appointment as the first Joel Professor of Physics in the Middlesex Hospital Medical School in 1920 established Russ as the leading British scientist in medical radiation physics.

A laboratory technician, Gladwys Scott, was appointed; she would become his research assistant for the next twenty-five years. Although she had no formal qualifications, her care and dedication resulted in a series of papers with him on radiobiology, particularly on animal studies with mice. His children knew her as "Scotty", remembering her as "a lovely person to know". She referred to him and as "The Lucid One". His "Physicists' Department" expanded with the addition of Bernard Watters and Leslie Clark, both co-authors of his next book, *Physics in Medical Radiology* (1928).

Russ held numerous committee positions. He was secretary of the MRC Radiology Committee and, from 1928 to 1934, was the first scientific secretary of the governmental Radium Commission, managing the national acquisition and distribution of radium for medical and scientific purposes. He helped to form the first British X-ray Units Committee. He served on the King's Fund Radium Committee and evolved safe practices for the handling, storage and transport of radium. He was awarded the CBE for his services to radium work, refusing a knighthood because "he did not have the corresponding assets". In 1939 he was responsible for transferring radium to a safe store near Luton, later designing bombproof safes for the radium returned for clinical use. He was the first chairman of the Hospital Physicists' Association in 1943, never accepting the term "medical physicist", associating the meaning to that in "medical missionary", implying a medical qualification.

Russ still found time to teach, but was better at public lectures and broadcast a talk on the future of radiology and another on ultra-violet rays, "given from the London Wireless Station on November 7, 1928".

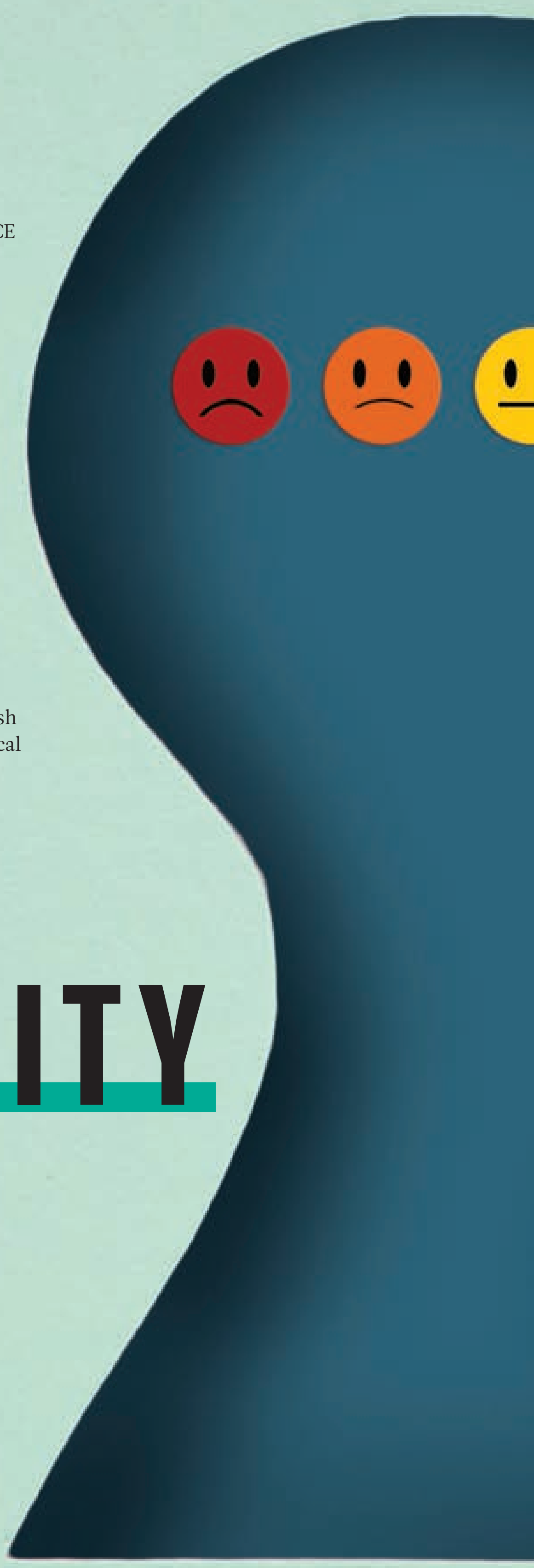
After retirement, Mary and Sidney moved to Bognor Regis 7 where Mary succumbed to TB in 1959. With spare time, he remembered skills learned as a young man, sewing a fur hat for his granddaughter Holly. He wrote a small book *Smoking and its Effects*, remarking that "I see no reason for a man giving up smoking". Sidney Russ died at home on 27 July 1963, of carcinoma of the bronchus.

Francis Duck *is a retired medical physicist who spent most of his career in medical ultrasound. He would like to thank John Russ for making available a copy of his biography of his father.*

7 Antique black and white photograph of Bognor Regis

EVIDENCING A HIGH-QUALITY SERVICE

Dr David Compton from UKAS outlines the progress, lessons learned and next steps in the development of the quality assurance scheme for medical physics and clinical engineering services.



Medical physics and clinical engineering (MPACE) are key components of virtually every patient care pathway, making significant contributions to both the management of risk and the delivery of diagnostic and therapeutic procedures.

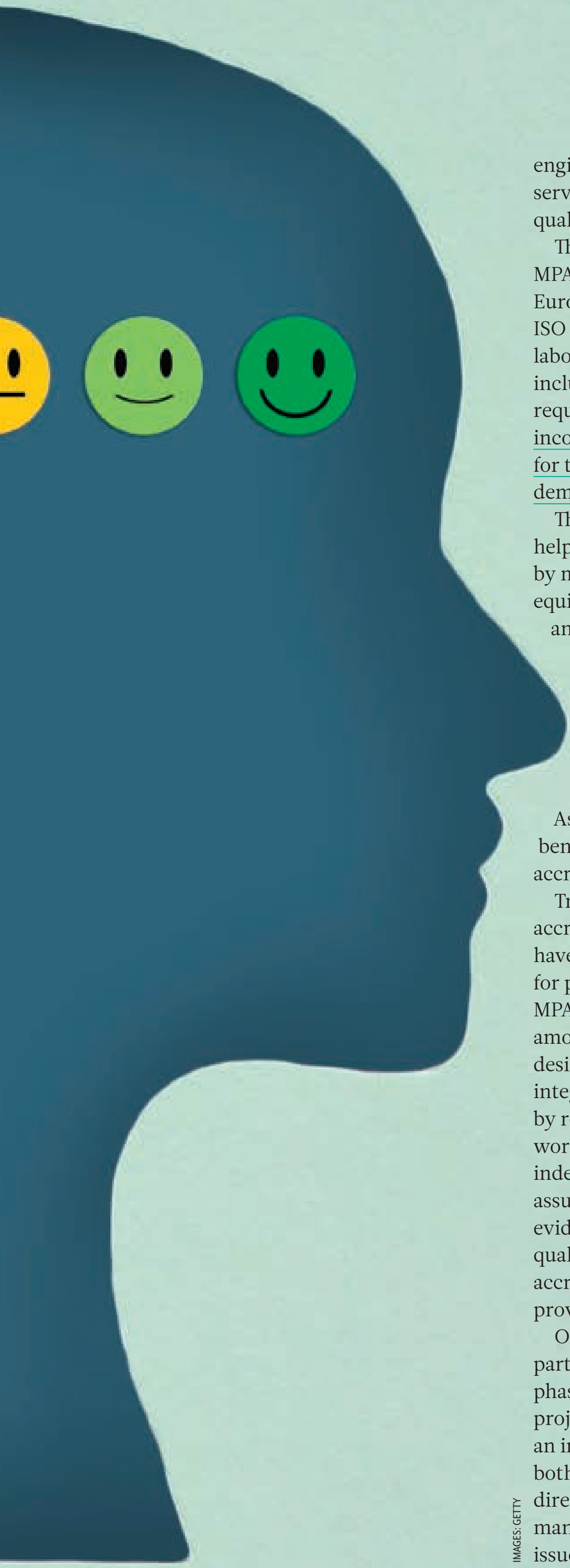
Following a successful two-year pilot assessment project, the first United Kingdom Accreditation Service (UKAS) accreditations for MPACE have now been awarded to The Royal Marsden NHS Foundation Trust (Medical Equipment Management) and Hull University Teaching Hospitals NHS Trust (Radiotherapy Physics).

