History lesson
The start of medical physics

Professional Registration
Engineering Council accreditation

The 2009 UK IMRT audit
A snapshot of the status of IMRT in the UK
New South Wales lies on the east coast of Australia and is the home of Sydney, Australia’s oldest and largest city. Set on one of the world’s most stunning harbours, Sydney is a great place to start your New South Wales working holiday.

When it comes to choosing your working holiday in Australia there is no argument – it’s New South Wales! Whether you are attracted to the surf and coastal lifestyle, nature and national parks, delicious food and wine, exciting adventure or a leisurely scenic journey, New South Wales has it all. With its iconic beaches and cosmopolitan lifestyle, Sydney is a must-do. Wine, dine and party the nights away. Stay along the North Coast and surf, hike, camp, or just relax on the endless stretches of golden beaches and subtropical rainforests. The Hunter Valley produces terrific wines, and festivals and jazz nights are a regular event for the wine lover’s diary. And don’t forget the Australian Outback with its vibrant colours and country adventure spirit. Whatever you’re after New South Wales can offer you.

** Radiation Oncology Medical Physicists wanted!**

NSW Health is offering sponsorship to experienced Radiation Oncology Medical Physicists to fill positions of up to two years, available in the fourteen publicly operated Radiation Oncology Departments servicing the state of New South Wales. The majority of medical physics services, including complex treatment procedures, are provided by the NSW public sector which has the largest number of Radiation Oncology Departments in Australia. Centres are located in both major metropolitan hospitals and large regional and rural centres, and have strong university links. This range of locations allows a diverse choice of lifestyles; from the beach to the mountains, from the vineyards to inner city living, from the outback to the coast. The Sydney based centres are located in Sydney suburbs of Liverpool, Penrith, Randwick, St Leonards, Camperdown, Kogarah, Darlinghurst and Westmead. The major regional Radiation Oncology Departments are located in Newcastle and Wollongong. Radiation Oncology Departments are also at the major rural cities of Port Macquarie, Coffs Harbour, Lismore. Centres in the rural and regional cities in Tamworth, Orange and Nowra are planned to open in the near future.

**It's not as hard as you think to come and work in Australia, and NSW Health Department will make it even easier!**

NSW Health wish to appoint highly motivated Radiation Oncology Medical Physicists committed to providing excellent care for the patients of NSW. Sponsorship is offered by NSW Health to obtain business visas (through the individual Radiation Oncology Departments), relocation assistance in the form of an economy airfare and accommodation subsidy*.

**Do you want to know more?**

To be considered for employment within NSW it’s as simple as contacting the Radiation Oncology Department directly, who will be able to provide you with further information. Visit the NSW HealthWeb site at: [www.health.nsw.gov.au/jobs/](http://www.health.nsw.gov.au/jobs/) for more information on the individual Radiation Oncology Departments.

**Like to know more?**

Email the NSW Health, Sydney, Australia on romposrp@doh.health.nsw.gov.au

* Conditions apply  photos courtesy Tourism NSW
As many people have observed, we live in an age of potential communication overload from television, radio, newspapers, magazines, internet, email, texts and tweets. Given this quantity, and this variety, what is the future for our scientific journals? There is of course a huge difference between the largely uncontrolled and essentially subjective discourse which is found online, and the objective peer-reviewed information which is published in our journals. Even self-regulated online sources such as Wikipedia can be subject to prejudice or bias, and there is a clear tendency in broadcast media to give greater emphasis to the subjective impressions and feelings of individuals affected by news events. For scientific publications we need greater objectivity, and the peer-review process is one way in which this can be sought. No-one would claim that peer review is perfect; after all it depends on busy people who are themselves subject to many other influences (see http://www.skeptical-science.com/science/witty-funny-peer-review-comments/ for some amusing examples). Nevertheless, the publication of peer-reviewed results, and even more, the open circulation of methods and results which enables others to confirm our measurements and to develop our ideas, remains the bedrock of scientific progress. I believe that IPEM has an exceptional record in this regard, with four highly regarded official scientific journals, in addition to Scope and the Newsletter. Naturally these will evolve, making increasing use of electronic media and rapid publication techniques.

However, I believe that there will still be a role for formal journals for many years to come, and I would strongly encourage all members to subject their work to the process of peer review. Only in that way will you be able to test your ideas against your peers and contemporaries, eliminate possible bias and contribute to scientific progress in your field. And, reverting to a more subjective argument, publications are also one of the most powerful ways of advancing your career prospects.

As many of you will know, IPEM has been seeking to improve our wider communications activity, and in particular to raise our profile with government, policy makers and the scientific media. To assist with this we created the role of Vice President for External Affairs, which has been ably filled by Steve Keevil. At the time of writing, we are making the final arrangements for a presentation which represents in many ways the culmination of this activity: The Parliamentary and Scientific Committee is a multidisciplinary cross-party grouping of members of the House of Commons and of the House of Lords. It provides an opportunity for liaison between members of parliament and scientific bodies, as well as science-based industry and academia. IPEM has been given the opportunity to present Medical Physics: from Blue-Skies to Bedside. Turning Today’s Cutting-Edge Science into Tomorrow’s Healthcare Technology at a meeting of the committee to be held at Portcullis House. This is largely physics based to complement a recent presentation to the Committee on biomedical engineering, which was organised by the Royal Academy of Engineering, and will be an opportunity to speak directly to members of parliament and other key policy makers, highlighting the role of IPEM members in scientific innovation in healthcare. Opportunities of this type are highly sought after, and I would like to pay tribute to Steve Keevil for his work in arranging the programme, and express my thanks to Andy Simmons, Nick Stone and Carl Rowbottom for agreeing to speak.

What does the phrase ‘healthcare science’ mean to you? If you work in the NHS, you will already know that the concept of healthcare science has developed from being a convenient administrative label (analogous to Allied Health Professional) for describing a disparate range of NHS staff, towards a model of more integrated training and career development. The Modernising Scientific Careers (MSC) process is speeding up, with many early adopter sites identified and recruitment to new training programmes underway. IPEM is well placed to contribute to this process, and many members are already involved at national and regional levels. I believe that scientific integration will continue, and this will bring both opportunities to be exploited and problems to be solved. As a result of this process, and probably linked to MSC, many NHS trusts are likely to establish arrangements for closer working amongst healthcare science disciplines, including the identification of Lead Scientist roles. I would strongly encourage IPEM members to become closely involved in such local developments, to ensure that physics and engineering are well represented in local forums and healthcare science groups. Leadership is an ill-defined and somewhat nebulous quality, but at times of change it is better to be making the running than walking behind.
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It is a pleasure to publish the first part in which we are heading for the siècle des Lumières.

A HISTORY LESSON

AFTER a sometimes excessive and always tiring Christmas break, returning to the reality of work is often difficult. In my case, to make matters worse, during the first week of January there is always a moment of sobering panic when I stare down at a nearly empty table of contents for the forthcoming issue of Scope.

However, contributors always seem to deliver the goods and after some extra Hajacking and broken deadlines (thankfully our Century One partners are very understandable) a large March issue can be put together. This one is no exception and it includes a varied selection of articles, meeting reports, book reviews and news items.

In the features, Geoff Budgell presents the results of the 2009 UK IMRT survey, while Philip Wright delivers a teaser for the leadership and management survey. Justin McCarthy and I delve through the history of copyright for some belated celebration of the tercentenary of the Statute of Anne. Finally, Azzam Taktak introduces a new series on Professional Registration for engineers. Marc Rea kindly agreed to be the first volunteer of the series, relating his experience of Chartered Engineer accreditation.

Tutorials also make a return with the ever-reliable Jenny Freeman this time tackling risk, differences between absolute and relative risks and how to measure them.

Sadly, both Theo Tulley and Keith Boddy passed away in 2010 and tributes are included in the members’ section.

As a schoolboy, history was my favourite subject and when I started studying science, I logically developed an interest in the history of science. While working at Guy’s Hospital, the Gordon Museum became my place of predilection to empty my head and in Cambridge, the Whipple Museum is a favourite of mine; it is small enough to pop in when you only have an hour or less to spare. I could only be excited when Francis Duck contacted me last year with his ‘History of Medical Physics’ project for Scope. It is a pleasure to publish the first part in which we are heading for the siècle des Lumières to witness the birth of la Physique Médicale. Hope you enjoy this issue!

MARC E. MIQUEL EDITOR-IN-CHIEF
Using chemotherapy for the treatment of cancer usually relies on cancer cells absorbing drugs by diffusion across the cell membrane. However, this is not always effective as the diffusion process is slow, and some cells use a natural pump mechanism to push the drug molecules back out.

Previous laboratory experiments on an alternative mechanism, called transmembrane convection, have shown that when cells are exposed to red laser light with a wavelength of 670 nm and an intensity of around 1,000 Wm\(^{-2}\), the density and viscosity of the interfacial water layer (IWL) is reduced. In order to regulate the density within the cell, some of the intracellular fluid is expelled. When the laser is turned off, the density of the IWL increases and again the density must be regulated, this time by absorbing water and other nutrients from the surrounding medium.

Researchers at the University of Ulm and the Karlsruhe Institute of Technology in Germany have applied this technique to accelerate the uptake of chemotherapy drugs into cells in vitro (J Control Release 2010; 148: 131). Three types of drug – doxorubicin, methotrexate and epigallocatechin gallate – were used in the study, and the uptake into cervical cancer cells was investigated. In addition, a fluorescent dye was used to allow a visual assessment of convective transport. It was found that 1 minute of exposure to a pulsed laser light was sufficient to force the cells to uptake significant amounts of dye, while non-irradiated cells showed no evidence of uptake.

The researchers noted that the local concentration of the chemotherapy drug is a critical factor in the convective uptake process, and when drug concentrations are low, convection has practically no effect on drug uptake. However, it is expected that this can be overcome by extending the irradiation time, using higher laser intensities and changing the laser pulse profile.

The study has shown the potential of transmembrane convection as a method to force cancer cells to uptake chemotherapy drugs. Research in this area is ongoing, and the controlled release of drugs is one area which warrants further investigation.
Combined optical and x-ray system for breast imaging

While mammography remains the primary imaging modality for the early diagnosis of breast cancer, other x-ray methods such as 3D digital breast tomosynthesis (DBT) are continuing to be developed. However, the high false-positive rate and the low contrast between tumour and dense breast tissue are still major challenges.

Researchers investigated co-registering DBT images with diffuse optical tomography (DOT) images, which provide complementary functional information about the tissue being imaged (Radiology 238: 89–97). The primary image contrasts in DOT are tissue optical absorption and scattering, which are related to physiological parameters such as concentrations of haemoglobin, water and lipids.

The combined system uses a standard DBT unit with an optical probe attached to the transparent x-ray compression paddles. The patient’s breast is compressed and optical data are acquired using laser sources with wavelengths of 690 and 830 nm. While keeping the breast compressed, the optical probes are detached and the x-ray images are subsequently acquired. Processing of the DBT and DOT measurements involves the reconstruction of the 3D DBT images, spatial registration between the DBT images and the optical probes, raw optical data calibration and 3D breast mesh generation from the DBT images.

DBT and DOT images were obtained from 189 breasts from a total of 125 subjects, of which 138 had negative mammographic findings, 26 had malignant lesions and 25 had benign lesions. All tumours were confirmed histologically. The results showed a significant difference between total haemoglobin concentrations between malignant tumours, solid benign tumours and cysts, and in haemoglobin oxygen saturation between solid benign tumours and cysts.

There are several limitations in the study, e.g. the small numbers of tumours, and the researchers noted that the structural information from the DBT images has not yet been fully exploited in the optical reconstruction.

MRS detects repetitive head trauma

Repetitive head trauma can result in a disorder known as chronic traumatic encephalopathy (CTE), causing progressive decline of memory and executive functioning, and is of increasing concern for people involved in contact sports. An estimated 3.8 million sports- and recreation-related concussions occur in the US each year and, in addition, subclinical concussions – injuries that cannot be diagnosed as concussions but have similar effects – are often unrecognised. The only definitive diagnosis of CTE is a post-mortem brain examination, which shows an accumulation of phosphorylated tau tangles, and there is an urgent need for a non-invasive method which will allow the detection and monitoring of early changes to the brain.

Researchers have investigated the neurochemical changes associated with CTE using magnetic resonance spectroscopy (MRS), and presented the results at the RSNA Annual Meeting in December 2010. The study involved five retired professional athletes with a history of concussions and cognitive symptoms associated with CTE, and five age- and size-matched controls with no history of concussion. All subjects were examined using a clinical 3T MRI scanner, and both single voxel (1D) and 2D proton MRS data were acquired.

The results showed reductions in the neuronal marker n-acetyl aspartate (NAA), increases in choline (Cho) which indicated membrane degeneration and increases in glutamine/glutamate (Glx) in the brains of the CTE subjects compared to the controls. The increase in Glx is of particular interest as it has been shown in molecular studies to be correlated with tau phosphorylation.

This study indicates that MRS may provide a non-invasive method for the early detection of CTE.
Clinical engineers design and test tools and equipment used by medical specialists. They also have an important role in research and development by bringing new and emerging technologies into clinical use. As well as having engineering training and skills, they work with patients and a range of professional staff as well as equipment manufacturers. They have to keep up-to-date with fast-moving scientific and medical research and develop their own laboratory, design, workshop and management skills.

Clinical engineers often seek Professional Registration with the Engineering Council (EC), indicating that their competence and commitment to professionalism have been assessed by other professionals. Other benefits to becoming registered are:

- identifying them as having competences that employers value;
- demonstrating that their competence may be compared with standards applicable in other parts of the world;
- confirming that their commitment to professionalism is underwritten by the support of a national engineering institution or society licensed by the EC, and
- international recognition of their qualifications.

As a result, registrants often find that it is easier to gain promotion or a new job, they have greater influence within their organisation and industry and their engineering credentials are respected in most parts of the world. There are benefits to the employers also as increasingly, tendering or post-tender contract compliance requires key members of the project team to have Professional Registration.

The IPEM has a licence from the EC to award Professional Registration to members working in clinical and biomedical engineering. There are three routes towards Professional Registration:

- Chartered Engineer (CEng);
- Incorporated Engineer (IEng), and
- Engineering Technician (EngTech).