NHS trusts have previously been certified via a number of separate medical schemes. While these schemes may have involved participation of the medical physics and clinical engineering departments, they were not MPACE focused and did not deliver the technical assurance that MPACE departments, trusts, commissioners and patients required.

Similarly, MPACE departments have stated that they could not rely on simply holding certification to ISO 9001 Quality Management Systems and ISO 13485 Medical Devices standards to prove their competence to patients and key stakeholders.

Consequently, the MPACE scheme was developed at the request of NHS England and is supported by IPEM. UKAS accreditation of the scheme provides confidence in the competence of an organisation to deliver reliable and safe MPACE services.

Organisations applying are assessed against the requirements of the new British Standard BS 70000 Medical physics, clinical



IMAGES: GETTY

engineering and associated scientific services in healthcare – requirements for quality safety and competence.

This is produced by a broad group of MPACE experts from both the UK and Europe and is based on the widely used ISO 15189 international medical laboratories standard. In addition to including the quality management requirements of ISO 9001, BS 70000 incorporates MPACE tailored requirements for technical competency, activity validity demonstration and peer review ❶.

The accreditation of MPACE services helps deliver consistently high quality care by maintaining the safety and accuracy of equipment and ensuring that diagnostic and therapeutic procedures are evidence-based, safe and effective.

Initial trust feedback

BS 70000 accreditation focuses on the competence of the organisation to deliver reliable and safe services. As a result, participating trusts have benefited from the scrutiny that accreditation places on them.

Trusts going through the accreditation assessment process have expressed additional motivations for participating in the MPACE scheme. Chief among these are a desire to better integrate departments by reducing silo working, and the independent assurance and evidence of service quality that UKAS accreditation provides.

Other organisations participating in the phase 1 of the pilot project have reported an improvement in both engagement with director-level management and issue escalation processes within the trust, contributing to a greater sense of "team".

> **"BS 70000 ACCREDITATION FOCUSES ON THE COMPETENCE OF THE ORGANISATION TO DELIVER RELIABLE AND SAFE SERVICES**

The accreditation process has also helped MPACE departments comprehensively review all relevant procedures and documentation, allowing them to identify errors and departures from OEMs, as well as potential efficiency gains.

This has enabled trusts to address variation and/or poor working practices, improve controls over third-party services and better implement services, enhancing their overall quality.

Work in progress

By their very nature, pilot schemes are rarely 100% the finished article, and valuable lessons are being learned by all parties throughout the pilot programme. Perhaps the most valuable feedback has come from the trusts who either have been, or are currently going, through the accreditation process.

Accreditation is a continuous process that is based upon a cycle of regular assessments, whereas the ability of healthcare practitioners is often indicated by passing a series of one-off examinations. One of the key challenges identified by phase 1

BS 70000

❶ BS 70000 incorporates a wide range of MPACE activities:

- Equipment management and technical servicing
- Medical electronics and instrumentation
- Medical engineering design
- Clinical measurement and development
- Biomedical engineering
- Diagnostic radiology and MR physics
- Nuclear medicine physics
- Radiopharmacy
- Radiation safety
- Radiotherapy physics
- Reconstructive science.

participants is how best to introduce an effective and efficient method to assess the competency of staff on an ongoing (rather than snapshot) basis. Similar questions were raised regarding implementing quality assurance measures that ensure service output is of the required standard.

When it comes to meeting the requirements of the standard itself, pilot participants reported issues with identifying the most appropriate source of uncertainty and, where possible, quantifying the level(s). Traceability in the areas of calibration and reference material also proved harder to determine than first anticipated, particularly with gaining supporting evidence from external suppliers. Similar experiences were expressed regarding satisfactorily verifying that services could perform equipment checks and maintenance in accordance with the manufacturer's instructions.

Inevitably, the introduction of a new standard leaves some room for interpretation, particularly as BS 70000 covers many MPACE areas, so cannot be explicit to a specific discipline. Any potential aspects of the standard that require modification, removal or addition are currently being discussed with BSI, the owner of the standard.

> "MPACE INVOLVES A BROAD RANGE OF DISCIPLINES, THERE ARE POTENTIAL AREAS OF OVERLAP WITH OTHER EXISTING ACCREDITATION SCHEMES

To help trusts identify what is required and where they need to improve, UKAS is in the process of developing an assisted learning programme. This will allow applicants to develop their quality management system to the required level by implementing improvements in easy-to-manage increments over a period of up to two years.

❷ Gerhardus Bosman and Muhammad Zia from The Royal Marsden NHS Foundation Trust receiving their accreditation certificate from Lorraine Turner David Compton and Peter Jarritt, all from UKAS.

Gaining traction

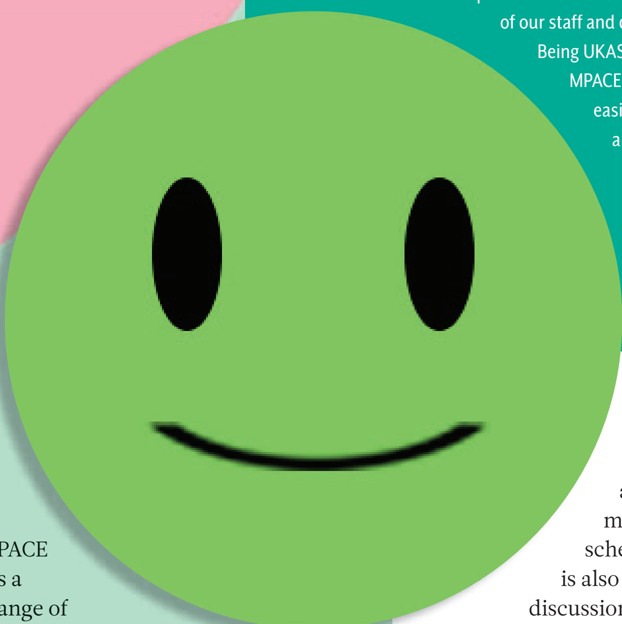
Despite MPACE services having a direct effect on the treatment that nearly every patient receives, MPACE departments can often feel that their relatively small size means that they do not have much visibility at board level within the trust. In turn, this could foster a belief within MPACE departments that they will not be able to secure the time and financial resources necessary to enable them to go through the accreditation process. However, as reported by phase 1 pilot participants, becoming accredited under the MPACE scheme not only benefits the standards of patient care, it also improves departmental efficiencies and visibility within the trust. Recognising the potential chicken-and-egg nature of this situation, UKAS is in discussions with the relevant professional groups – such as CMAS, RESMaG and BNMS – to help gain recognition of the value of accredited MPACE services within trusts, thus assisting with internal funding applications.

CUSTOMER FEEDBACK

Hardus Bosman, Clinical Engineering Manager at The Royal Marsden NHS Foundation Trust, says:
"MPACE assessment is more technically involved than other audits we have experienced. In addition to improving inaccuracy detection, going through the UKAS accreditation process has helped standardise our policies and procedures. In turn, this has increased both staff and OEM involvement in the quality management process and helped us improve staff competency levels and training workshops.

"The resulting improvements to patient care, together with increased recognition of our department within the trust, means I would recommend the MPACE scheme."

Richard Whitlam, Quality Manager at Hull University Teaching Hospitals NHS Trust, says:
"Our medical physics department has been ISO 9001 certified for many years, but we were looking to increase levels of patient, CCG and professional assurance in the competence of our staff and quality of our service. Being UKAS accredited under the MPACE scheme means we can easily evidence that our staff are technically competent and that we deliver a high-quality service that is focused on putting patient care first."



As MPACE involves a broad range of disciplines, there are potential areas of overlap with other existing accreditation schemes. For example, elements of diagnostic imaging requirements could be met by QSI (formerly ISAS), while ISO 15189 (the medical laboratories standard) may cover some laboratory requirements.

UKAS already accredits several organisations against either, or both, of these standards, some of which may be or are considering accreditation under the MPACE scheme. UKAS is, therefore, currently exploring ways in which the assessment teams can be harmonised and common assessment processes rationalised for these organisations, bringing economies of scale for trusts seeking UKAS accreditation against multiple, overlapping-schemes/standards. UKAS is also engaged in similar discussions with the National School of Healthcare Science to minimise duplication when assessing areas around training.

Trusts too can also play a significant role in improving cost and assessment efficiencies across multiple pathways. For example, the first step could be to align quality management teams to operate under a common management system, which encompasses all the requirements of the different standards under review. As the relevant standards share many of the same core elements, this should be a more straightforward measure than it might first appear to be.

While it is UKAS' understanding that accreditation of MPACE services is likely to remain voluntary, there is a drive within NHSE, devolved governments, commissioners and individual trusts to achieve equal external quality assurance across all diagnostic services. Holding accreditation under the MPACE scheme could be relied upon to support other commissioning and regulatory requirements. For example, the Care Quality Commission (CQC) already recognises the value of UKAS-accredited schemes as information sources to support its inspection visits. As BS 70000 is a new standard, it has yet to receive formal CQC recognition, but this is something UKAS, NHSE, NHSI, CQC and MHRA are working towards for MPACE.

Widening the scope

In addition to confirming that BS 70000 is the appropriate standard to assess MPACE services against, phase 1 of the MPACE pilot scheme established both the scope of accreditation for MPACE services as well as a robust assessment approach.

Phase 1 of the MPACE pilot initially focused on radiotherapy physics and the management of medical equipment within clinical engineering. UKAS is working with the relevant experts and organisations in other MPACE service areas to include them in the final accreditation scheme. To initiate phase 2 of the pilot, calls for expressions of interest have been made to service providers in the fields of clinical movement analysis and rehabilitation engineering. In addition, a proposal for a harmonised assessment for MPACE and QSI is currently under consideration in the nuclear medicine discipline.

As with phase 1, the main aim of phase 2 is to develop an accreditation scheme which provides external assurance on the quality and competence of the relevant services and to drive improvement of standards within this area. UKAS accreditation provides confidence to all service users, including patients and commissioners, and promotes delivery of better quality services, which, in turn, leads to better quality patient outcomes.

Dr David Compton *is Development Section Head at UKAS. For more information and detailed FAQs on MPAC accreditation, visit the UKAS website.*

IMBT

The radiation acronym you've probably never heard of

A look at the wide range of approaches to intensity-modulated brachytherapy in cancer treatment therapy.

Brachytherapy (BT) remains an essential tool in the radiation oncologist's armoury, potentially offering patients shorter treatment durations and lower doses to organs at risk (OARs). Brachytherapy sources naturally produce a symmetric isotropic field, but this does not lend itself to producing the most conformal plan possible, particularly for irregularly shaped organs, or those in close proximity to an OAR.

High-Z materials have long been used to shield OARs across different radiation therapy modalities. However, the use of such materials to create an intensity modulated brachytherapy (IMBT) plan is still under investigation. Researchers from the University of Iowa have made a systematic literature review covering the different techniques of IMBT (Callaghan 2019 *IJROBP*), which can be distinctly separated into two: static IMBT and dynamic IMBT. Each of these can be categorised into two further subgroups, dependent on whether the shield is associated with the source or the applicator, giving a total of four groups: shielded source static IMBT; shielded applicator static IMBT; shielded source dynamic IMBT; and shielded applicator dynamic IMBT.

Literature review

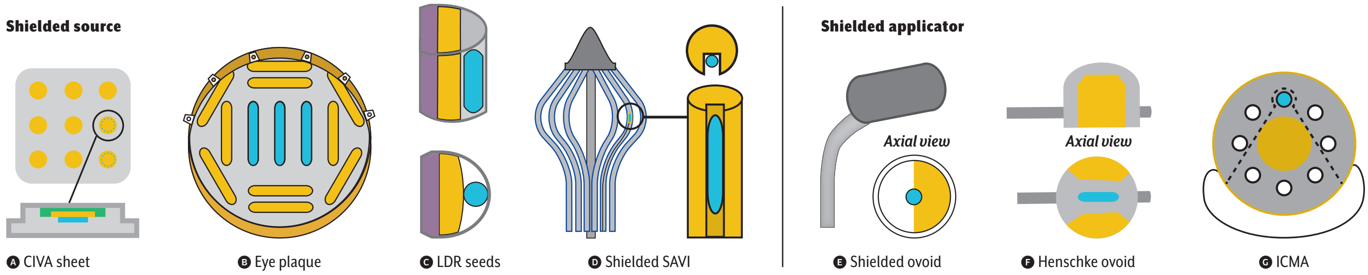
Inclusion criteria for the literature review were any peer-reviewed journal articles published between 1980 and 2018 that included a range of terms, such as "HDR brachytherapy shielding", "IMBT" and "dynamic-modulated brachytherapy". Following typical exclusion criteria, such as language, non-peer-reviewed articles and unavailability of the full text, a total of 78 peer-reviewed articles were included in the final analysis. A summary of the different techniques for static IMBT (below) and dynamic IMBT (right) will be referred to throughout the remainder of this article.

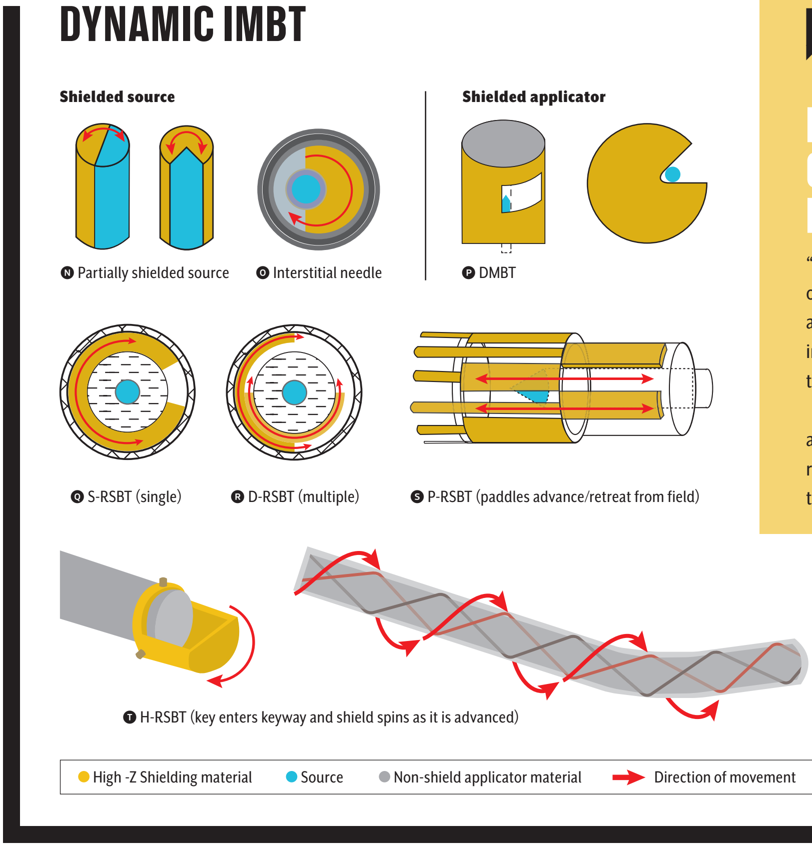
Static IMBT

Static IMBT refers to those in which the shield does not move relative to the source or surrounding tissues during delivery. Static-shielded approaches are typically applied to low energy, photon-emitting sources, such a ^{125}I or ^{103}Pd. A shows the CIVA sheet – a watch battery-shaped design with an array of ^{103}Pd sources, each encapsulated by a gold shield. The array, which is hot on one side and cold on the side of the gold, can be cut to the size of the treatment area. B shows an example eye plaque for ocular melanoma. C shows the use of a gold shield to create a D-shaped source with a uniform dose over a 180-degree sector. D is the shielded SAVI technique, which can be used with lumpectomy cavities.