The EC have published the UKSPEC Standard which sets out generic competences for CEng, IEng and EngTech. IPEM has adapted these competencies to be appropriate for clinical engineers. CEng and IEng candidates have to demonstrate competence through a Professional Review Interview.

In this series of articles, we will bring to readers some case studies of members who have successfully registered with the IPEM. The candidates will describe their motivation, experience and future aims.
If you are working or training in a field related to engineering you may be thinking about registering for accreditation as a Chartered Engineer (CEng). As a recent graduate of the scheme and former slogan writer for Nike my advice to you would be – just do it!

Achieving CEng accreditation is a rewarding process that does not require massive amounts of extra paperwork and depending on your Part II specialty may be largely incorporated as part of your training. To encourage your participation in the scheme I have written up a recount of my CEng experience which resulted in me finally passing my viva in June 2010.

**MY STORY**

Even while studying for a physics degree, I always had a preference for the more practical modules such as electronics, optics, computing and basically anything based in the lab in which we got to build something practical and test its performance. Graduation and employment as an electronic engineer followed and I quickly learned that working in a semiconductor fabrication plant was just as boring as working in a biscuit factory. I knew I liked a bit more chocolate on my biscuit and so took another dunk and eventually got into medical physics.

During my Part I training at Sunderland and Newcastle I stood my ground and insisted that despite the better job opportunities, I did not want to do a radiotherapy placement, and instead took my chances with three ‘engineering’ subjects: electronic instrumentation, computing and bioengineering. I was then made aware of the possibility of CEng pre-registration and my training supervisor encouraged me to do this, and although the 5 years of required experience seemed a long way off I knew I had found a job I wanted to do and would hopefully stick out.

For my Part II training I took a job which was advertised as MRI Physicist/Engineer, and not knowing a whole lot about MRI meant that initially I had to work harder to get up to speed, not only with the principles of MR imaging but also the various technologies which made it all possible. This was a dream job for me as I soon learned that I would need all of my previously acquired experience and skills in electronics, physics, computing and even bioengineering! At this point I thought I would have a good chance of completing the CEng registration criteria, and was lucky enough to have a boss and a number of colleagues who were also CEng accredited. I contacted IPEM and began to think about what would be required in addition to completing Part II. I was given a mentor who set up a meeting and we discussed my potential route to accreditation. The good news was that it seemed that around 80 per cent of the requirements would be covered by my Part II work!

After 2-and-a-half years I completed my ACS training and became a registered Clinical Scientist; I believe I was the first candidate to pass the ACS exam under the dual modalities of non-ionising radiation (MRI) and clinical engineering. The subsequent party was long and late, yet once the hangover began to fade my thoughts turned back to CEng. Could I complete the training?

Another meeting was held to attempt to clarify which of the CEng competencies I had covered and which I needed to work on. We found that there was still around 30 per cent of the requirements that I needed to work on, and I made a plan with my boss that would allow me to attain these missing parts in the next year. It appeared that this may present a stumbling block since the areas of attainment which were
it might well be a cause (or a symptom?) of my rapidly expanding collection of titanium-coloured hair that I am gradually taking more responsibility for my own work. The plus side is that I can ensure this involves a good mix of clinical support and research activity. Also, what I lose in hair pigmentation I have definitely gained in chest hair! I have worked recently on many exciting projects and have now started my own project to compile MR protocol information from across our trust, and maybe eventually from across the world. Meanwhile I am also busy working closely with colleagues from Imperial College London where we are developing, among other things, the world’s first parametrically-amplified MRI coil.

In hindsight (and somewhat predictably), I would say that going through the CEng process has been both a trying and rewarding experience which I hope will continue to be worth the extra £31 a year in IPEM fees (no, really – it is!). I would recommend anyone with a background, a job or even just a professional interest in the field of medical engineering to investigate the possibilities and pre-register for the scheme.

Examples of my recent work are shown in the photos above.
COPYRIGHT REVISITED

Marc E. Miquel and Justin P. McCarthy (IPEM Publication Committee) outline the history of copyright and how it applies to publishing scientific information

In 2007, Graham Cornish published in this magazine a useful introduction to copyright. Following some recent changes in our copyright policies and to celebrate the tri-centenary of its statutory birth,* we are revisiting the issue.

INTRODUCTION: WHAT'S IN A NAME?

Although the idea of copyright is simple, its applications and implications can be varied and sometimes open to interpretation. Taken literally, copyright is the right to copy and indeed, juristically, copyright are exclusive rights granted to the creator of original works, including the right to copy but also to distribute and adapt. Unlike other forms of intellectual properties, copyright does not protect ideas; it only protects their expression or fixation. In most jurisdictions, copyright arises upon fixation and does not need to be registered; in other words as soon as your work is created, be it text, music, or other, the copyright is created. You might of course have to prove that the work is yours if infringement occurs and, consequently, it might still be worth registering your work with an appropriate agency, like the UK Copyright Licensing Agency. The process is mandatory in some countries.

Copyright owners hold exclusive statutory rights to exercise control over copying and other exploitation of their works for a specific period of time. This again will vary depending on country and material type. The period can be quite long, typically 50 or 70 years (but can extend to 100 years in some countries like Mexico) after the death of the last surviving author. After copyright has expired, works fall into the public domain; however, some works may never fully reach this stage. In the UK, a perpetual Crown copyright is held for the Authorized King James Version of the Bible,† and the Copyright, Designs and Patents Act 1988 (Schedule 6) requires royalties to be paid for performances of Peter Pan within the UK as long as the copyright holder, Great Ormond Street Hospital for Sick Children, continues to exist.‡ Orphan works, for example where the legal owner cannot be traced, are not part of the public domain.

A BRIEF HISTORY OF COPYRIGHT

Initially copyright law solely applied to the copying of books but over time, it was extended to other uses such as translations and derivative works. It now covers a wide range of works, including maps, dramatic works, paintings, photographs, sound recordings, films and computer programs. The history of copyright is intimately linked with censorship and the evolution of printing and duplication methods. It also follows through time the shift of mentality on ownership of works, from book owners to printers to authors.

In ancient Greece and Rome, scholars first began to be concerned with being credited as authors of their works. Laws were passed to provide the authors credit, but no specific ownership or economic rights were granted. However, there is some scattered evidence that a few authors received payments for their work. Authors did not control production of their books and the right to copy lay with the owner of the books and, with some rare but notable exceptions, book production was limited to a few volumes. Such an exception was Atticus, literary patron and close friend of the philosopher Cicero, who was allegedly capable of producing 1,000 copies of a small volume in a single day thanks to his army of slaves.
Court cases in France helped refine the definition of public domain, and a famous court case in 1761 involving the granddaughters of the fabulist Jean de la Fontaine legitimised the right of inheritance.7

With the arrival of new technology came new challenges. In 1938, Chester F. Carlson invented an electrostatic dry-printing process: xerography (from xeros – dry – and graphein – to write). In the 1960s, the Xerox Corporation began marketing the machine as a photocopier and it became possible to make copies of any type of document, even images, quickly and cheaply. The new machine never made it economical for individuals to copy entire books but it was adopted by companies and academia. It is in the latter world that the limits of the fair use concept were tested (figure 2). If publishers could and can tolerate photocopying for personal use, the more or less industrial scale operations taking place in some American libraries in the 1960s could not be ignored. The most famous court case opposed Williams & Wilkins to the National Library of Medicine and the National Institutes of Health in 1968. Although the libraries won the case on a split jury decision in the name of fair use, the following US

Copyright is of global interest.

* Due to a delay in publication, we are now celebrating its 301st anniversary. † This year will mark the 500th anniversary of the completion of the King James Bible. Work on the new translation started in 1604 following the Hampton Court Conference. It took 42 scholars 7 years to complete the translation from Greek (New Testament) and Hebrew (Old Testament).

It was not until the early eighteenth century that the balance was redressed in favour of the authors. The Statute of Anne, 1710 (1709, in old calendar money), or to give it its full name An Act for the Encouragement of Learning, by Vesting the Copies of Printed Books in the Authors or Purchasers of such Copies, during the Times therein mentioned, is widely regarded as the first copyright law and it finally recognised the rights of the authors (figure 1). However, this came at a cost – all authors had to supply copies to the nine major libraries: the Royal Library, the Libraries of the Universities of Oxford, Cambridge, St Andrews, Glasgow, Aberdeen and Edinburgh, the Library of Sion College in London and the Library of Advocates at Edinburgh.† Just imagine if today, after successfully writing and publishing your book, you had to pay to stock up all the university libraries…

Copyright history is littered with court cases that challenged its moral, ethical and financial nature and consequently, helped shape and refine its own meaning. Due to limited space we could include only a few such cases but if you are interested we have included a bibliographical list at the end.

This situation hardly evolved during the Middle Ages with book duplication mainly remaining under control of the Church and monasteries. This was about to change when Johann Gutenberg developed the printing press in the 1440s. Suddenly, it was possible to produce en masse, accurately and cheaply, more copies of a book than literate persons could read it. At first encouraged by the Church and various countries as a way to quickly disseminate the Bible and state information, it soon became apparent that the new printing method facilitated the circulation of dissident ideas. This ushered in an era of censorship, licensing and monopolies that lasted until the eighteenth century. In England, the first copyright privileges can be traced all the way back to 1518 and were issued to Richard Pynson, King’s Printer and the successor to William Caxton (who had introduced the printing press from Germany). Control over the printing industry was formally established by the Crown in 1577 with the creation of the Stationers’ Company. Their Charter effectively limited the right to print in England, to the Universities of Oxford and Cambridge and 21 printers in the city of London.5

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FIGURE 1. Happy Birthday copyright! The Statute of Anne (1710) is regarded as the first copyright law and a shift from printers’ licensing to authors’ right. Document in the public domain.

FIGURE 2. Fair use or Xeros piracy? The case between Williams & Wilkins and American libraries highlighted the limits and extent of fair use in the USA. © Bion Smalley, used with permission.

Anno Octavo
Annæ Reginae.

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The latest imaging physics textbook will not become a Hollywood blockbuster

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Today, international agreements (Berne Convention, European directives) do bring some standardisation to copyright laws; however, national laws on licensing, transfer and assignment of copyright still vary greatly between countries and copyrighted works are licensed on a territorial basis – some countries like Laos do not have any copyright laws.

IPEM JOURNALS, SCOPE AND COPYRIGHT

IPEM has four official journals: Medical Engineering & Physics published by Elsevier, Physics in Medicine & Biology and Physiological Measurement published by IoP Publishing and the Journal of Medical Engineering & Technology published by Informa Healthcare.

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Free Software Foundation: http://fsf.org
The IET produced a series of informative ‘Who owns?’ articles in its Engineering & Technology magazine. They are available at: http://kn.theiet.org/magazine/issues/1011/index.cfm

FURTHER READING

Patry W. Moral Panics and the Copyright Wars. OUP USA, 2009.

FIGURE 3. All wrongs reserved, all rights reversed! The TINY BASIC project was an early example of copyleft and an open source project. Document in the public domain, originally published as open source.

FIGURE 4. Follow the sign. Top row: copyright. Second row, left to right: copyleft, Creative Commons, public domain. Third row: Creative Commons license types – (by) attribution, (nc) non-commercial, (nd) No Derivative Works, (sa) ShareAlike. Bottom row: Open Access logo. Copyright, copyleft and public domain signs are in the public domain, Creative Commons logos are licensed by Creative Common under -by license, Open Access originally designed by the Public Library of Science and used under Creative Commons license -by-sa.
like a job of its own but usually, it is not a taxing or lengthy process. Thanks to the Internet, it took less than 45 minutes to have permission to reprint Bion Smalley’s cartoons: 10 minutes to track him down, 5 minutes to type and send an email, and half-an-hour to have a cup of tea while waiting for his answer!

TO THE RIGHT, TO THE LEFT, TO THE COMMONS!
The Internet did not just allow us to track down and contact someone quickly, it allowed for an explosion of material to be available at a click of a button. Copyright never was an easy moral or ethical question but with the arrival of the personal computer and new digital media, problems arose rapidly and a new copyright revolution brewed over quickly. Nowadays endless perfect digital copies can be created in a flash and put at the disposal of millions worldwide; this potentially creates a legal minefield. But if you think carefully, just by looking at a webpage you are already making a copy of it (albeit temporarily in your cache and most likely falling under fair use). Digital copying is not new nor are the ideas of open source and copyleft – the process of making a work free and requiring that any derivative or extension be distributed in the same way.

General Public License (GPL) or Berkeley Software Distribution (BSD). BSD licenses are permissive and allow proprietary uses, hence BSD codes are present in well-known proprietary products, for example Mac OS-X. This can become complicated quite quickly and would deserve an article in its own right; please refer to the ‘Websites of interest’ section for further information.

Creative Commons (CC) licenses (figure 4) are now some of the most common copyright licenses found on the Internet. They are available in an increasing number of countries and have been adopted by large sites: most photographs on Flickr are released under Creative Commons. Licenses come in a variety of flavours but even in their most stripped-down form, they recognise the moral right of attribution. The CC ShareAlike is a copyleft license similar to the GNU GPL. The issue of Creative Commons licenses came to the limelight in a dramatic fashion in 2007 when Virgin Mobile Australia used a series of photographs from Flickr for their advertising campaign without contacting the original photographers. Although the company did not infringe copyright, the lack of ‘model release’ agreement did lead to some judicial pursuits. In 2000, the ‘license art libre’ was the first art dedicated free license to be released in the spirit of GNU GPL. There is no real single and coordinated anti-copyright movement but different groups oppose copyright to various degrees and for various reasons: economical, ethical, moral, legal or in the name of creativity itself (‘If creativity is the field, copyright is the fence’ – John Oswald). Opponents of the classic forms of copyright should not just be dismissed as anti-establishment and of little importance, from open source to free content to free culture their impact can be felt in our everyday life and we have benefited from it. Who would deny the impact of open access in academic publishing?

However, the case for the commercial side of copyright can still be reasonably argued and copyright as we know it still has many birthdays to come.

REFERENCES

1 Cornish GP. Copyright – easy to create, hard to protect. Scope 2007; 16(3): 10–11.
THE 2009 UK IMRT AUDIT
A SNAPSHOT OF IMRT IN THE UK: OUTLINE RESULTS

Geoff Budgell (Christie NHS Foundation Trust, Manchester) was recently involved in a national IMRT audit. Here, he describes how the audit was organised and carried out, describing a few problems encountered along the way. He also outlines some of the results obtained from the audit and from the follow-up questionnaire sent to each centre.