Static-shielded applicators were first introduced in 1947 to reduce bladder and rectal doses for cervical cancer treatments: E and F show the shielded ovoid and Henschke applicator designs. G shows the ICMA, which is used for rectal cancer. ^{192}Ir sources can be passed through any of the surrounding eight channels and there is a central shielding rod that provides partial shielding of the

STATIC IMBT





COMMENT

MEDICAL PHYSICS COMMISSIONING EDITOR PAUL DOOLAN:

"This study succinctly summarises the range of IMBT approaches that exist. Some of these are very well established and have been used in patient treatments, while others remain theoretical approaches.

"With such a wide range of techniques available it seems likely that IMBT will have a role to play in radiation oncology for some time to come."

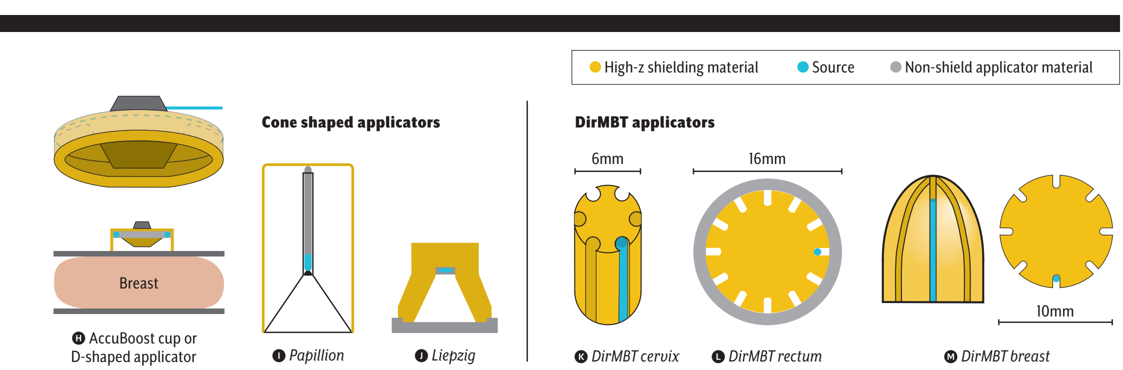
tissue opposite. H shows the D-shaped applicator, which can be pressed up against the surface of the skin. AccuBoost is one such implementation, which is pressed up against the breast to provide a boost to the post-operative bed. I shows the Papillon device, which uses an eBT source of 50kVp low-energy photons. These are introduced into the rectal cavity via a proctoscope with a stainless steel casing. The Leipzig applicator J is used for nonmelanoma skin cancer and is conically shaped with tungsten to allow shields of 10-30 mm in diameter. It uses a ^{192}Ir source in parallel or perpendicular orientation.

Direction-modulated brachytherapy (DirMBT) applicators use a central cylinder with symmetrically placed grooves around the periphery, into which the sources can be placed. The source can be placed in any of the channels and the dose is modulated by the groove direction. K shows the cervix applicator, which is used with ^{192}Ir, ^{60}Co or ^{169}Yb sources. L shows the rectal cancer applicator and M shows the DirMBT applicator that can be placed in lumpectomy cavities. Compared with conventional BT plans, static-shield IMBT techniques increase delivery times, but these still remain around 20 minutes.

Dynamic IMBT

Dynamic IMBT encompasses techniques in which the shield changes orientation relative to the source of tissue during treatment. Theoretical models of a cylindrical source, in which half or three-quarters of the source is replaced by stainless steel or tungsten shields, and then rotated to deliver an anisotropic dose distribution, have been studied N. A similar approach using an eccentric source of ^{153}Gd has been explored O, but the potential increase in treatment time would be considered unacceptable when compared with conventional ^{192}Ir interstitial prostate HDR BT (154 mins vs 12 mins).

P shows the design for an applicator for rectal cancer treatment, in which a rotating tungsten cylinder with a 45-degree opening housed an ^{192}Ir source. In 2013, a rotating-shield brachytherapy (RSBT) design was proposed, using an eBT source with a single 0.5mm tungsten shield that could rotate around a central axis Q. Two tungsten shields rotating around a 50kVp source has been proposed R. The use of two shields allows the dimensions of the shielded and unshielded emission windows to be altered, leading to the technique being termed dynamic RSBT. Paddle-based RSBT was proposed in 2015 S, with paddles that could be retracted or advanced as another method to alter the shielding window. A multihelix RSBT applicator was suggested in 2015 T. As the source advances, the high-Z shield rotates as it is translated through the helical keyways.



Following on from the first part of her story on life working in Qatar, published in December's issue of *Scope*, **Aquila Sharif** returns to deliver the second instalment.

DELIVERING IN DOHA

There was a clear aim for Al Amal Hospital in Doha to become the National Centre for Cancer Care and Research. This involved gaining international accreditation through IAEA quality assurance team for radiation oncology (QUATRO) and achieving the status of regional training centre.

The centre had treated its first patient in 2004 and we were now in 2008. To make it more challenging, there was a radiotherapy equipment-replacement programme, which had to be completed with no disruptions to the services.

The first challenge was to recruit for vacancies in physics, dosimetry and radiography to rebuild a team to deliver the project. The final physics team consisted of five internationally certified physicists two ABR, two Health and Care Professions Council registered and one with registration from New Zealand. The skillset of the team was a great mix of all-round experience, with two of them having experience on the Varian system, which proved to be extremely useful. This physics team was supported greatly by two experienced radiographers who ran the pre treatment section and over saw the dosimetry as well a team of experienced radiographers.

Phase one – six-month plan

The hardware and software in Table 1 had been finalised, together with the services to be delivered. The additional physics quality assurance equipment was ordered to enable four-dimensional computed tomography (4DCT), stereotactic ablative radiotherapy (SABR) and stereotactic radiosurgery (SRS), as well as equipment to assess MR scanner performance for RT use. Redundancy programmes for equipment failures, as described in the previous article, were part of the standard procedures. Safe and efficient patient pathways were supported by the single-vendor solution and we were redesigning the workflows processes, not editing existing ones to fit.

Challenges

Due to staff resource limitations and reduced timelines, the project was planned in detail and we split into two independent physics teams, consisting of two physicists each to ensure independent cross-checks were being completed and clinical duties allocated on a weekly basis. The staff training for the treatment-planning system and record-and-verify system was carried out prior to delivery of the equipment.

A test box supplied by Varian consisting of Aria and Eclipse together with Varian golden beam data was used for training. Having access to this meant a clear understanding of the beam modelling

Table ❶ summarises the services that were on offer and the enhanced services to be offered: The project was delivered in phases.

2008 RT SERVICE		2010 RT SERVICE	
Equipment and software	**Service**	**Equipment and software**	**Service**
EXTERNAL BEAM		**EXTERNAL BEAM**	
Siemens Primus Linacs	IMRT – step and shoot	Varian Linacs Trilogy Clincac iX MicroMLC	VMAT SABR SRS Gated treatment
Mosaiq	R&V Paper files White board patient management	Aria	R&V Paperless Patient care pathway – patient management system
Xio	Treatment planning system Paper prints with signed prescriptions on central slice	Eclipse Brainlab – SRS only	Treatment planning system Electronic prescription and plan approval
PRE-TRT EQUIPMENT		**PRE-TRT EQUIPMENT**	
Siemens – Syngo	CT scanner	Siemens – Syngo via	CT scanner +4D capability
Siemens – Simulator	Simulator	GE MRI SIM – flat table top	MRI scans RT planning Brachytherapy Docking patient support system specifically for brachytherapy HIFU MR-guided treatment
Siemens	MRI – diagnostic scan Completed by non RT staff in main hospital		
		Siemens PET/CT SIM	PET/CT sim Increasing efficiency with a flat table top and reducing additional dose
HDR BRACHYTHERAPY		**HDR BRACHYTHERAPY**	
Nucletron – HDR Unit		**Gynae treatments**	
Helax TPS	Film-based and CT-based treatment planning Paper file and signed prescriptions	Nucletron – HDR Unit	Gynae treatments Expanding to breast and prostate

section as well as creation of planning templates, plan reports and the creation of the verification-point plans was completed in advance. Plans for end-to-end testing using the IPEM phantom were created, together with planning work instructions required to go live for all the common sites in the clinic. The Aria setup of the clinic, user rights, patient-care pathways and the dynamic documents was completed by a physicists with previous experience as an Aria administrator. Having the test box six months prior to go-live was a great facilitator to the success of phase 1 of the project.

The decision was made as a department we would go live with an electronic patient file – no paper, no transition period and no discussion. Once completed, it was great to see the patient-care pathways with dynamic documents working in the clinic so efficiently.

There were a few issues along the way, such as machine breakdowns and gun changes on the clinical linac leading to weekend and evening work on both machines. As the second linac was being replaced, the final write ups of the commissioning reports and work instructions for the new processes were being finalised in readiness for the QUATRO audit. The department was all aligned and the flurry of activity in the last weeks left us as ready as we could be.

"IT WAS GREAT TO SEE THE PATIENT-CARE PATHWAYS WITH DYNAMIC DOCUMENTS WORKING IN THE CLINIC SO EFFICIENTLY

QUATRO IAEA audit

This audit focuses on the evaluation of quality of all components that make up the practice of radiotherapy in an institution, including its professional competence, with a view to supporting and promoting quality improvement. We were visited by a multidisciplinary team that took five days to complete the audit. Measurement of output and energy on the treatment units formed part of the audit together with a review of commissioning reports for the linacs and the associated planning systems and QA devices. The attending physicist

IMAGES: GETTY / SCIENCEPHOTO / ISTOCK

made a point of congratulating us for the comprehensive commissioning reports, he singled out the report for the treatment planning system, he also requested a copy to use as a sample for training purposes. The hospital achieved recognition as an IAEA centre of competence – a job well done and a much-deserved reward for the entire team's hard work in a short period of time.

Momentum continues

Delivering phase one was the most difficult, and parts two to four seemed to fall into place quite easily. The accreditation meant management were quietly confident that we would deliver, so additional staffing requests made were met with smiles and deep pockets. The GE MR simulator was delivered with two fully detachable beds to support the brachytherapy workflow and ease removal of patients in an emergency.

A fulltime clinical oncologist for MR-guided brachytherapy was recruited who was a member of the team which wrote the original GEC-ESTRO guidelines. An MRI physicist also joined to help with MRI sequences and QA. He recommended a comprehensive training program with six weeks of hands-on and classroom training. With the support of the MRI physicist, the scanner was commissioned and in use promptly for RT and external beam treatments and work began to commission the MR-guided brachytherapy service.

> "THE MANAGEMENT WERE QUIETLY CONFIDENT THAT WE WOULD DELIVER, STAFFING REQUESTS MADE WERE MET WITH SMILES

MR safe applicators for planning were already in use due to the reduced artefact. Test runs with applicators submerged in water tanks and home-made phantoms with different MRI sequences were run to ensure applicator visualisation, catheters filled with MRI contrast were used to help visualise the void.

By June 2011, all patients who had no MR contraindications were offered MR-guided brachytherapy and treatments progressed rapidly from fixed-geometry simple applications to ring-based needle applications. A pre-insertion MRI was used to create a pre-plan to assess suitable applicator and needle placement required. Clear visibility of the region to be treated meant we could now treat more accurately. This was the start of adaptive online HDR treatments in 2011.

THANKS

This article is based on when **Aquila Sharif** was Lead Physicist in external beam and brachytherapy at Al Amal Hospital in Doha between 2008 and 2013. She would like to thank and acknowledge the teams she worked with and the hospital management for their support and commitment.

We are only now seeing a similar evolution with the availability of MR linacs in the external beam space and there are similarities between the processes and resources used. The progression from film, CT to MRI-based brachytherapy in five years was quite an achievement for a relatively new department.

SABR with 4DCT and SRS followed shortly after the MR-guided brachytherapy and a decision was made to add a CyberKnife unit to the department to support the SRS and SABR workload.

The PET/CT simulator was added as a much-needed diagnostic service in the country (it was the only one at the time) and to support research. The CT was commissioned as a standard CT sim with a flat tabletop and immobilisation equipment purchased this meant all patients having a PET/CT no longer required an additional CT scan for RT planning.

Conclusion

As an expat working in Doha, I can truly say the opportunities to set up and implement processes starting with a blank sheet was a great experience. In all other roles to date, there are restrictions, mainly due to the larger departments and established practices. Change is not easy to implement and a gradual steady-as-she-goes approach is taken to make sure you take a much larger team along.

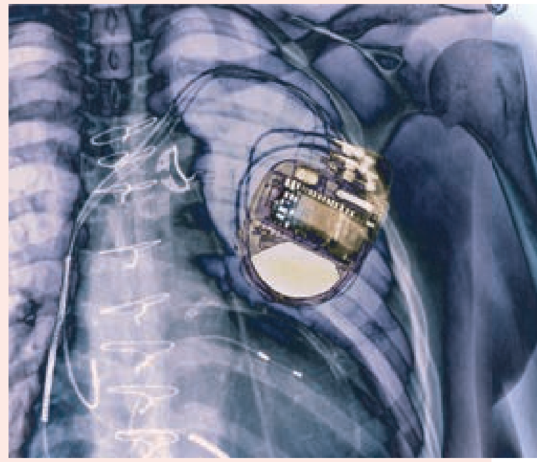
Magnetic resonance safety

Clinical Scientist **Sam Butler** reports on the biennial MR Safety Update, which was organised by IPEM's Magnetic Resonance Special Interest Group.

The MR Safety Update is a fantastic opportunity for magnetic resonance physicists, radiologists and radiographers to keep up to date with and share their knowledge of the latest developments in MRI safety.

This year, hot topics in MRI safety included the scanning of pacemakers and implantable cardiac defibrillators (ICDs), gadolinium retention, MRI-related heating of implants and discussions on the role of the medical physicist in MRI.

❶ Sarah Prescott presents Dr Jessica Winfield her certificate as winner in the proffered talk category



❷ The safe scanning of pacemakers and ICDs is a hot topic in MRI safety

IMAGE: SCIENCEPHOTO

Safe scanning of pacemakers and ICDs

Featuring heavily on the conference agenda was the safe scanning of pacemakers and ICDs – one of the most talked about subject in MR safety ❷ at the moment. In August 2018, the British Cardiovascular Society and the Clinical Imaging Board stated that "patients with cardiac devices should no longer be disadvantaged and have the same access to MRI scanning in the NHS as everyone else". In 2017, two large studies were published on the risks associated with scanning patients with non-MR conditional pacemakers or ICDs using MRI.

Consultant Cardiologist Dr Diane Barker gave a cardiologist's perspective on the safe scanning of cardiac devices. She highlighted the increasing use of cardiac devices as indications expand and pathological detection improves. Strikingly, at least half of patients with such devices will develop a clinical indication for MRI during their lifetime after device implantation.

The introduction of MR conditional devices has allayed some of the traditional safety concerns. However, there are still large numbers of patients with non-MR conditional devices. Cardiology consensus seems to be that the removal of the device is riskier than MR scanning with the device in place.

The theme of scanning active cardiac devices continued as Sarah Prescott shared her experiences of setting up a non-MR conditional pacemaker service at the University Hospitals of North Midlands NHS Trust. This sparked a great discussion about the best way to involve all relevant medical specialities to ensure the risks and benefits are carefully considered for each patient with a non-MR conditional device. A key point from this talk, which resonated with many attendees, was that a good relationship between radiology, cardiology and physics is essential in setting up a service such as this.