In May 2009 an advert appeared in the IPEM mailing (figure 1) courtesy of Steve Bolton from the IPEM audit group. For the first time a national IMRT audit had been set up and was being offered free of charge to any UK radiotherapy centre. How did the audit come about and what has it told us? Some of you will have been at the IPEM Biennial Radiotherapy meeting in Cardiff in July and will already have an idea of the results. It is planned that the full results will be published within the next few months within a peer-reviewed journal, so in this article we will be concentrating on the extra information we were able to ascertain about the state of IMRT in the UK at the time of the audit (June 2009–January 2010) and will describe some of the problems encountered along the way in trying to run a national audit in your spare time!

The history of the audit began with an NRIG meeting back in the autumn of 2008 when concerns were raised as to the slowness of uptake for IMRT in the UK and...
how accurately it was being implemented. As a result Peter Williams (then head of North Western Medical Physics) suggested the idea of a national IMRT audit. My mistake was simply to be in the same department as Peter – and as a result I was sucked into the planning and organisation. A proposal was drawn up, circulated among a number of interested parties and discussed via email. During the process the NPL offered to supply their alanine service as part of the audit. It was important that whatever proposal was adopted could be used for any combination of linac and planning system; hence three centres with completely different sets of equipment tried out the proposal independently: the Christie using Elekta linacs and Pinnacle, Ipswich using Varian and Eclipse, and Cambridge using Siemens and Xio. The results were reasonably encouraging – a steering committee met in London in April 2009 and agreed that the audit should go ahead, kicked off by Steve’s advert.

**MEASUREMENTS**

One of the aims of the audit was to ensure that it could be done entirely remotely, with all measurements performed by a physicist in the participating centre using equipment available at all centres. Hence films and alanine pellets were sent to the centres, along with a perspex holder for the alanine pellets (figure 2). These were irradiated in a simple treatment geometry – a flat water-equivalent phantom, isocentric, at a depth of 5 cm and gantry angle 0. Absolute dose measurements were made using alanine and the centre’s own small volume ion chamber. Films were irradiated for each individual beam and also a calibration film. The alanine and films were mailed back to the analysis centres. Each centre calculated expected doses and the dose maps using their own treatment planning systems and sent the results to the analysis centres for comparison with the measured doses.

**ORGANISING THE AUDIT**

Clearly, an audit of this scale couldn’t purely be done in people’s spare time. Most of the hard work on the audit was done by members of staff who spent a significant proportion of their time on it over the months of the audit. Many of you will have received emails from Ellie Bradshaw, our Radiotherapy Quality System Manager at the Christie, who took on the administration for the audit. Two members of staff carried out the bulk of the analysis of the films; Joe Berresford and Michael Trainer. NPL staff under Peter Sharpe’s direction processed and analysed the alanine results.

It wasn’t possible to audit everybody at once; hence the audit was divided into seven rounds. Centres were asked when they would be able to carry out the audit and were placed in suitable rounds accordingly. We had 10 spaces in each round, but never quite filled them up until the last round – everyone wanted to be in the last round. Hence the final round (round 6) actually became two rounds (6 and 7) in order to fit everyone in. Once the film and alanine results were available they were collated into a preliminary results form that was sent back to each centre. If any problems had arisen, this gave a chance for those to be looked at further – otherwise, the preliminary results were also the final results.

**PRACTICAL PROBLEMS IN RUNNING THE AUDIT**

We encountered, as one would expect, a series of different problems in running the audit. One centre submitted their results 7 months late. Another centre neglected to put a stamp on the envelope containing their irradiated films. It may not have been a coincidence that this particular envelope was damaged when it reached us and one of the films had been scuffed to the extent where it had been exposed to light and ruined. All the paid-for parcels came through the post unscathed!

Some of the treatment planning system dose maps caused problems, for instance fields of view too small to

---

**AT LAST!! Practical, free help with IMRT!!**

This is a once in a lifetime chance to perform your own IMRT audit and get your personal results sent straight to your inbox!

NRIG the National Radiotherapy Implementation Group is keen to encourage the wider take up of routine IMRT within the UK. To this end a working party has developed a means whereby all radiotherapy departments can set up an IMRT plan of their own choosing on their TPS and then irradiate Kodak EDR film (supplied free courtesy of AXREM) in a standard water equivalent phantom at 95 cm FSD, 5 cm deep. Also, supplied by the NPL, will be a set of alanine dosemeters which will be used to measure absolute delivered dose at a known point.

Any commercial planning system can be used as long as the calculated dose grid can be exported in a standard format (DICOM or ASCII).
encompass the full extent of the treatment field or a format that the analysis software could not read. We also had to use one version of the analysis software to read in DICOM files and an earlier version to analyse them against films. We also had some problems identifying the correct depth/plane in some of the submitted dose cubes due to different orientations of the phantom. More than one centre exported all beams superimposed on top of one another.

We encountered some film positioning and notation problems. For instance, some films were not marked with the field name and had to be matched by eye with the relevant TPS files, and other films did not have crosshair markings making it difficult to match the isocentre with the TPS files. Occasionally the irradiated section of the film would be close enough to the edge of the film to overlap the pin pricks marking the crosshairs. One TPS allowed the introduction of artificial pinpricks into their calculated dose maps. These managed to reduce the dynamic range of our analysis software to the extent that the dose map was quantised into dose steps and gave poor agreement with the film (figure 3).

RESULTS

The results were first presented at the Cardiff IPEM Biennial Radiotherapy meeting and the full results will be submitted to a peer-reviewed journal. Hence the full results should be available within the next few months. However, good dosimetric agreement was found between predicted and measured dose, with only 9/389 dose maps outside tolerance and 4/78 alanine results outside tolerance. Most of the out-of-tolerance results have been traced to human error. The centres with out-of-tolerance results have all taken up the offer of a repeat audit to ensure there is no systematic dosimetric problem. Although the results are reassuring and suggest that IMRT has been safely implemented in the UK, this was a relatively simple audit and we should expect this level of accuracy – there is no reason for complacency on the basis of these results.

SURVEY

As part of the audit, each centre was asked how much IMRT they are performing at present, what equipment they are using to deliver IMRT and what verification procedures are being used.

Of the 57 centres included in the audit, 30 centres were already clinical with IMRT, but five only very recently, having treated between 1 and 3 patients. Another five planned to go live before the end of 2009 and 17 were planning to go clinical in 2010. Two centres were still in the early stages of implementation and didn’t have a planned start date.

Of the 21 centres who gave numbers for routine IMRT, the average numbers were seven per month. Eleven centres treated less than five cases per month, eight centres treated between five and 12 cases per month, and the other two centres treated 20 and 35 cases per month, respectively.

Patient verification methods varied dramatically in extent and complexity. Of the methods mentioned by clinical centres, 24 used ion chambers, 13 films (a mix of conventional and radiochromic), 20 2D arrays, four were using the delta4 device and eight were using portal...
### Questionnaire

<table>
<thead>
<tr>
<th>Questions</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Did you find the audit straightforward to carry out?</td>
<td>39/42 respondents replied ‘yes’</td>
</tr>
<tr>
<td>2. If not, why not?</td>
<td>Those who commented all said that it was time consuming, especially the alanine measurements</td>
</tr>
<tr>
<td>3. Had you performed QA on an IMRT plan before the one for the audit?</td>
<td>30/42 had done so</td>
</tr>
<tr>
<td>4. Have you treated an IMRT patient before this audit?</td>
<td>27/42 had done so</td>
</tr>
<tr>
<td>5. When did you go clinical with IMRT?</td>
<td>See figure 4</td>
</tr>
<tr>
<td>6. Did the results give you confidence in your technique?</td>
<td>38/42 said ‘yes’</td>
</tr>
<tr>
<td>7. When do you intend to start any rotational IMRT or if you have already started, when did you start?</td>
<td>5 centres had started already, 14 planned to start in 2010, four in 2011, four in 2012 and 13 had no plans to do so</td>
</tr>
<tr>
<td>8. Would you like to have another national audit of this type for fixed-field IMRT and /or rotational IMRT?</td>
<td>35 centres said ‘yes’, four specified rotational IMRT, one specified fixed-field IMRT</td>
</tr>
<tr>
<td>9. The National Cancer Peer Review Programme 10-3T-310 states that ‘the department should annually take part in an EQC audit for ongoing IMRT’. This audit has been provided for free but for a future audit would you consider applying to your Trust for funding?</td>
<td>19 centres replied ‘yes’, nine ‘maybe’ and seven mentioned funding as an issue</td>
</tr>
</tbody>
</table>

Dosimetry. Five mentioned independent MU check software as part of their verification procedures and one mentioned diode in vivo dosimetry. Clearly most centres were using a combination of methods and there was no clear main accepted method. In general, however, almost all centres were performing some kind of absolute dose measurement and some method to verify the 2D dose distributions. The same mix of equipment and methods was reflected in centres working up to clinical implementation who submitted their planned verification methods.

A number of centres mentioned that they were moving towards the implementation of rotational IMRT techniques (VMAT or tomotherapy).

**Follow-up Questionnaires**

After the audit, a follow-up questionnaire was sent out to all the participants, as shown in the table above.

It is interesting to compare these figures with a recently published survey of IMRT availability in the UK between July and September 2008.1 In that survey, out of 50 centres that responded, 32 centres were carrying out forward-planned IMRT and 18 centres were carrying out the inverse-planned IMRT, with 38 centres offering one or the other to some of their patients. Forty five of the centres expected to be able to offer inverse-planned IMRT by 2010. Those results suggest a difference in the definition of IMRT between the two surveys: figure 4 shows that 20 centres were live with IMRT in 2008, suggesting that respondents tended to define IMRT as inverse planned in their responses to our survey. With 12 more live by mid-2010, this is consistent with the stated aim of most centres being IMRT-live by 2010, with a lot of new IMRT activity in the last 2 years.

**Conclusions**

The 2009 UK IMRT audit has now been completed and suggests that IMRT has been safely implemented across the UK. It was a one-off exercise, providing a free service to UK radiotherapy centres. Consideration now needs to be given to how often future IMRT audits should take place, what form they should take and how they should be organised and funded.

**Reference**

The development of management and leadership skills in trainees

Philip Wright (Salisbury District Hospital) surveyed Part II clinical scientists

Leadership ... is central to our expectations of the healthcare professionals of tomorrow – this is the bold assertion of Lord Darzi’s paper, High Quality Care for All. High Quality Care for All further contends that the modern NHS needs healthcare professionals who excel not only in leadership but also in management. Clinical scientists may well wonder to what extent their training prepares them to meet such expectations.

I recently had the opportunity to investigate this topic as part of my Masters Degree in Management and Leadership in Health and Social Care (Bristol Business School, University of the West of England). The detailed aims of the study were, firstly, to investigate whether the training of pre-registration (Part II) clinical scientists prepared them for management and leadership roles in the future and, secondly, to determine whether clinical scientists who had gained state registration within the last 3 years felt able to fulfil the management and leadership roles that they now occupied. A survey was therefore carried out of pre-registration (Part II) clinical scientists and clinical scientists state registered within the last 3 years. The survey was conducted by inviting potential participants to complete an online questionnaire supported by the software platform SurveyMonkey. There were 18 questions in the questionnaire ranging from the generic, ‘Can you list three skills of a good manager?’ or ‘Can you list three skills of a good leader?’, to the specific, ‘How would you rate your management skills?’ or ‘How would you rate your leadership skills?’

I am most grateful to Cathy Brown, Membership and Training Manager (IPEM), for sending email invitations to 167 pre-registration (Part II) clinical scientists and 234 clinical scientists to take part in this survey. I would also like to express my sincere thanks to the 48 pre-registration (Part II) clinical scientists and 31 clinical scientists who completed the online questionnaire.

One noteworthy finding of the study was that although clinical scientists state registered within the last 3 years felt able to carry out the management and leadership roles that they now occupied, most felt that their management and leadership skills were no better than satisfactory and none considered them to be excellent.

I am now planning to submit a detailed analysis and discussion of the full results of this study for publication in a peer-reviewed journal. This will help identify to what extent the training of clinical scientists prepares them to meet the management and leadership roles that are expected of them in today’s NHS.
The analysis of data related to risk is important to many fields in medicine, particularly when explaining different treatment options to patients. There are various ways in which risk can be measured and this paper will explain some of the more common measures used including absolute risk, relative risk, odds, odds ratio and number needed to treat.

RISK DATA
It is often of interest to know about the risks associated with particular events or exposures, for example the risk of developing lung cancer for smokers. At the most basic level risk data are often divided into categories depending on whether individuals are exposed to the hazard of interest or not, and whether they experience the event of interest or not. Data such as these can be organised as shown in table 1 below, where:

\[
a = \text{number of individuals who are exposed and have the event of interest;}
\]
\[
b = \text{number of individuals not exposed who have the event of interest;}
\]
\[
c = \text{number of individuals exposed who do not have the event of interest;}
\]
\[
d = \text{number of individuals not exposed who do not have the event.}
\]

RISK/ABSOLUTE RISK
The simplest measure of risk is the absolute risk of an event occurring. This is sometimes simply referred to as the risk and is the number of individuals in the population under study who experience the event of interest within a defined period of time divided by the total number of individuals in the group at the start of the time period.

Absolute risk of an event = number who have the event of interest / number in the group at the start of the follow-up period

For the data in table 1:
\[
\text{absolute risk of event for the exposed group } = \frac{a}{a + c}
\]

\[
\text{absolute risk of event for the unexposed group } = \frac{b}{b + d}
\]

The absolute risk is a measure of how likely an event is to occur and is a probability. All probabilities range between 0 and 1; a value of 1 denotes an event that is certain to happen and 0 denotes an event that is never going to happen. It is only possible to obtain the risk of an event occurring with data that are longitudinal in nature as in order to calculate the risk of an event in a given period of time it is necessary to know the total number who were at risk at the start of the time period. Thus, it is not possible to compute a risk for data collected as part of a case-control study (a case-control study is one in which a group of subjects [cases] with the disease or condition of interest are compared to a group of subjects [controls] without the disease).