❸ The conference was held as the Thinktank, Birmingham Science Museum (Birmingham Museums Trust)

❹ Prizes and giveaways, courtesy of Dr Frank Shellock

Gadolinium retention

Another hot topic in MR safety at the moment is the retention of gadolinium after multiple gadolinium-based contrast agent injections and the possible long-term effects of this.

Dr Giles Roditi, a Consultant Radiologist at Glasgow Royal Infirmary, gave us a radiologist's insight into the history of gadolinium use in MRI, its proven safety record, relationship with nephrogenic systemic fibrosis, and recent findings of gadolinium retention – a valuable safety insight from a speaker

who had drafted the recent Royal College of Radiologists guidance on gadolinium-based contrast agent administration to adult patients.

> "
> **ONE OF THE MOST IMPRESSIVE ASPECTS IS THE CONTRIBUTION TO SCIENTIFIC ADVANCES OF MEDICAL PHYSICS**

Role of a medical physicist

Battling his way through jet lag, having travelled all the way from Washington University School of Medicine to speak at the conference, Dr Trevor Andrews gave us an interesting insight into MR safety landscape in the US.

Notably, there has been a huge increase in MR safety training courses available in the US, with approximately 2,300 MR Safety Certified individuals in the last five years.

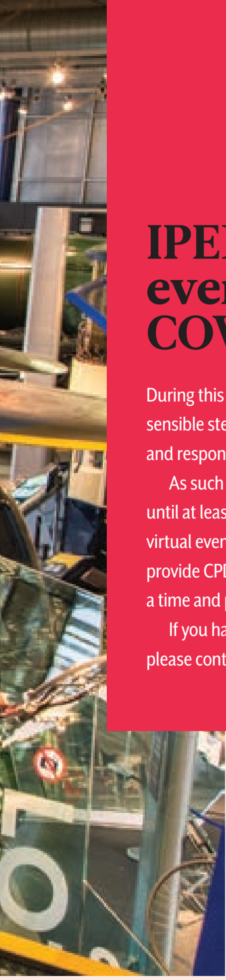
Among many other topics, Dr Andrews also discussed the growing adoption of the consensus document on cardiac implantable electronic devices in the US (a common theme).

Sharing his lessons learned in designing an MRI suite with versus without medical physics involvement, the role of the medical physicist was also discussed by Dr Cormac McGrath. He showed how involving medical physics right from the beginning of planning can prevent costly changes and delays down the line.

Safety of ultra-high field MRI

I found that one of the most impressive aspects of a conference such as this is the contribution to scientific advances that medical physics can make.

Dr Shaihan Malik gave a wonderful talk on parallel transmit MRI, which can overcome some of the limitations of ultra-high field 7T scanners. He expertly explained how the radiofrequency



IPEM events and COVID-19

During this current crisis, IPEM is taking sensible steps to maintain community safety and respond to the government's advice.

As such it has been agreed that all events until at least January 2021 will be held as virtual events. This way we can continue to provide CPD and networking opportunities at a time and place that suits you.

If you have any queries about your booking please contact **conferences@ipem.ac.uk**

magnetic field can be controlled spatially to compensate for non-uniformities. It transpires that parallel transmit RF can also be used to reduce heating levels, which is especially important for patients with conductive implants, such as deep brain stimulators where induced currents could lead to tissue damage.

Continuing the ultra-high field theme, Dr Sarah Allwood-Spiers explained how she rigorously safety tested their custom-built eight-channel transmit, 32-channel receive head coil at 7T.

RF heating tests matched simulations well and this custom-built parallel transmit head coil is now successfully imaging volunteers – this was a talk that won her second place award in the proffered talk category.

Winner in the proffered talk category was Dr Jessica Winfield ❶ for her talk on satisfying the challenging scanning conditions set by manufacturers of spinal cord stimulators.

She was a worthy winner, and both Jessica and Sarah were awarded copies of Dr Frank Shellock's book *Reference Manual for Magnetic Resonance Safety, Implants, and Devices*.

Sell-out conference

Those attending the sell-out conference saw many more thought-provoking talks, such as "evaluating the efficacy of ferromagnetic detector systems", "creating safety checklists for neonates who have not left the hospital" and, my own talk, "an audit of intra-ocular foreign body screening" – more of the same in 2021, please.

Sam Butler *is a Clinical Scientist at Royal Stoke University Hospital, University Hospitals of North Midlands NHS Trust*

Total immersion

Mike Woodward, a trainee Clinical Scientist at Imperial College Healthcare NHS Trust, spent a month in Sacramento with the team behind the world's first total-body PET/CT scanner. Here's what he learned.

The uEXPLORER total-body PET/CT scanner has an axial field view of 194cm, which is large enough to encompass greater than 99% of the adult population. This has been achieved by constructing the scanner with eight connected units, each with an axial field of view of 24cm, which are separated by 2.5mm. The effect of this increase in the axial field of view, and the underlying principle driving the construction of the uEXPLORER PET/CT scanner, is a huge gain in sensitivity of potentially up to 40 times the effective count rate compared to a conventional scanner.

Pros and cons

There are various possible advantages that this increase in sensitivity presents. Firstly, this allows for higher quality imaging, resulting in the visualisation of small features that on a conventional PET/CT scanner would not have been identified. Secondly, instead of aiming for better image quality, it is possible to reduce the scan time, allowing for greater patient throughput or even single-breath-hold PET imaging. Thirdly, it can increase the time-window after injection that scanning is still feasible, giving greater flexibility with very short-lived isotopes, or potentially uncovering previously unknown biological mechanisms and allowing for more thorough investigations in to pharmacokinetics. Finally, the activity injected into the patient can be lessened, reducing the radiation burden undertaken by the patient.

Example images of these advantages ❶ are shown on the opposite page. There are many combinations of the above and it may become possible to optimise these for the needs of each individual patient.

However, good things come at a price. In this instance, the price is going to be high, given that a conventional PET/CT scanner is $1.5-2m and uEXPLORER is roughly eight times longer, with a similar increase in the amount of detector material. Along with this cost, an investment in high-power computing systems and data storage solutions is necessary to be able to cope with the sheer quantity of data that each scan produces and to perform reconstructions in a timely manner.

On the other hand, uEXPLORER may result in potential cost savings in other areas, such as savings acquired by using reduced activities.

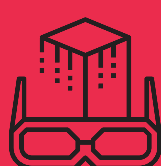
My visit

Discussions and preparatory work began in 2005. It then took 14 years for first

FAST FACTS

15
SECONDS
A full body scan can be done in a minimum of 15 seconds

40
TIMES
The uEXPLORER is up to 40 times more sensitive than a traditional scanner



4D
IMAGING
Breaks through 3D to create real-time 4D imaging

The scanner possibilities

VISUALISING DRUG EFFICACY:
Offers 4D display of the real-time metabolic status of drugs *in vivo*, assesses drug efficacy from all aspects, and greatly accelerates the R&D of new drugs for critical illnesses.

EXPOSING TUMOURS:
Accurately locates tumours throughout the body, monitors the micrometastasis and offers continuous recheck and correction with minimal doses.

VOCALISING CELLS:
Determines neurogliocyte changes through metabolic information, thus examining the relationship between multiple organ nerves.

clinical scan using the uEXPLORER total-body PET/CT scanner to be completed. I visited just after this occasion, which meant I was able to attend the uEXPLORER Symposium, celebrating the opening of the uEXPLORER Molecular Imaging Centre. There was a range of interesting talks at this symposium, especially a presentation on the potential use of total-body PET imaging to detect methylation abnormalities associated with mental disorders. The research it described may reveal a new level of understanding of the biological processes behind these disorders.