EXAMPLE 1
A recent study looked at the effects of the introduction of laparoscopic bariatric surgery in England. The authors examined the 28-day readmission rates by type of procedure. Of the 3,191 patients who underwent gastric bypass, 308 were readmitted within 28 days, whereas of the 3,649 patients who underwent gastric banding, 232 were readmitted within 28 days. These results are reported in table 2. The columns represent the type of procedure and the rows represent readmission within 28 days.

For these data:
\[
\text{the absolute risk of readmission (within 28 days) for those patients who underwent a gastric bypass is } \frac{308}{3191} = 0.097;
\]
\[
\text{the absolute risk of readmission (within 28 days) for those patients who underwent gastric banding is } \frac{232}{3649} = 0.064.
\]

ABSOLUTE RISK DIFFERENCE
This is the absolute additional risk of an event due to a particular exposure. It is calculated as the risk in the exposed minus the risk in the unexposed.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Exposure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>a</td>
<td>a+c</td>
</tr>
<tr>
<td>No</td>
<td>c</td>
<td>b+d</td>
</tr>
<tr>
<td></td>
<td>a+b+c</td>
<td>b+d+n</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Exposure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastric bypass</td>
<td>308</td>
<td>2,883</td>
</tr>
<tr>
<td>Gastric banding</td>
<td>232</td>
<td>3,417</td>
</tr>
<tr>
<td>540</td>
<td>6,300</td>
<td></td>
</tr>
</tbody>
</table>

For the data in Table 1:
\[
\text{absolute risk of event for the exposed group } = \frac{a}{a + c}
\]

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\]
\[
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\]
group minus the risk in the unexposed group (ignoring the sign).

Absolute risk difference = |risk in the exposed – risk in the unexposed|

If the risk is harmful, so that the risk is increased by the exposure, this difference is called the absolute risk excess (ARE) for example the absolute risk excess for gastric bypass compared to gastric banding is [0.097 – 0.064] = 0.033 and it represents the absolute increase in risk for those exposed compared to the unexposed. If the risk is decreased by the exposure (for example using sunscreen to reduce the risk of melanoma) then this difference is called the absolute risk reduction (ARR). A recent randomised controlled trial looking at the risk of secondary lymphoedema following treatment for breast cancer compared a group who had early physiotherapy and education with a control group who had education alone. At the end of a year’s follow-up the two groups were compared for the occurrence of lymphoedema. The data are shown in table 3.

The risk of lymphoedema for the physiotherapy group was 4 / 59 = 0.068 and the risk of lymphoedema for the control group was 14 / 57 = 0.246. Thus the absolute risk reduction was 0.246 – 0.068 = 0.178. Hence the relative risk reduction

Relative risk reduction

RRR / RELATIVE RISK REDUCTION

In clinical trials, when looking at the benefits of one treatment compared to another, the relative risk reduction can also be calculated. This is the extent to which a treatment reduces a risk in comparison to a group not receiving the treatment of interest. In this context the risk is an adverse outcome or event. It is calculated as follows:

Relative risk reduction

RRR / RELATIVE RISK REDUCTION

EXAMPLE

For the data in table 2 the odds of readmission to hospital within 28 days for patients undergoing gastric bypass was 3.417 / 232 = 0.068.

ODDS RATIO

The odds ratio is the ratio of the odds of an event in the exposed group compared to the unexposed group. Using the terminology of table 1:

Odds ratio of an event (for exposed compared to not exposed)

which is the same as the odds ratio of an event. The relative risk does not have this property. For the data in table 2 the odds ratio of readmission to hospital for patients having gastric bypass compared to patients having gastric banding was 1.57 / 0.068 = 1.52. Note that in this case, as the event of interest (readmission to hospital) is relatively rare, the odds ratio is very similar to the relative risk of 1.52.

NUMBER NEEDED TO TREAT

This is a measure of the impact of a particular risk on patients often used in clinical practice. It is the additional number of people that would need to be given a new treatment in order to cure readmission to hospital within 28 days for patients undergoing gastric banding was 232 / 3,417 = 0.068.
one extra person compared to the old treatment, and is calculated as the reciprocal of the absolute risk reduction = 1 / ARR. Alternatively, for a harmful exposure the number needed to treat is referred to as the number needed to harm. It represents the additional number of individuals who need to be exposed to the risk in order to have one extra person experience the event of interest, compared to the unexposed group. For the gastric bypass study the number needed to harm is 1 / 0.178 = 5.6. Thus the number needed to treat in order to have one additional person without lymphoedema is 6.

However, when calculating the number needed to treat it is important to know what the absolute risks that it is based upon are. Even though the risk in the control group can change dramatically, giving very different relative risks, the number needed to treat can stay constant, as illustrated in figure 1. Each bar represents the results of a fictional study. For all of these studies the number needed to treat is 3. The figure shows how the relative risk changes for different values of the risk in the control group. When the risk in the control group is 0.01 (i.e. 1 per cent risk of an event) the relative risk is 34.3, whereas when the risk in the control group has increased to 0.5 [50 per cent risk of an event] the relative risk has decreased to 1.67.

**RISK LADDERS**

A risk ladder is a visual way of quantifying different risks, in comparison to each other. It is often used in clinical practice when explaining individual risks to patients and enables patients to quantify their particular risk in relation to other risks. One of the most well-known is the Calman Chart (table 4).3

**POINTS TO CONSIDER WHEN COMMUNICATING RISK**

Individuals who do not deal with numbers and data regularly can often struggle to understand measures of risk, and in this case it can be useful to express risks in terms of natural frequencies rather than percentages. Thus if we assume that the success rate following a single cycle of IVF is about 33 per cent then it is more easily understood by stating that of 100 women undergoing treatment, 33 will become pregnant. In addition, how a risk is perceived will depend upon how it is presented. Relative risks are often presented, but these cannot be properly understood without reference to the baseline risks involved. Whilst a relative risk of 2 might sound large, if the underlying baseline risk is 1 in 10,000 and this increases to 2 in 10,000, then this will represent a very different risk to an individual than if the baseline risk were 1 in 10 compared to 2 in 10. They both have the same relative risk, but the absolute risk to an individual is very different. When presented with a risk expressed in relative terms it is always useful to know what the baseline risk is. A good further description of both risk ladders and the communication of risk can be found in an article by Edwards et al.4

It is also worth bearing in mind that in all the data that have been presented in this tutorial, no other factors have been taken into account. This is particularly important when considering the gastric bypass/gastric band data. As these are data from an observational cohort study and not from a randomised controlled trial, it may be that the patients who underwent gastric bypass were different to the patients who underwent gastric banding. These possible differences between the two patient groups could explain some or all of the difference in risk of readmission by 28 days, rather than any underlying risk associated with the actual procedure.

### REFERENCES


### TABLE 4

<table>
<thead>
<tr>
<th>Term used</th>
<th>Risk range</th>
<th>Example</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>1:100</td>
<td>Transmission to susceptible household contacts of measles and chickenpox (A)</td>
<td>1:1 to 1:2</td>
</tr>
<tr>
<td></td>
<td>1:100 to 1:1,000</td>
<td>Transmission of HIV from mother to child (Europe) (A)</td>
<td>1:6</td>
</tr>
<tr>
<td></td>
<td>1:1,000 to 1:10,000</td>
<td>Gastrointestinal effects of antibiotics (A)</td>
<td>1:10 to 1:20</td>
</tr>
<tr>
<td><strong>Moderate</strong></td>
<td>1:1,000 to 1:10,000</td>
<td>Smoking 10 cigarettes a day (D)</td>
<td>1:200</td>
</tr>
<tr>
<td></td>
<td>1:10,000 to 1:100,000</td>
<td>All natural causes, age 40 (D)</td>
<td>1:950</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>1:1,000 to 1:10,000</td>
<td>All kinds of violence and poisoning (D)</td>
<td>1:3,300</td>
</tr>
<tr>
<td></td>
<td>1:10,000 to 1:100,000</td>
<td>Influenza (D)</td>
<td>1:5,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accident on road (D)</td>
<td>1:8,000</td>
</tr>
<tr>
<td><strong>Very low</strong></td>
<td>1:10,000 to 1:100,000</td>
<td>Leukaemia (D)</td>
<td>1:12,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Playing football (D)</td>
<td>1:25,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accident at home (D)</td>
<td>1:26,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accident at work (D)</td>
<td>1:43,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Homicide (D)</td>
<td>1:100,000</td>
</tr>
<tr>
<td><strong>Minimal</strong></td>
<td>1:100,000 to 1:1,000,000</td>
<td>Accident on railway (D)</td>
<td>1:500,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vaccination-associated polio (A)</td>
<td>1:1,000,000</td>
</tr>
<tr>
<td><strong>Negligible</strong></td>
<td>&lt;= 1:1,000,000</td>
<td>Hit by lightning (D)</td>
<td>1:10,000,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Release of radiation by nuclear power station</td>
<td>1:10,000,000</td>
</tr>
</tbody>
</table>

**TABLE 4**

Descriptions of risk in relation to the risk of an individual dying (D) in any one year or developing an adverse response (A) in one year.
The Biennial Radiotherapy Meeting: Developments and Hot Topics
Narinder Lalli and Reshma Patel
University College London Hospitals

Cardiff University 6th–7th July 2010

The Biennial Radiotherapy Meeting organised by the IPEM Radiotherapy Special Interest Group took place over 2 days at Cardiff University. A varied programme, reflecting the current hot topics in radiotherapy, had been planned.

Session 1: EPID Dosimetry
Following an introduction by Graham Chalmers (Queen Elizabeth Hospital, Birmingham), the first session of the day concentrated on the latest developments and new applications in electronic portal imaging devices (EPID) dosimetry. Although EPIDs have been around for some time now, recent work has been undertaken in using it as a dosimetric tool for both quality assurance (QA) purposes and patient in-vivo dosimetry.

David Willis (Royal Marsden Hospital, London) began the session by discussing his work in developing a transit dosimetry system. After gathering some initial commissioning data, he demonstrated how the mid-plane patient dose could be obtained from the signal at the EPID. EPID in-vivo dosimetry has advantages such as no extra set-up requirements, is relatively inexpensive (using existing equipment) and provides a truly in-vivo measurement. He was able to make the whole process more automated by developing a database that retrieved the image from the client/server DICOM system and performed the necessary image analysis. The collated results can then be reviewed on a patient by patient basis (a schematic of this is shown in figure 1). He was able to show that a routine and automated transit dosimetry system could be developed in-house. His initial results show that the system is at least as accurate as diodes but with advantages such as no extra set-up requirements, is relatively inexpensive (using existing equipment) and provides a truly in-vivo measurement. He was able to make the whole process more automated by developing a database that retrieved the image from the client/server DICOM system and performed the necessary image analysis. The collated results can then be reviewed on a patient by patient basis (a schematic of this is shown in figure 1). He was able to show that a routine and automated transit dosimetry system could be developed in-house. His initial results show that the system is at least as accurate as diodes but with advantages such as no extra set-up requirements, is relatively inexpensive (using existing equipment) and provides a truly in-vivo measurement.

SESSION 2: NATIONAL PHYSICAL LABORATORY AND AUDITS IN THE UK

The use of audit within the UK has really developed over the last 20 years and regional groups have been well established. Such audits provide existing centres with reassurance and those centres starting out with confidence in new complex techniques, such as IMRT. New developments in treatment techniques also require developments in dosimetry and calibration which is where collaboration between hospitals and the National Physical Laboratory (NPL) is required.

The radiotherapy community and its needs are continually changing due to advances in treatment techniques and treatment delivery. This leads to the need for new or improved calibration procedures and dosimetry.

Catherine Clark (Royal Surrey County Hospital, Guildford) presented a talk called ‘Working together with the radiotherapy community – NPL future strategies’. Dr Clark spoke about a review that took place in October 2008 involving the NPL and 22 departments in the UK. The outcome of this review is leading the NPL to tailor their services to better fit with the needs of the radiotherapy community.

The aims of the NPL and the notion of future collaborative work with hospitals in terms of research and development were delicately highlighted. One of the aims for the NPL is to develop a primary standard and traceable calibration chain for the arrival of high-energy protons and ions into the UK. An example of some of the collaborative work includes the involvement of the NPL in the national IMRT audit for which they are researching and developing smaller and thinner alanine chips. Other work the NPL is involved in is the HDR (high dose rate) brachytherapy audit where they are also looking into developing a water phantom for measuring 3D dose distributions for HDR Ir-192 sources using alanine pellets (figure 2).

The support in terms of dosimetry developments by the NPL is important for the continual developments in radiotherapy. This talk has also highlighted the importance of teaching and research. This is paramount to creating an environment to allow positive feedback for improving our system of work.

Geoff Budgell (Christie Hospital, Manchester) presented on the 2009 UK National IMRT Audit. The National Radiotherapy Advisory Group (NRAG) has expressed concerns for the slow uptake and accuracy of IMRT. The aim of this audit was to check the implementation of IMRT in UK centres and identify any problems in the modelling and delivery of IMRT using measuring techniques that are independent from the LINAC, treatment planning system and delivery methods.

An independent method that met these requirements was developed, and centres across the UK acquired ion chamber, film and alanine measurements for chosen IMRT plans (figure 3). Dose point measurements were made for IMRT beams at specific locations using alanine chips, supplied by the NPL, and ion chambers which were compared to the TPS (treatment planning system).

Film measurements were made in specific dose plane and were compared using gamma analysis with the...
FIGURE 1. The transit EPID dosimetry system as developed by Dr David Willis (Royal Marsden Hospital, London).

FIGURE 2. NPL’s water phantom design, under development, will be used to measure 3D dose distributions around HDR Ir-192 sources.

FIGURE 3. Alanine measurements (right) and an EPID image (left), all gathered as part of the 2009 UK IMRT.
TPS. The results were reassuring with just under 95 per cent of the alanine results for IMRT fields within the 5 per cent tolerance level when compared to dose points from the TPS. The ion chamber results also compared very well with the alanine measurements and with the TPS.

The results of the national IMRT audit presented show that as a nation we are doing well; it was suggested that future audits should be adopted to test a different system. There were concerns raised over proper funding for any future audits. Some of these future audit plans include RT imaging, rotational IMRT and brachytherapy.

The open discussion at the end of the day raised some questions about the widely discussed topic that is in-vivo dosimetry. Which is better: exit vs. entrance? A discussion then ensued about the modernisation of scientific careers; the route to which one obtains registration is becoming more defined in the future, apparently.

SESSION 3: NEW DOSIMETRY TOOLS
This session discussed characterisation and implementation of commercially available dosimetry tools for the many new techniques in radiotherapy.

Martyn Gilmore (Clatterbridge Centre for Oncology, Wirral) showed us his work in evaluating two Rapidarc treatment verification methods – EPIQA (uses portal dosimetry and compares 2D dose distributions) and Delta4 (diode array in phantom, compares 3D dose to 2D diode grids). He found both test tools to be similar when comparing a range of patient plans. But he then introduced errors (MLC, monitor units) into the plan to see whether they would be picked up by either QA method. He suggested that the gamma criteria should be used with caution as it was highly dependant on the sensitivity of the system. The key point from his talk was the need to test whether the dosimetric system was able to identify the errors that you were looking to detect from your system.

With an ever increasing, wider range of commercial dosimetric tools available, Jackie Monk (St Bartholomew’s Hospital, London) in her talk about gel dosimetry highlighted the need for a systematic and consistent approach to testing new dosimeters so that they could be efficiently dismissed or implemented into the clinical environment.

SESSION 4: OTHER TALKS
Session 4 was a mix of talks, one of which was presented by Margaret Bidmead (Royal Marsden Hospital, London) on the new code of practice for the high dose rate dosimetry of HDR Ir-192 sources. The recommendations for original method of calibration were introduced jointly by BIR/IPSM in 1992 which is based on measuring AKR (air kerma rate) using a Farmer chamber/electrometer and jig combination exposed to an x-ray source. In 2004 the NPL introduced a new calibration method for Ir-192 sources where the user’s Farmer chamber and electrometer combination and jig are sent to the NPL for calibration. However, due to the range of jigs available, the NPL had no standardised calibration procedure.

Sixteen years on from the BIR/IPSM recommendations a HDR brachytherapy working party, which consists of representatives from several hospitals around the UK and from the NPL, have joined together to produce the IPEM HDR Code of Practice (COP) for the determination of the RAKR (reference air kerma rate). The NPL have now introduced a new calibration service for the re-entrant well chambers.

The new COP recommends centres use a re-entrant well chamber for source calibration measurements traceable to the NPL primary standard. They are easier to set up, provide less uncertainty and the measurement system is more sensitive and therefore produces a higher measurable ionisation current. However, the well chambers come with their own issues, such as saturation at high currents and issues with locating the ‘sweet spot’; the NPL found that this method still provided less uncertainty than the Farmer/jig method (figure 4).

The working party have investigated the stability, consistency and constancy of well chambers. Chris Lee, a member of the working party, carried out a comparison of stability measurements between the old Farmer method recommended by BIR/IPSM 1992 and the new method in the COP.

As most centres will only have a single re-entrant well chamber it raises the question of how second checks will be carried out. In the talk suggestions of
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using the Farmer/jig as a second check was made. Another suggestion was to build in-house phantoms into which a calibrated Farmer can be placed for taking measurements. There is the option to also follow Austria, the Netherlands, Belgium and Norway, who are using the AKR from the source certificate as a ‘second check’. This should be OK if the method used to obtain the value given on the source certificate is understood and is measured by an accredited centre.

It was emphasised that the working party suggests that a regional audit is very important to allow:
1. output calibration checks using the new COP;
2. independent output calibration checks carried out by a regional lead using a calibrated system and positional checks with an applicator and film, and
3. planning system verification by carrying out measurements using a specifically designed phantom which will be sent to each centre.

Overall the new COP provides a more reliable and robust method for calibrating HDR sources and the results of the audit will provide the required level of security and verification for those centres with a HDR unit.

The most memorable quote of the day was: ‘Audits are awesome, achievable and available’.

Overall, this 2-day meeting was enjoyable with a clear overview of some of the challenging work ahead for radiotherapy physicists.

QUANTITATIVE IMAGE ANALYSIS: THEORY AND PRACTICE

KONSTANTINOS MICHAEL Royal Free Hospital London

UCL INSTITUTE OF CHILD HEALTH, LONDON 4th October 2010

IMAGE ANALYSIS, THAT IS, the extraction of information from images, is implemented in routine quality assurance (QA) to ensure that the diagnostic images produced are of sufficiently high quality. With expansion in the use of digital technology, computers are used to a greater extent in assessing image quality. In this way the tedious work of extracting and analysing quantitative information can be performed by a software program and not by the user. However, automated quantitative image analysis is not an easy task, includes rigorous statistical analysis and implies that the user is aware of the methodology used. This meeting was designed to describe quantitative image analysis basic principles like the modulation transfer function, noise power spectrum, detective quantum efficiency, variance and signal-to-noise maps. In addition, some practical aspects in making measurements were also discussed. More than 50 delegates attended this meeting with the vast majority of them being medical physicists working for the NHS or in academia.

Alistair Mackenzie (Royal Surrey County Hospital, Guildford) gave two very interesting talks describing the theory behind linear systems, modulation transfer function (MTF, figure 1), noise power spectra (NPS) and detective quantum efficiency (DQE, figure 2). I found these talks quite essential in introducing the subject to people like myself who have limited experience in quantitative image analysis. Laurence King (Royal Marsden Hospital, London) showed how pre-sampled MTF of a digital mammography system is measured in his department by using two steel plates with finished edges. They calculated MTF by using two different software programs: OBJ_IQ and IQWorks. After optimising IQWorks analysis parameters they noted that MTFs obtained from OBJ_IQ and IQWorks are in good agreement. The next talk given by David Platten (Northampton General Hospital) was investigating the effects of experimental set-up on the measurement of MTF and NPS. David’s group considered two experimental set-ups: the first set-up was an approximation of the International Electrotechnical Commission (IEC) where an expensive aluminium filter is required (99.9 per cent purity); the second set-up used a readily available 1.5 mm copper filter. Surprisingly, they showed that both set-ups gave similar results for NPS and MTF.

Andrew Reilly (Oxford Radcliffe Hospitals), the author of IQWorks, also delivered two sessions. The first session explained how IQWorks could be used to ensure that compatible measurements are undertaken on different radiotherapy imaging modalities. The second session was devoted to describing principles like the contrast-to-noise ratio, and variance and how they can be used in routine QA.

Michael Hughes (Oxford Radcliffe Hospitals) introduced his MSc project, for which he developed a method to predict the results of manually scored contrast detailed experiments from measurements of the NPS and MTF. He hopes that after completing his project this model should provide a better understanding of the relationship between quantitative and psychophysical measurements and assist with the integration of quantitative measurements into existing QA. Finally, the last half-hour was devoted to the delegates for discussion. The discussion was mainly on software tools used in departments for image analysis. In addition, as requested by the delegates, Andrew Reilly updated us on the latest IQWorks developments.

Overall this was a very interesting day; the venue was excellent, the coffee breaks ample and the quality of the lunch satisfactory. In the end we all agreed that quantitative image analysis is the way forward and should be adapted in the future by all departments performing image analysis for QA checks. Finally, as all presenters pointed out, IPEM Report 32 VII: Measurement of the Performance Characteristics of diagnostic X-ray Systems: Digital Imaging Systems is finally released.
FIGURE 1. How to measure MTF.

Measuring MTF

FIGURE 2. DQE for two different systems.

Detective Quantum Efficiency (DQE)
THE NEW ESTRO COURSE ‘Advanced Imaging for Physicists’ was held in the University Medical Centre (UMC), Utrecht, part of the largest university in the Netherlands. About 70 delegates attended the course, coming from all over the world: from many parts of Europe, Asia and Australia. The focus of the course was the imaging techniques used in radiotherapy, providing lectures on the basic physics of MRI, PET and CT, and the potential for and issues with using these techniques in radiotherapy environments.

The course began bright and early on a Sunday morning, with a welcome lecture from the course director Uulke van der Heide (UMC, Utrecht, Netherlands). This provided a general outline of the course, and an introduction into how imaging has revolutionised radiotherapy practice and its applications throughout the care pathway: from diagnosis, target and normal tissue localisation to characterisation, image guidance for treatment and monitoring of treatment response. He also set out the key challenges in using these techniques in radiotherapy rather than diagnostic settings.

After this interesting talk the real work began with a series of lectures on the basics of MR physics from Dag Rune Olsen (University of Bergen, Norway) and Gary Liney (Queen’s Centre for Oncology, Cottingham, UK). We were introduced to the classical and quantum descriptions for the NMR phenomenon, the mechanisms of T1 and T2 relaxation and how these allow contrast to be formed in a basic spin-echo sequence. We then moved swiftly on to spatial encoding and an introduction to the use of magnetic field gradients for slice selection, frequency and phase encoding to localise voxels within the volume, then the basics of reconstruction and k-space. As you can imagine this was a lot of information for one morning and a lot of the delegates looked somewhat shell-shocked by the time we got to lunch!

The first afternoon session brought a little relief from the complicated physics with a lecture from Gary on the main components of an MRI scanner and the technical and practical issues that come with it. The talk took us through: site design; installation within an RF cage; the requirements for the magnets, gradient and RF coils; compatibility of peripheral equipment such as monitors, injection pumps, interventional and test objects; and issues specific to radiotherapy such as flat couch tops, dedicated RF coils and patient immobilisation.

The last lecture of the day was a fascinating guest lecture from Bas Raaymakers (UMC, Utrecht, Netherlands) on hybrid MRI-RT systems. Bas is working on the prototype MR-linac project in Utrecht and explained the various design strategies for real-time MR imaging during treatment delivery that have been proposed and are currently under construction around the world. There are many technical issues such as RF and magnetic interference between the two systems and the impact of magnetic fields on dose distributions and on dosimetry. These have been addressed in different ways by different research groups, for instance using Cobalt instead of linacs to remove the complex electronic systems, novel magnet and RF cage designs, and the use of passive and active shielding.

The final sessions of each day were used for small group discussions on contrast formation and artefacts in MRI, based around a number of case studies. These were a good opportunity for us to make a bit more sense of the information we had been given, and raised areas that needed further explanation such as the differences between spin and gradient echo sequences, k-space sampling and Ernst angles. The first day’s discussion was followed by a much-needed drinks reception!

The second day began with delegates forcing their way onto packed buses to reach the venue, to continue with lectures in MRI: firstly a whistle-stop tour through techniques for fast scanning, and then two lectures on artefact formation. MR images can be distorted in many ways, through mechanisms inherent in the scanning sequences and physical systems such as k-space sampling, magnetic field homogeneity and magnetic susceptibility, as well as from external influences such as patient motion. Therefore by understanding how different artefacts are produced did much to improve our understanding of the modality.

Monday also saw our first clinical talk of the day, by Cynthia Menard (Princess Margaret Hospital, Toronto, Canada) on MRI applications in brain imaging. The brain is the first and best established site for using MRI in radiotherapy; however, MRI always involves compromises between contrast, resolution and geometric accuracy, and by improving one aspect you will tend to degrade another. As well as aiding tumour delineation, MR sequences can be used to show additional information such as spectroscopy to give molecular information, mapping white matter tracks to avoid sensitive areas of the brain and diffusion imaging to monitor treatment response. Expert knowledge is needed to analyse images produced from different sequences with different contrast formation mechanisms. Geometric accuracy is clearly important, for instance when imaging stereotactic markers.

After lunch we had another clinical lecture, this time on MRI-guided radiotherapy for cervical cancer by Ina Jurgenliemk-Schulz (UMC, Utrecht, Netherlands). Historically, although chemo-radiotherapy is the treatment of choice in advanced disease, results are poor both in terms of local control and toxicity. In this region of the body there are a number of OARS in close proximity to the tumour, and the potential for a large range of internal motion both of tumour and OAR volumes. MRI is becoming a vital tool at all stages,
from diagnosis and staging to target and OAR definition, for both external beam radiotherapy and brachytherapy as departments move from treating large standardised volumes to individualised and optimised treatment plans.

For the last lecture of the day we moved away from MRI and onto PET with Daniela Thorwarth (University Hospital Tübingen, Germany). This lecture and the first two of the third day covered the basic physics of PET imaging, hardware requirements, acquisition techniques, image formation, reconstruction and correction methods, and a look at the properties of available tracers. PET is a functional rather than anatomical modality and as such can provide valuable extra information in a radiotherapy environment when combined with CT or MR, for instance in lymph node staging, target delineation and assessing tumour response.

After this (relative) light relief we moved back to MRI with a great lecture from Dag on diffusion-weighted imaging (DWI), which provides information on cell density and cell membrane integrity and is finding a role in cancer imaging where the high density of cells restricts diffusion relative to surrounding normal tissues. This technique does not require extra contrast medium as it uses the random Brownian motion of water molecules to provide contrast: a spin-echo sequence with an extra set of bipolar gradients will rephase static spins but not those which have moved out of the volume between the two gradient pulses. The signal reduction is proportional to the diffusion occurring so this technique produces a quantitative map of apparent diffusion coefficient (ADC) values.

A clinical example of how this technique can be used was given in the following guest lecture on MRI-guided radiotherapy for head and neck cancer by Piet Dirix (University Hospitals, Leuven, Belgium). CT does not suffer from geometrical artefacts like MRI but has limited contrast where tumour does not border on bone or air. MRI has good soft tissue contrast but it can be difficult to immobilise patients in the radiotherapy treatment position and the images are susceptible to swallowing motion. PET is also commonly used, for lymph node staging and identifying metastases. The message was that all three modalities show different aspects of the truth and as such all individually can miss areas of disease. DWI has promising indications in lymph node staging and response assessment; however, there are as yet no accepted standards for quantitative thresholds and we do not yet have a full understanding of the mechanisms involved at a microscopic level.

The morning lectures were followed by a fascinating site visit to the Utrecht prototype MR-linac and the new MR-brachytherapy facility. The delegates then had the afternoon free to explore the city, in my case involving a walk to a wonderful pancake house by the river.

Gary kicked off Wednesday’s lectures with another functional MRI technique: dynamic contrast enhancement (DCE). Use of exogenous contrast agents such as gadolinium and fast gradient sequences allow dynamic imaging of contrast uptake with applications in imaging neoangiogenesis in cancer by highlighting fast-growing leaky vessels. Dynamic imaging means a compromise between spatial and temporal resolution, and can produce large datasets which need to be presented efficiently, usually by registering images and plotting uptake against time to produce curves corresponding to different tissue types.