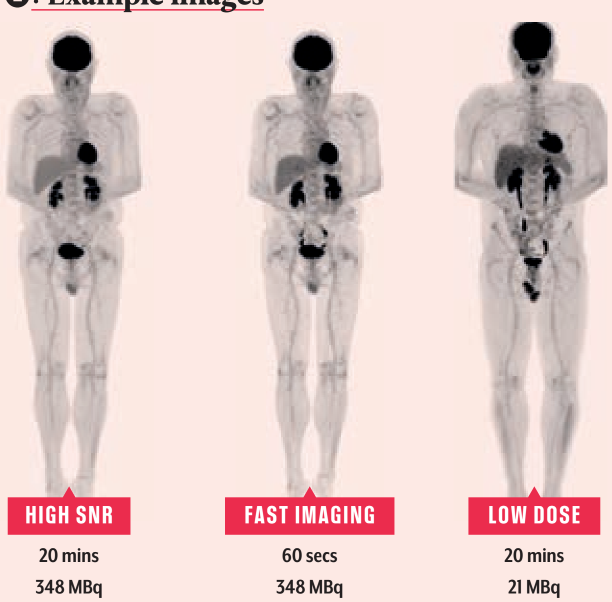
I spent the majority of my time at the uEXPLORER Molecular Imaging Centre undertaking a project exploring the potential benefits of the scanner for paediatric imaging. I chose this project as I was interested in the possible reduction of dose, which is particularly pertinent with regards to children as, relatively, they are more sensitive to radiation than adults, and in the possibility of scan times so short that general anaesthesia may not be necessary, alleviating any concerns about the associated neurotoxic risk.

The original plan was to perform a phantom study, as the uEXPLORER was in clinical use and camera time was extremely limited.

Therefore, a pre-existing low-activity acquisition using a small adult was utilised, with the scan reconstruction time altered as a surrogate of activity. We found that, using the uEXPLORER scanner, it is possible to acquire a good quality image while using only 4.625MBq of F-18-FDG, which would result in a radiation dose in a five-year-old patient of 0.27mSv – roughly equivalent to 1.5 transatlantic round trip flights. I was able to submit and subsequently present a poster on this project at the UC Davis 25th Annual Cancer Research Symposium during my month in Sacramento.

I'm hopeful that one day a uEXPLORER PET/CT scanner will make its way to the UK, but, in the meantime, I'm looking forward to seeing the results of the research being performed in Sacramento.

1: Example images



THANKS
The author would like to thank **Professors Simon R Cherry** and **Ramsey D Badawi** and everyone else who made the trip possible.

Cutting-edge nuclear medicine

Clinical Scientist **Margo Macnab** talks through the highlights of the European Association of Nuclear Medicine Congress 2019.

In October 2019, the 32nd Annual Congress of the European Association of Nuclear Medicine (EANM) was held in Barcelona. The venue, Barcelona International Convention Centre, is located in the new urban business district of the city with views of the sea from the top floor lecture suites and balcony. Throughout the large auditorium and numerous lecture theatres, there were more than 150 presentation sessions available to attendees. With up to 11 sessions to choose from at any one time, EANM has a helpful app to let you plan your personal programme. Almost every aspect of nuclear medicine was covered, with streams such as the molecule to man, dosimetry and molecular radiotherapy, clinical oncology, neuroimaging, cardiovascular and technologist.

Physics sessions

EANM is designed to cater to clinicians, physicists and technologists, with its wide scope and coverage of nuclear medicine topics. While many sessions are likely to appeal to a range of attendees, other streams are tailored to more specific groups. One of the physics-dedicated sessions, hosted jointly by the Physics and Dosimetry Committee and the American Association of Physicists in Medicine, focused on interventional nuclear medicine. Talks by A. Kirov from the Sloan Memorial Kettering Center, and F. van Leeuwen from the Orsi Academy, included PET-guided biopsies and ^{99m}Tc-PSMA-guided robotic surgery, with the aim of resolving inconclusive biopsies and detecting cancer recurrence.

An overview of hybrid imaging techniques during van Leeuwen's presentation also brought to attention dual modality-tracers, such as ^{68}Ga-IRDye800CW-BBN, which can be used with a PET/near infrared fluorescence probe to localise glioblastoma multiforme pre- and intraoperatively via the same molecule receptor.

FAST FACTS

32
The 32nd annual Congress of the European Association of Nuclear Medicine took place in October 2019 in Barcelona.

150
There were more than 150 sessions across five days.

6200
More than 6200 people attended to network, socialise and discuss the latest in nuclear medicine.

Congress summary

EUROPEAN ASSOCIATION OF NUCLEAR MEDICINE

EANM is designed as a conference with as broad a scope as possible and, while it is based in Europe, it was clear from the broad geographical bases of both the speakers and attendees that it is a global conference.

It provided the opportunity to learn about trends and upcoming advances in nuclear medicine, as well as other techniques relating to my own work. With a range of topics that would appeal to anybody who works in the field, EANM provides a full overview of current nuclear medicine practice. EANM 2020 is set for Vienna in October.

As part of a further physics-dedicated session on reconstruction algorithms, I was due on the Monday afternoon to present my work looking at observer detection of small lesions with varying reconstructions. Despite Catalan independence riots breaking out across Barcelona as the session began, the talk went ahead and there were a number of interesting further talks on assessment of reconstruction algorithms. This gave a great learning opportunity on comparative techniques and experimental setups.

Trends across the conference

Across the congress programme, there were two main trends: the use of artificial intelligence (AI) in nuclear medicine and PET imaging with prostate-specific membrane antigen (PSMA). When it came to AI, the first plenary session set the tone. We learnt that we can now more accurately predict whether or not a person is suffering from depression with their social media data than with the analysis of a clinician. With further improvements in technology, it is inevitable that the use of AI across many fields, including radiological interpretation, will continue to grow. Multiple talks covered segmentation using deep learning. Further presentations discussed outcome prediction from radiomics features and lesion classification in ^{18}F-FDG PET/CT, with one presenter discussing a comparison between conventional radiomics and deep learning for the analysis of PET/CT lung cancer.

A session that embodied both trends was "Clinical oncology: new tracers and machine learning rapid fire", which covered textural analysis of ^{68}Ga PSMA PET/CT and radiomics with both ^{18}F-PSMA PET/CT and PET/MR. Aside from this, one pre-symposium and five sessions were dedicated to PSMA, covering theranostics, dosimetry and imaging. Despite its name, PSMA is not just suitable for use with prostate cancer patients and is likely to be increasingly widely used as a tracer across many cancer types.

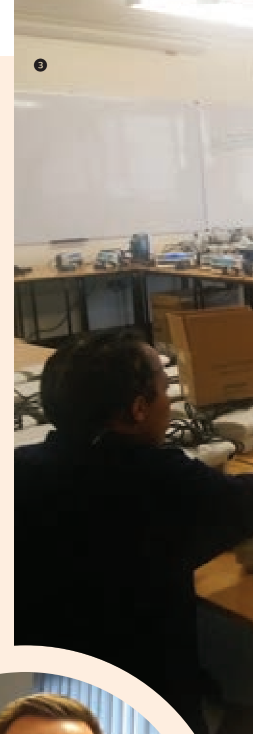
PSMA was also the main topic in the second plenary lecture led by the soon-to-be Congress Chair Stefano Fanti, who was keen to indicate his intention for future changes to the structure of the conference. Starting with a performance by Jari and the Isotones, a band compromising people working in nuclear medicine, the session was set up as a "horse race", with each speaker making the case for different PET tracers in shortened slots. The current frontrunner of the race appears to be ^{18}F-PSMA-1007, with potential superiority over ^{68}Ga-PSMA-11 for patients with prostate cancer recurrence and low PSA levels. This new format for the plenary lectures is set to be a staple under the chairmanship of Fanti. The new plenary lecture structure reflects Fanti's preference for a larger number of shorter and more focused talks, aiming to cover a topic from a variety of different perspectives.