We then moved on to looking at the use of PET and CT in radiotherapy of the lung with Uulke. These are the most commonly used modalities for staging and target delineation, the combination improving consistency of delineation over single modality, but requiring thought about how thresholds should be applied. PET also has good negative predictive value for lymph node staging and residual uptake post-treatment can indicate poor survival. Motion is a big issue with these modalities, with CT capturing a moment in the respiratory cycle but PET averaging over a longer time frame. Techniques for 4D scanning, target definition and PTV generation, and on-treatment imaging were introduced which sparked an interesting debate on the merits of gating treatments.

The next two lectures focussed on CT, which is the gold standard imaging technique in many clinical situations but the technical aspects had not yet been discussed on this course. Koos Geleijns (Leiden University Medical Centre, Netherlands) started these entertaining lectures with a historical background to CT from the introduction of head scanners in the 1970s, where very quickly patents were granted for many of the developments that have only become available much more recently, such as helical scanning, multi-slice, multi-source or volumetric imaging. The technical aspects and range of applications of CT and CBCT were compared, before moving on to the physics of image acquisition and reconstruction via filtered backprojection to iterative reconstruction which (although widely used in nuclear medicine) is currently being promoted by manufacturers. We were also introduced to new techniques such as gating and super-fast multi-slice imaging to freeze cardiac motion and allow dynamic CT imaging.

Cynthia then gave two lectures on interventional MRI, the main applications being in needle or catheter guidance, for instance for biopsy guidance, brachytherapy or placing fiducial markers. Even MR-compatible needles and markers will produce artefacts and susceptibility issues, so understanding the characteristic signatures is important. Technical and safety issues were discussed, such as choice of coils, methods of navigation and verification, and awareness of increasing heating with repeated imaging. These techniques are particularly useful in imaging and treating prostate cancer, as was described in depth by Cynthia in the first lecture of the following (final) day. Different MRI sequences can show not only the boundary of the prostate which is unclear on CT, but also areas of disease allowing targeting of biopsies and potentially of treatment which is a major paradigm shift: from whole organ to tumour targeting.

The final lecture of the course on MR spectroscopy was given by Gary. This technique has been used in chemical and biological analysis since the 1950s, and its use in radiology dates back around 20 years. Small concentrations of molecules produce peaks in the Fourier transform of the free induction decay signal due to a chemical shift created by electron shielding. Requirements such as magnetic field uniformity and water suppression, basic sequences, localisation and post-processing techniques were all introduced; however, in a single lecture it is hard to even scrape the surface of this topic.
The final discussion session of the course was, by request, used to talk about the requirements for setting up an MRI service and the different aspects of work involved.

This was a new course, specifically addressing the imaging requirements of a modern radiotherapy department, and one which I would recommend to radiotherapy physicists who have little experience in other areas or who feel that their knowledge of the advanced imaging modalities being introduced into many departments is out of date. There were a few issues with the order in which some of the lectures were given and some of the content, which I’m sure will be addressed next time. For those delegates with no prior knowledge of MRI in particular it was a steep learning curve but without dedicating an entire course to the subject the pace was necessary. The lecturers and delegates were all very approachable and a lot of useful discussion went on outside of the lectures, and at the excellent course dinner!

I would like to thank IPEM for the bursary which supported my attendance at this course.

RISK, REASON & RESPONSIBILITY: CLINICAL SCIENCE IN PHYSIOLOGICAL MEASUREMENT

JASDIP MANGAT Addenbrooke’s Hospital

THE INAUGURAL PHYSIOLOGICAL MEASUREMENT study day was held in a bitterly cold York (figure 1), organised by the Physiological Measurement Special Interest Group to augment and enhance physiological measurement training to both scientists and technologists. The programme was carefully designed to cover competencies, which are often poorly addressed in many training centres. These include research and innovation, regulation and risk, and signal processing.

Paul White (Cambridge University Hospitals) started the day by enlightening the audience on the status of the ‘Modernising scientific careers’ agenda and its potential impact on clinical measurement. He had been challenged by the organising committee to answer the controversial question ‘Do we need scientists in clinical measurement?’

The talk emphasised that current proposals of MSC have failed to provide a clear roadmap for either scientists or technologists entering the medical physics profession to train and study in physiological measurement. Paul indicated that IPEM are strongly opposing the unpopular decision to omit clinical measurement as a specialist subject area from the scientific training programmes (STP). The simple answer to the question, dissected from the talk, was that routine patient measurements shall only be provided by clinical technologists in the future, whereas the role of a clinical scientist in this modality...
FIGURE 2. Intellectual property rights should be considered by inventors in the NHS.

**Intellectual Property Rights**

- Protects your ideas and allows for them to be commercialised

**Types of IP:**
- Patents (inventions)
- Trademarks (distinguishing signs)
- Design rights (features of appearance)
- Copyright (works)
- Confidential information (know-how and trade secrets)

Do we need scientists?

- Yes!
- Unique skills set
  - Analytical
  - Good grounding in physics, metrology and physiology
  - Strong communicator: with patients, clinicians, and other scientists
  - Innovative: don’t stand still!
shall be solely service development/improvement, management and research and innovation. Obviously this is of great concern to scientists who currently provide a successful gold-plated routine service around the UK.

As a Part I examiner and experienced supervisor of Part I trainees in clinical measurement John Pickett (Royal London Hospital) then gave his own personal opinion of what is expected of a clinical scientist trainee to successfully complete the Part I module in physiological measurement. The content was carefully absorbed by trainees in the audience.

The research and innovation session consisted of three talks. Louise Stockley (Cambridge University Hospitals) gave a thorough review of the IRAS process, with the main emphasis on medical device related studies. This was of great interest to both the trainees and also more experienced delegates. Stuart Thompson (Health Enterprise East, Cambridge) followed by giving a very interesting and amusing overview of the complex topic of intellectual property (IP), which is often not considered by many inventors within the NHS. Stuart used many examples of IP ranging from a simple paperclip to more sophisticated medical devices (figure 2). Rodney Gush (Moor Instruments, Axminster) completed the session by advising the audience on the considerations to be made and processes involved with taking medical devices to the market. He neatly revolved his inspiring talk around a burns imager marketed by his own company, now successfully used in many major burns centres worldwide.

A presentation entitled ‘Regulation and risk in clinical measurement technology’, written by Roy Smith (Royal Free Hospital, London), was kindly presented by Kevin Howell (Royal Free Hospital, London). This preliminary talk of the regulation and risk session covered the generic risk assessment process and provided hazard considerations common to all clinical measurement procedures. Control measures in the form of regulation, such as local and national policy and standards e.g. CQC, NICE, and national guidance e.g. NICE, were presented in addition to the new ‘buzz’ phrase ‘QIPP’, which for those who don’t know is an abbreviation for quality, innovation, productivity and prevention. I am sure you will all be hearing more about this in the future.

Continuing this theme, Justin McCarthy (University Hospital of Wales, Cardiff) gave a very clear and interesting refresher on medical electrical safety testing requirements as in the strongly recommended IPEM Report 97, which he, amongst others in the audience, had been instrumental in writing and publishing.

The session was brought to a close by Rob Simpson (National Physical Laboratory, Teddington), who clearly defined the important terms calibration, uncertainty and traceability to the audience. As Rob has a keen interest in temperature measurement it was an appropriate choice to apply the principles to thermally related examples.

Great appreciation was given to David Keating (Gartnavel General Hospital, Glasgow) who battled the appalling Scottish travelling conditions to attend and gave a compelling insight into the importance of using appropriate signal processing techniques. The talk covered topics related to filtering and analogue to digital conversion using both example data from his area of interest, in monitoring visual-evoked potentials, and also acknowledged material kindly provided by David Simpson (Southampton University).

After testing the audience’s attention through a carefully designed workshop exercise, a ‘day’ in the life of a clinical scientist working in clinical measurement was provided by Kevin Howell and Jason Britton (Leeds Teaching Hospitals). Dr Howell gave a very interesting overview of his career, which has seen him develop the use of thermal imaging technology for use in detection of microvascular disorders. The modality is now a routine service run entirely by himself, Jason, who has great experience in providing scientific support to urodynamics clinics, also provided insight into his involvement in implementing new clinical measurement techniques in Leeds, such as thermal imaging, bio-impedance measurements in renal medicine and oesophageal pH monitoring tests. Both talks ended somewhat controversially with Dr Howell answering the earlier posed question, ‘Do we need scientists in clinical measurement?’ (figure 3), and Jason showing an advertisement for carrying out free prostate checks at a large American department store. Could this be a sign of things to come?

The meeting organisers would like to thank IPEM for supporting this meeting, which we hope has helped those undertaking or considering training in this very broad, challenging but satisfying area of clinical science. ■

**COMPUTATIONAL BIOMEDICAL PHYSICS MEETING**

**SARAH HARRIS** University of Leeds, **MARTIN ROBINSON** University of York

**NOTTINGHAM UNIVERSITY, 14th September 2010**

This was a new meeting organised jointly between the Institute of Physics (IoP) Medical Physics Group (contact Martin Robinson, York) and the IoP Biological Physics Group (contact Sarah Harris, Leeds). It was an extension to the Institute of Physics and Engineering in Medicine (IPEM) annual Medical Physics and Engineering Conference (MPEC) which was held in Nottingham this year. The aim of this computational section of the conference was to bring together researchers in biological physics and medical physics modelling to inspire new collaborations between the two fields. The meeting covered time and length scales from atomistic simulation to models of the whole body. There were between 30 and 40 attendees present at the meeting. They enjoyed talks by five invited speakers, who covered topics as diverse as simulations of individual biomolecules (Charlie Laughton, University of Nottingham), mesoscopic models of DNA and lipids for drug delivery (Syma Khalid, University of Southampton), ▶
heart modelling (Richard Clayton, University of Sheffield), modelling of solid cancerous tumours (Helen Byrne, University of Nottingham) and models of the activity of the brain (David Halliday, University of York). Contributed talks also covered a wide range of computational research projects, including modulating protein/protein interactions with drugs (Jon Fuller, University of Leeds), systems biology of cell death (Tongli Zhang, University of Oxford), fractal dimensions of cell growth (Jon Blackledge, Dublin Institute of Technology), the dielectric response of tissues (Janet Clegg, University of York) and polarisation enhanced x-ray imaging (Zdenka Kuncic, University of Sydney, Australia). The poster presentations were similarly diverse (figure 1).

The meeting also featured a questionnaire where delegates were asked for their opinions about the barriers to collaboration between ‘academic’ and ‘clinical’ modellers, their ideas as to how these might be overcome and the potential scientific benefits to the two disciplines. This generated a lively debate and many interesting ideas. The barriers to communication that were identified were the different languages and priorities of the two communities. Suggestions for overcoming these were future meetings involving the two communities, the standardisation of computer codes and computational methodologies, PhD studentships jointly supervised between the two disciplines, developing simple language for communication, and most importantly taking the time to effectively communicate with colleagues from the opposite discipline. The potential scientific benefits that were identified, however, indicated that this increased effort could be well worth the investment. Firstly, such collaboration would prevent one or the other discipline ‘reinventing the wheel’. It would also provide modellers with access to clinical data to validate their models. A common theme was achieving overlap between the various time and length scales (molecular, cellular networks, tissue modelling) that are vital to both biological and biomedical physics. Clearly, this is an area in which further communication and collaboration should be strongly encouraged.

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**FIGURE 1.** An atomistic model of the protein MUP, showing a bound ligand. Thank you to Steve Homans for providing the simulation data and Kate Howarth for making the picture.
### IPEM MEETINGS

<table>
<thead>
<tr>
<th>Meeting</th>
<th>Venue and dates</th>
<th>More information</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Physics and Technology of Medical Ultrasound</td>
<td>Bar Convent, York, 16th March</td>
<td>This biennial meeting is aimed at physicists, sonographers, engineers, technologists, researchers and practitioners to exchange ideas and present new results, and aims to encourage dialogue between professionals from the different backgrounds.</td>
</tr>
<tr>
<td>2nd Urodynamics Measurement Meeting</td>
<td>Fairmount House, York, 25th May</td>
<td>This meeting will provide a continued opportunity for networking between medical physics and engineering staff who have a key role in providing local urodynamics services, whilst also learning about new technologies and areas of innovation.</td>
</tr>
<tr>
<td>Optical Radiation Measurement Workshop</td>
<td>St Thomas’ Hospital, London, 28th June</td>
<td>This workshop will demonstrate, through hands-on experience, how to perform practical assessments of sources commonly encountered in the healthcare environment. Further details will soon be available on the IPEM website.</td>
</tr>
<tr>
<td>IPEM 2011 Medical Physics and Engineering Conference</td>
<td>Trinity College, Dublin, Ireland, 1st–3rd September</td>
<td>The conference will be held as a part of the European Medical Physics and Engineering Conference 2011.</td>
</tr>
</tbody>
</table>

### EUROPEAN MEETINGS

<table>
<thead>
<tr>
<th>Meeting</th>
<th>Venue and dates</th>
<th>More information</th>
</tr>
</thead>
</table>
| 13th European ALARA Network Workshop        | Oscarsborg Fortress, Norway, 7th–10th June | The workshop will cover topics covered by the following working groups.  
• Challenges for the optimisation of patient and staff radiation protection in the medical sector.  
• Policy and tools for implementing the ALARA principle in the medical sector.  
• Education, training and communication to improve ALARA in the medical sector.  
• Technical developments and quality assurance in the implementation of the ALARA principle in the medical sector.  
| European Medical Physics and Engineering Conference 2011 | Trinity College, Dublin, Ireland, 1st–3rd September | Incorporating:  
• IPEM’s annual Medical Physics and Engineering Conference  
• EFOMP’s 5th European Conference on Medical Physics  
• IAPM’s Annual Scientific Meeting  
The expansion and consolidation of the union of countries across Europe has increased our opportunities for new knowledge in the field of medical physics. Consequently the aims of the 2011 conference are:  
• to represent the diverse activities in medical physics of all countries in the expanded Europe;  
• to unite professionals from different countries so that research programmes and themes can be developed as collaborations and in unison;  
• to present state-of-the-art research to a wider medical physics audience in a convivial environment in one of Europe’s most interesting and lively cities, and  
• to provide equal access to medical physics professionals across all EU countries to attend a landmark conference in Ireland. |
### MEETINGS 2011

#### EUROPEAN MEETINGS CONTINUED...

<table>
<thead>
<tr>
<th>Meeting</th>
<th>Venue and dates</th>
<th>More information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensors and their Applications XVI</td>
<td>Clarion Hotel, Cork, Ireland 12th–14th September</td>
<td>The Sensors and their Applications series of conferences provides an excellent opportunity to bring together scientists and engineers from academia, research institutes and industrial establishments to present and discuss the latest results in the field of sensors, instrumentation and measurement.</td>
</tr>
<tr>
<td>Engineers and Surgeons: Joined at the Hip III</td>
<td>Royal College of Surgeons, London 1st–3rd November</td>
<td>Following on from the success of the 2002 and 2007 events, this conference will once again bring together engineers and surgeons, academics and industrialists to discuss the latest issues and to act as a platform for the future development of hip arthroplasty. For conference enquiries contact <a href="mailto:b_miah@imeche.org">b_miah@imeche.org</a></td>
</tr>
</tbody>
</table>

#### NORTH AMERICAN MEETINGS

<table>
<thead>
<tr>
<th>Meeting</th>
<th>Venue and dates</th>
<th>More information</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE International Symposium on Biomedical Imaging: From Nano to Macro</td>
<td>Chicago, IL 30th March–2nd April</td>
<td><a href="http://www.biomedicalimaging.org/">http://www.biomedicalimaging.org/</a></td>
</tr>
<tr>
<td>Annual Meeting of the Southwest Chapter of the AAPM</td>
<td>Dallas, TX 31st March–2nd April</td>
<td><a href="http://chapter.aapm.org/swaapm/">http://chapter.aapm.org/swaapm/</a> Email: <a href="mailto:bcparker@marybird.com">bcparker@marybird.com</a></td>
</tr>
<tr>
<td>SEAAPM 2011 Symposium</td>
<td>Myrtle Beach, SC 6th–8th April</td>
<td>‘Changing Times: Quality Assurance for the Medical Physicist’ <a href="http://chapter.aapm.org/seaapm/">http://chapter.aapm.org/seaapm/</a> Email: <a href="mailto:canoelke@novanthealth.org">canoelke@novanthealth.org</a></td>
</tr>
<tr>
<td>Short Course on Monte Carlo Radiotherapy Treatment Planning</td>
<td>Philadelphia, PA 7th–9th April</td>
<td><a href="http://www.fccc.edu/cancer/treatment/radonc/treatment/monte-carlo-course.html">http://www.fccc.edu/cancer/treatment/radonc/treatment/monte-carlo-course.html</a> Email: <a href="mailto:Charlie.Ma@FCCC.EDU">Charlie.Ma@FCCC.EDU</a></td>
</tr>
<tr>
<td>SEAAPM 2011 Scientific Meeting</td>
<td>Myrtle Beach, SC 8th–9th April</td>
<td>‘Advanced Technologies = Advanced Safety Challenges’ <a href="http://chapter.aapm.org/seaapm/">http://chapter.aapm.org/seaapm/</a> Email: <a href="mailto:canoelke@novanthealth.org">canoelke@novanthealth.org</a></td>
</tr>
<tr>
<td>2011 ABS Annual Conference</td>
<td>San Diego, CA 14th–16th April</td>
<td></td>
</tr>
<tr>
<td>Principles and Practices of Radiation Safety: Occupational and Environmental Radiation Protection</td>
<td>Boston, MA 25th–29th April</td>
<td><a href="https://ccpe.sph.harvard.edu/finder.cfm?type=search&amp;precise=OER">https://ccpe.sph.harvard.edu/finder.cfm?type=search&amp;precise=OER</a> P0411</td>
</tr>
<tr>
<td>The 5th IEEE EMBS International Conference on Neural Engineering</td>
<td>Cancun, Mexico 27th April–1st May</td>
<td><a href="http://ne2011.embs.org/">http://ne2011.embs.org/</a></td>
</tr>
<tr>
<td>Cancer Imaging and Radiation Therapy Symposium</td>
<td>Atlanta, GA 29th–30th April</td>
<td>Co-sponsored by ASTRO and RSNA <a href="http://www.cancerimagingandrtsymposium.org/">http://www.cancerimagingandrtsymposium.org/</a></td>
</tr>
<tr>
<td>American College of Medical Physics (ACMP) 28th Annual Meeting</td>
<td>Chattanooga, TN 30th April–3rd May</td>
<td><a href="http://www.acmp.org/meetings/2011AM/">http://www.acmp.org/meetings/2011AM/</a> Email: <a href="mailto:laurie@aapm.org">laurie@aapm.org</a></td>
</tr>
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## MEETINGS 2011

### NORTH AMERICAN MEETINGS CONTINUED...

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<thead>
<tr>
<th>Meeting</th>
<th>Venue and dates</th>
<th>More information</th>
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<tbody>
<tr>
<td>50th International Meeting of the Particle Therapy Co-Operative Group</td>
<td>Philadelphia, PA 8th–14th May</td>
<td><a href="http://www.ptcog50.com/">http://www.ptcog50.com/</a></td>
</tr>
<tr>
<td>CRCPD Annual Meeting</td>
<td>Austin, TX 16th–19th May</td>
<td>Conference of Radiation Control Program Directors</td>
</tr>
<tr>
<td>Society for Imaging Informatics in Medicine (SIIM) IIP Bootcamp</td>
<td>Washington, DC 1st June</td>
<td><a href="http://www.siimweb.org/">http://www.siimweb.org/</a></td>
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<tr>
<td>SIIM Annual Meeting</td>
<td>Washington, DC 2nd–5th June</td>
<td><a href="http://www.siimweb.org/index.cfm?id=6934">http://www.siimweb.org/index.cfm?id=6934</a> Email: <a href="mailto:nsmith@siimweb.org">nsmith@siimweb.org</a></td>
</tr>
<tr>
<td>Radiation Safety Officer Training for Laboratory Professionals</td>
<td>Boston, MA 6th–10th June</td>
<td><a href="https://ccpe.sph.harvard.edu/finder.cfm?type=search&amp;precise=OER">https://ccpe.sph.harvard.edu/finder.cfm?type=search&amp;precise=OER</a> P0411RSO0611REP881&amp;DESC=1 Email: <a href="mailto:contedu@hsph.harvard.edu">contedu@hsph.harvard.edu</a></td>
</tr>
<tr>
<td>Annual Meeting of the American Association of Medical Dosimetrists (AAMD)</td>
<td>St Louis, MO 12th–16th June</td>
<td><a href="http://www.medicaldosimetry.org/meetings/annual.cfm">http://www.medicaldosimetry.org/meetings/annual.cfm</a> Email: <a href="mailto:stlouis2011@medicaldosimetry.org">stlouis2011@medicaldosimetry.org</a></td>
</tr>
<tr>
<td>Frontiers of Biomedical Imaging Science III</td>
<td>Nashville, TN 13th–16th June</td>
<td><a href="http://www.cvent.com/EVENTS/Info/Summary.aspx?i=de408f0-86d5-495d-8988-983d2a090074">http://www.cvent.com/EVENTS/Info/Summary.aspx?i=de408f0-86d5-495d-8988-983d2a090074</a> Email: <a href="mailto:frontiers@vanderbilt.edu">frontiers@vanderbilt.edu</a></td>
</tr>
</tbody>
</table>

### REST OF THE WORLD

<table>
<thead>
<tr>
<th>Meeting</th>
<th>Venue and dates</th>
<th>More information</th>
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</thead>
<tbody>
<tr>
<td>International Hospital Federation, 37th World Hospital Congress</td>
<td>Dubai 8th–10th November</td>
<td><a href="http://www.ihfdubai.ae/">http://www.ihfdubai.ae/</a></td>
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</tbody>
</table>
### NEW MEMBERS 2010

<table>
<thead>
<tr>
<th>Full name</th>
<th>Job title</th>
<th>Organisation</th>
<th>Town</th>
</tr>
</thead>
<tbody>
<tr>
<td>Christopher Nutting</td>
<td>Consultant Radiotherapist</td>
<td>Royal Marsden Hospital</td>
<td>London</td>
</tr>
<tr>
<td>John Pitt McGarrity</td>
<td>Deputy Manager of Medical Equipment Services</td>
<td>Victoria Infirmary</td>
<td>Glasgow</td>
</tr>
<tr>
<td>Paul Antony Brittain</td>
<td>Clinical Technologist Training Co-ordinator</td>
<td>Southern General Hospital</td>
<td>Glasgow</td>
</tr>
<tr>
<td>Glenn David Flux</td>
<td>Head of Radioisotope Physics</td>
<td>Joint Dept of Physics, Royal Marsden Hospital &amp; Inst. of Cancer Research</td>
<td>Sutton</td>
</tr>
<tr>
<td>Michael Stephen Bradham</td>
<td>Head of Clinical Physics and Bioengineering</td>
<td>Greater Glasgow &amp; Clyde Health Board</td>
<td>Glasgow</td>
</tr>
<tr>
<td>Andrew Davies</td>
<td>Trainee Clinical Scientist</td>
<td>Queen Alexandra Hospital</td>
<td>Portsmouth</td>
</tr>
<tr>
<td>Lynsey Hamlett</td>
<td>Trainee Clinical Scientist</td>
<td>The Christie NHS Foundation Trust</td>
<td>Manchester</td>
</tr>
<tr>
<td>Jim John Phillips</td>
<td>Trainee Clinical Scientist</td>
<td>Queen Elizabeth Hospital</td>
<td>Birmingham</td>
</tr>
<tr>
<td>Aaron Jude McCann</td>
<td>Research Officer</td>
<td>Northern Ireland Regional Medical Physics Agency</td>
<td>Belfast</td>
</tr>
<tr>
<td>Barry O’Connell</td>
<td>Clinical Scientist</td>
<td>NHS Lothian</td>
<td>Edinburgh</td>
</tr>
<tr>
<td>Mathias Koutalonis</td>
<td>Medical Physicist</td>
<td>Bart’s &amp; The London NHS Trust</td>
<td>London</td>
</tr>
<tr>
<td>Sarah Ellen McDermott</td>
<td>Trainee Clinical Scientist</td>
<td>Norfolk and Norwich University Hospital</td>
<td>Norwich</td>
</tr>
<tr>
<td>Peter Arthur Cook</td>
<td>Medical Equipment Clinical Engineer</td>
<td>Guy’s &amp; St Thomas’ NHS Foundation Trust</td>
<td>London</td>
</tr>
<tr>
<td>Helena Clare Wilking</td>
<td>Trainee Clinical Scientist</td>
<td>NHS Royal Devon &amp; Exeter Foundation Trust</td>
<td>Exeter</td>
</tr>
<tr>
<td>Craig Richard Edwards</td>
<td>Clinical Scientist</td>
<td>University Hospital of North Staffordshire</td>
<td>Stoke-on-Trent</td>
</tr>
<tr>
<td>Angela Diane Mayo</td>
<td>Trainee Clinical Scientist</td>
<td>Royal United Hospital Bath</td>
<td>Bath</td>
</tr>
<tr>
<td>Navinah Nundall</td>
<td>Trainee Clinical Scientist</td>
<td>University Hospital Birmingham NHS Foundation Trust</td>
<td>Birmingham</td>
</tr>
<tr>
<td>Sean Coumane</td>
<td>Medical Physicist</td>
<td>St James’s Hospital</td>
<td>Dublin</td>
</tr>
<tr>
<td>Clifford Paul Double</td>
<td>Healthcare Inspector</td>
<td>Healthcare Commission</td>
<td>London</td>
</tr>
<tr>
<td>Lawrence Bernard Brown</td>
<td>Clinical Scientist</td>
<td>Royal Hallamshire Hospital</td>
<td>Sheffield</td>
</tr>
<tr>
<td>Wesley Raymond Davies</td>
<td>Team Leader Wheelchairs and Special Seating</td>
<td>Rockwood Hospital</td>
<td>Cardiff</td>
</tr>
<tr>
<td>Jeffrey Ronald Chivers</td>
<td>Trainee Clinical Scientist</td>
<td>Rockwood Hospital</td>
<td>Cardiff</td>
</tr>
<tr>
<td>Laura Kate Howard</td>
<td>Trainee Clinical Scientist</td>
<td>Royal Liverpool University Hospital</td>
<td>Liverpool</td>
</tr>
<tr>
<td>Claire Margaret Tarbet</td>
<td>Trainee Clinical Scientist</td>
<td>NHS Greater Glasgow &amp; Clyde</td>
<td>Glasgow</td>
</tr>
<tr>
<td>Rebecca Robinson</td>
<td>Trainee Clinical Scientist</td>
<td>Royal Liverpool University Hospital</td>
<td>Liverpool</td>
</tr>
<tr>
<td>Philip Davenport</td>
<td>Trainee Clinical Scientist</td>
<td>South Birmingham PCT</td>
<td>Birmingham</td>
</tr>
<tr>
<td>Natalie Louise Hamidt</td>
<td>Trainee Clinical Scientist</td>
<td>Leeds Teaching Hospitals NHS Trust</td>
<td>Leeds</td>
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<tr>
<td>Yuk Gyn Lau</td>
<td>Trainee Clinical Scientist</td>
<td>Leeds Teaching Hospitals NHS Trust</td>
<td>Leeds</td>
</tr>
<tr>
<td>Samuel Soo</td>
<td>Trainee Clinical Scientist</td>
<td>St George Healthcare NHS Trust</td>
<td>London</td>
</tr>
<tr>
<td>Gillian Ward</td>
<td>Trainee Clinical Scientist</td>
<td>Leeds Teaching Hospitals NHS Trust</td>
<td>Leeds</td>
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<tr>
<td>Talitha Jane Smith</td>
<td>Trainee Clinical Scientist</td>
<td>Leeds Teaching Hospitals NHS Trust</td>
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<tr>
<td>Martin Kerr</td>
<td>Trainee Clinical Scientist</td>
<td>Derby Hospitals NHS Foundation Trust</td>
<td>Derby</td>
</tr>
<tr>
<td>Maria del Rosario Lopez Gonzalez</td>
<td>Research Associate</td>
<td>University of Glasgow</td>
<td>Glasgow</td>
</tr>
<tr>
<td>Aheed Syed</td>
<td>Medical Device Management Officer</td>
<td>Guy’s &amp; St Thomas’ NHS Foundation Trust</td>
<td>London</td>
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<tr>
<td>Jamie Robinson</td>
<td>Trainee Clinical Scientist</td>
<td>Aberdeen Royal Infirmary</td>
<td>Aberdeen</td>
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<tr>
<td>Tania Telford</td>
<td>Specialist Technical Officer</td>
<td>Leeds Teaching Hospitals NHS Trust</td>
<td>Leeds</td>
</tr>
<tr>
<td>Kerry Anne Hart</td>
<td>Trainee Clinical Scientist</td>
<td>Sheffield Teaching Hospitals</td>
<td>Sheffield</td>
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<tr>
<td>Katherine Lisa Goudie</td>
<td>Trainee Clinical Scientist</td>
<td>Royal Hallamshire Hospital</td>
<td>Sheffield</td>
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<tr>
<td>Qualifications</td>
<td>New applicant or transfer</td>
<td>Category</td>
<td>Date elected</td>
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<tr>
<td>-------------------------------------------------------------------------------</td>
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<td>----------------</td>
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</tr>
<tr>
<td>BSc Cell Pathology, London / MBBS Medicine, London / MD Intensity Modulated/Radiotherapy, London</td>
<td>New applicant</td>
<td>Medical Fellow</td>
<td>18 Oct 10</td>
</tr>
<tr>
<td>MEng Electrical &amp; Electronic Engineering, Glasgow</td>
<td>New applicant</td>
<td>Incorporated</td>
<td>27 Oct 10</td>
</tr>
<tr>
<td>BSc Instrumentation with Applied Physics, Glasgow</td>
<td>New applicant</td>
<td>Incorporated</td>
<td>27 Oct 10</td>
</tr>
<tr>
<td>BSc (Hons) Theoretical Physics, London / PhD Physics as applied to Medicine, Inst. of Cancer Research</td>
<td>Transfer</td>
<td>Fellowship</td>
<td>18 Oct 10</td>
</tr>
<tr>
<td>BA Engineering, Cambridge / MA Engineering, Cambridge / PhD Clinical Physics, Glasgow</td>
<td>Transfer</td>
<td>Fellowship</td>
<td>10 Nov 10</td>
</tr>
<tr>
<td>MPhys Physics, Sheffield / MSc Radiation &amp; Environmental Protection, Surrey / PhD Radiation Protection, Surrey</td>
<td>New applicant</td>
<td>Associate</td>
<td>6 Aug 10</td>
</tr>
<tr>
<td>BSc Medical Technology, Liverpool / MSc Medical Physics, Manchester</td>
<td>New applicant</td>
<td>Associate</td>
<td>6 Aug 10</td>
</tr>
<tr>
<td>MSc Physics, Birmingham / MSc Medical &amp; Radiation Physics, Birmingham</td>
<td>New applicant</td>
<td>Associate</td>
<td>6 Aug 10</td>
</tr>
<tr>
<td>BSc (Dual Hon) Applied Mathematics &amp; Physics, Belfast / MSc Opto-Electronics, Belfast / PhD Medical Imaging, Belfast</td>
<td>New applicant</td>
<td>Associate</td>
<td>20 Aug 10</td>
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<tr>
<td>BA (Mod) Natural Sciences, Dublin / MSc Medical Physics, Aberdeen / PhD Astrophysics, Dublin</td>
<td>Transfer</td>
<td>Associate</td>
<td>20 Aug 10</td>
</tr>
<tr>
<td>BSc Applied Physics, Athens / MSc Medical Physics, Patras / PhD Medical Physics, Patras</td>
<td>New applicant</td>
<td>Associate</td>
<td>20 Aug 10</td>
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<tr>
<td>BSc (Hons) Experimental Physics, Galway / MSc Medical Physics, Galway</td>
<td>New applicant</td>
<td>Associate</td>
<td>10 Sep 10</td>
</tr>
<tr>
<td>MEng Electrical and Electronic Engineering</td>
<td>Transfer</td>
<td>Corporate</td>
<td>14 Sep 10</td>
</tr>
<tr>
<td>MPhys Physics, Oxford</td>
<td>Transfer</td>
<td>Associate</td>
<td>21 Sep 10</td>
</tr>
<tr>
<td>BSc (Hons) Physics, East Anglia / MPhil Medical Physics, Keele / PhD Medical Physics, Keele</td>
<td>Transfer</td>
<td>Fellowship</td>
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</tr>
<tr>
<td>BSc Physics, Lancaster</td>
<td>New applicant</td>
<td>Associate</td>
<td>6 Oct 10</td>
</tr>
<tr>
<td>BSc Mathematics &amp; Computer Science, Manchester / MSc Physics &amp; Computing In Medicine &amp; Biology, Manchester</td>
<td>New applicant</td>
<td>Associate</td>
<td>6 Oct 10</td>
</tr>
<tr>
<td>BSc Theoretical Physics, Dublin / MSc Physical Sciences in Medicine, Dublin / PhD Radiation Physics, Dublin</td>
<td>Transfer</td>
<td>Associate</td>
<td>7 Oct 10</td>
</tr>
<tr>
<td>Transfer</td>
<td>Corporate</td>
<td>29 Oct 10</td>
<td></td>
</tr>
<tr>
<td>Transfer</td>
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<td>29 Oct 10</td>
<td></td>
</tr>
<tr>
<td>Transfer</td>
<td>Corporate</td>
<td>29 Oct 10</td>
<td></td>
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<tr>
<td>BSc (Hons) Physics, Nottingham</td>
<td>New applicant</td>
<td>Associate</td>
<td>29 Oct 10</td>
</tr>
<tr>
<td>BSc (Hons) Physics, Glasgow / PhD Experimental Nuclear Physics, Edinburgh</td>
<td>New applicant</td>
<td>Associate</td>
<td>29 Oct 10</td>
</tr>
<tr>
<td>BEng Medical Electronics &amp; Instrumentation, Liverpool</td>
<td>New applicant</td>
<td>Associate</td>
<td>29 Oct 10</td>
</tr>
<tr>
<td>BEng Electrical &amp; Mechanical Engineering, Edinburgh / MSc Biomedical Engineering, Surrey</td>
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<td>Associate</td>
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Welcome to the first 2011 edition of Scope magazine. In this issue, we bring you three book reviews and an update on new reports.