Technologists

With only one dedicated stream, the technologists attending the conference had fewer options, but there was still an opportunity to learn about a variety of topics. These ranged from the technicalities of theranostics and imaging techniques to the practicalities of dealing with incidents and patient communication. There are undoubtedly fewer technologists who attend the conference, but this seems an underutilisation of this opportunity especially, with a number of technologist oral presentation sessions available.

Margo Macnab, *a Clinical Scientist in Nuclear Medicine from Aberdeen Royal Infirmary, attended the congress thanks to travel funding from IPEM.*

ENDNOTES



Professor **Dan Clark**, Head of Clinical Engineering at Nottingham University Hospitals NHS Trust, talks about their vital role in the fight against COVID-19.

MY WORKPLACE

Clinical Engineering in the time of COVID-19

Clinical Engineering teams can sometimes feel undervalued. Often hidden away in the bowels of the hospital, these dedicated professionals ensure medical equipment is appropriate, legal, safe, properly maintained, used correctly by clinical colleagues and available in the right places and in the right amounts.

As a breed, we don't tend to seek the limelight, being content in the knowledge that high-quality patient care is dependent on our skills and hard work. For years we've tried to raise our profile, to seek recognition for our contribution and to increase our influence in the executive corridors. Well – be careful what you wish for. When the pandemic struck, the limelight found us, whether we wanted it or not. From our usual role supporting from the background, we were thrust into centre stage and became among the most important and busiest teams in the hospitals.

Increasing capacity

Initially, this effort was concentrated working with clinical colleagues identifying the medical equipment needed to meet the expected significant increase in patients coming into the hospitals and then sourcing and ordering, commissioning and deploying and training and supporting the clinical teams in using it all.

At the outset of this crisis, probably the most important – certainly most urgent – activity was to increase the ITU bed capacity. In normal times, Nottingham has 31 adult ITU beds. We can rapidly double this by commandeering other critical care beds across the trust, including PICU, cardiac intensive care and our two HDUs. So we almost immediately got our ITU capacity up to 60. Then we had a surge plan, in four phases: firstly, we increased up to 90 beds by converting two theatre blocks, then a succession of phases to take us up to a theoretically maximum of about 200 beds. Each successive phase was harder to achieve, but we did have a plan that could, just about, deliver 200 ITU beds.

Creating these additional ITU beds meant converting operating theatres into critical care facilities. We converted each theatre to

❶ Mark Westby Medical Equipment Services Manager. ❷ Mark Westby (front standing) and Marie Copland (front seated) with the first group of volunteers. ❷ Volunteers arrive for basic technical training. ❹ Infusion devices, lined up and awaiting testing in the University seminar room.

take three or four ITU beds and used the recovery area to create several more. We'd done this before, as part of normal winter surge plans – but never on this scale. Even the SARS and swine flu outbreaks only saw one set of theatres converted; this time we were talking about six or seven. Of course, you need a lot of equipment to support these beds, not just the ventilators that were all in the news but a whole range of kit: in fact, an ITU patient needs probably about 15-20 items in total, so we had to order and commission all this extra equipment and deploy it into converted theatres.

That was just the ITU patients. For every ITU patient, we were expecting about 10-15 COVID-19 patients needing oxygen therapy, but not sick enough to need ITU. So we also needed a huge amount of medical equipment to manage these too.

In total, we identified nearly 6000 items of equipment and in the first two weeks of the crisis we commissioned nearly 4000 of these. We normally commission about 5000 items all year

FAST FACTS

EQUIPMENT

6000
items of equipment were needed.

4000
commissioned in the first two weeks of the crisis.

5000
pieces of equipment are normally ordered in a year.

BEDS

31
beds are normally in ITU at Nottingham.

60
beds were achieved by commandeering other critical care beds.

200
beds were achieved in the final plan.

– so in two weeks we essentially did a year's worth of equipment commissioning. We had neither the space nor the people needed to do this. Luckily, because we're co-located close to the University of Nottingham Medical School and because they were closed due to COVID-19, we were able to commandeer four large teaching rooms close to one of our main hospital workshops. Because the trust had stopped most of its routine clinical activity, there were hospital staff available to support us. So we recruited 40 volunteers who we trained up on basic technical tasks and we set up a production line to receive the crates of equipment coming in, unpack the boxes and assemble the equipment. Then technical staff did the acceptance testing, labelled them and inventoried them before the volunteers delivered them round the hospital.

Demand on training

With this large increase in equipment, plus the fact a lot of clinical staff were being moved in to support ITU, there was also a huge demand on training. Our small team of medical device trainers, who themselves were two staff down because of COVID-19, were rushed off their feet.

The next problem we faced, like so many hospitals, was one of oxygen supply; or, more accurately, oxygen delivery into our ward areas. With predictions of so many patients using oxygen – on ventilators in ITU and non-invasive ventilators in ward areas – we identified significant risks in being able to meet this demand. We have two vacuum-

5 A hive of activity as volunteers get busy.
6 Equipment stands, all in a row.

insulated evaporators (VIEs) which are in theory able to deliver 3000 litres of oxygen a minute, but when you calculate how much oxygen you need to supply all these patients, and work out the flows and pressures required, and see how much the pipes ice up under high flow, and realise that the pressure valves could cut in under certain (not that unexpected) conditions, then you quite quickly see that there is a good chance of being unable to meet the oxygen demands of all our patients.

A lot of work took place with clinical colleagues, our estates team and pharmacy staff and a range of contingencies and mitigations were put in place. Even so, this was perhaps the biggest risk the trust faced and had our patient numbers surged as high as was originally forecast then there might have been some very scary moments.

National allocation

Of course the problem with a pandemic is it is international. All over the world hospitals were buying up all the same medical equipment. Nationally and internationally manufacturers simply ran out of medical equipment and we got nothing like everything we ordered. This brings me to the second element of work we've been involved in here in Nottingham – the national allocation programme for medical equipment.

Once it became apparent that there were going to be significant equipment shortages the government took over central control of the supply of key items. It announced the National Ventilator Challenge Programme, put out requests for donations of equipment, went on a shopping spree on the international markets and bought just about anything that looked like it might be intensive care medical equipment. There were four streams of new equipment – the equipment bought centrally through NHS supply chain, the ventilator challenge, the international market and the donations.

As these started to arrive, they were held centrally at an RAF base near Telford. A national committee was set up to look at which hospitals were in the most dire need and allocate equipment to them from this central store. The first wave of this centrally allocated equipment ran into some significant problems; so much so that the recipient hospitals couldn't use them. Basically, the equipment they'd bought wasn't suitable for use in UK hospitals.

> **"A LOT OF WORK TOOK PLACE WITH CLINICAL COLLEAGUES, OUR ESTATES TEAM AND PHARMACY STAFF**

A vital role

At this point, the government asked for help in sorting this out and (I must have been in the wrong place at the wrong time) I was "volunteered" by IPEM. Items bought centrally by NHS supply chain and those designed in the UK as part of the ventilator challenge programme were assumed to be suitable form the UK market. However, it was immediately apparent that items bought directly from the international markets and donated equipment would need to be evaluated before they were distributed. A process was established to provide technical due diligence, utilising the Nottingham clinical engineering team, which saw items sent from the military store at Telford to Nottingham for assessment before release into the NHS. Following technical review, recommendations were sent back to the centre on whether they could be used in the NHS or not and, if they could, with what provisos. It's been, interesting, to say the least – working with the different branches of government – NHS England, the Cabinet Office, the MoD and DHSC, but the system essentially worked ensuring equipment was technically evaluated before it was sent out to NHS hospitals.

Clinical engineering teams have always known the importance of our role in enabling modern healthcare. This crisis has further showcased our skills and reminded people of the importance of technology and medical equipment (and the teams who facilitate it) to patient care. There will be further challenges as we transition out of the current crisis and consider the long term. Technology will play an increasingly central, indeed essential, role and clinical engineering teams will be vital for this.

I'd like to thank the team in Nottingham and all NHS clinical engineering teams for their fantastic effort throughout this crisis, at all times in supporting high-quality patient care. Enjoy the limelight – I suspect we're going to have to get used to it

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