Beyond the 'New Reports' section, we present you with an interesting review from our own Editor-in-Chief, Marc Miquel, of the popular science text Neutrino. This is followed by an exciting review by Professor Angela Newing of the recent Department of Health publication Extraordinary You! Christopher Thomas has reviewed The Quest for a Fusion Energy Reactor: An Insider’s Account of the INTOR Workshop.

The 'Just Published' and 'New Reports' sections detail recently or soon to be published books and reports, covering a mixture of medical physics and engineering topics.

We would like to encourage our IPEM Scope readers to join the SCOPEBookReviews Ubidesk online workspace. The book review list in the online workspace has now been updated for 2011, so please take a look to see if you would like to review any text featured on the site. To join, please drop us an email and we will send you the relevant details for joining. The joint book review editors look forward to welcoming you to the online community.

Usman I. Lula (Usman.Lula@Poole.nhs.uk or usmanilula@gmail.com)
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Neutrino
Frank Close is a particle physicist who is rightly renowned for the accessibility of his lectures and popular science books, and Neutrino is no exception to the rule.

Close decided to tackle neutrinos, ‘the commonest and weirdest’ of all the particles, after writing the Guardian’s obituary of Ray Davis, the ‘first person to look into the heart of a star’, in 2006.

The hunt for the elusive particle is a fascinating detective story that sometimes feels like a chronicle of apparent failures. However, Close clearly demonstrates that in particle physics, the failure to discover something ‘implicitly proved’ the existence of something else.

If the prey is captivating, the life of some of the hunters is even more so. Close offers a glimpse into the life of the colourful Cold War traitor Bruno Pontecorvo. Pontecorvo worked with Fermi and like him fled Italy under Mussolini. His journey first took him to France, then the US and Canada. After the war he became a British citizen before defecting to the Soviet Union in 1958 where unfortunately, his work became largely unnoticed to the West.

Neutrino also clearly underlines the gap in time and effort between theory, its acceptance and experimental proofs. The experiments required are always complicated and on a scale sometimes hard to fathom: 60 tonnes of gallium anyone?

Overall, Neutrino is a delightful and informative little book that enticed me to have another look at Frank Close’s back catalogue.

Marc E. Miquel

Extraordinary You!

I am sorry that this publication is only available on the Internet, as it is an interesting and informative collection of interviews with scientists working in the NHS. It will provide a good selection of career possibilities for undergraduates and for graduates working, at the moment, in other disciplines but who may be considering a career change.

Scientists from all the disciplines across the NHS are interviewed and all of them are full of enthusiasm for their specialty. Among the group are four or five bioengineers and 12 medical physicists. Most of these are people at the top of their profession, but this is no bad thing as it shows what can be achieved. I was rather amused to find that all the physicists (and the biochemists, audiologists and psychologists) are described as ‘Exceptional Scientists’ while others have their job titles.

The final page suggests that this is ‘just a snapshot of the extraordinary work of scientists in the NHS’. Most readers of Scope will not find this at all extraordinary. It is a pity that the compilers in the Department of Health didn’t know much about what we do. Let’s hope that they will now appreciate our work better.

I recommend this publication to careers advisers in schools and universities as well as to potential members of our professions.

Professor Angela Newing (Retired)

The Quest for a Fusion Energy Reactor: An Insider’s Account of the INTOR Workshop

The Quest for a Fusion Energy Reactor: An Insider’s Account of the INTOR Workshop has the most accurate and informative title of any book I have ever read. It is precisely that – one person’s account of numerous meetings between 1978 and 1988. The author describes the international collaborations and scientific work carried out during this period within the INTOR (International Tokamak Reactor) workshop. This workshop aimed to develop the concept and design ideas for the first multinational fusion reactor, and in doing so led the fusion community onto the design of ITER (International Thermonuclear...
Experimental Reactor), due to be operational in 2018.

I originally wondered who exactly the readership would be for this book (maybe 100 people – most of whom would get the book free as they had been name-dropped multiple times), and to some extent I still do, but towards the end I actually began to enjoy reading it. There were some science tidbits such as competing designs for the magnetic confinement and diverter, although as a scientist myself I felt I needed more of these.

It was also interesting to hear about the relations between the EU, USA, USSR and Japanese representatives. These were of course noticeably strained throughout the whole of the INTOR project. Learning a little about their discussions and debates on the most appropriate design features and location of the future reactor was interesting. However, there was too much emphasis on who attended each particular meeting or who participated in each report. For example, more than half of page 52 explains where all of the authors of the EU, Japanese and USSR reports originated from. I think I could have done without this. Nonetheless, the author successfully managed, somehow, to glamorise the meetings (mostly held in Vienna) and made me feel I had missed out on one of the major international scientific collaborations of the century.

The scientific discussions would have been interesting, the politics would of course have been frustrating what with the USSR contingent adamant that the reactor be built in their nation and the Japanese getting ahead of themselves all the time. The post-meeting drinks and meals hosted by each international party would have been entertaining.

I wouldn’t particularly recommend this book to every medical physicist out there because you won’t really learn a lot in terms of science, and you’d have to be interested in the history of fusion reactors otherwise it is a bit dull in places. However, if you are part of an international collaboration of scientists (or want to be) then you might be interested in this book. Or perhaps you are a scientific historian, or one who seeks a job at ITER? Or, in fact, interested in the history of fusion reactors around the world with their vital statistics.

Christopher Thomas

New Reports

- Recommended Ethics Curriculum for Medical Physics Graduate and Residency Programs: Report of Task Group 159. AAPM; 2010.
- The Design of New HPA Personal Thermoluminescence Dosimeter. HPA-CRCE-007; 2010.

Just Published!

Nuclear Medicine Physics by Joao Jose De Lima (Taylor & Francis) presents a full description of nuclear medicine imaging physics and methodology (from radioisotope production to data acquisition and processing), serving as a useful reference of the basic principles and applications. Special emphasis is placed on the physics of biological functions.

Theory of Quantitative Magnetic Resonance Imaging (qMRI) by Hernan Jara (World Scientific Publishing Co. Pte Ltd) focuses solely on the theoretical aspects of the rapidly evolving field of qMRI, which are treated and analysed at three different spatial scales; specifically: the quantum physics scale of individual spins; the semi-classical physics of spin packets, and the imaging scale of voxels.

Biomaterials for Tissue Engineering Applications: A Review of the Past and Future Trends by Jason A. Burdick and Robert L. Mauck (Springer) provides a concise overview of tissue engineering technologies and materials towards specific applications. The text is divided into two sections, one on general materials technology (e.g. fibrous tissue scaffolds) and the other on applications in engineering of specific tissues (e.g. materials for cartilage tissue engineering).

Microsystems for Bioelectronics: The Nanomorphic Cell (Micro and Nano Technologies) by Victor V. Zhiznev and Ralph K. Carrin (William Andrew Publishing) considers physical principles and trends in extremely scaled autonomous microsystems for biomedical applications. The fundamental scaling limits for energy sources, sensors, computation and communication subsystems are developed. The text examines various facets of semiconductor bioelectric microsystems.

The Physics of Coronary Blood Flow by M. Zamir (Springer) is a text devoted to the dynamics and physics of coronary blood flow, approaching the subject from a biomedical engineering viewpoint.

Biophysics Demystified by Daniel Goldfarb (McGraw-Hill Professional) provides an introduction to the topic and covers biophysical tools and techniques, subcellular physics and cellular and anatomical physics.

Quantum Physics for Poets by Leon M. Lederman and Christopher Hill (Prometheus Books) makes the seemingly daunting subject of quantum physics accessible, appealing and exciting – from the first experiments through to the strange behaviour of ‘particles’ that can be in many places at once, to the latest developments including quantum string theory.

Physics of Societal Issues: Calculations on National Security, Environment and Energy by David Hafemeister (Springer) is a textbook for those who seek to understand the fundamental issues of energy use, nuclear weapons and the environment using facts and figures. Using Fermi’s famous ‘back of the envelope’ calculations, the text shows how to capture the essence of a problem with rough estimates of important parameters and how to use those estimates to gauge the effects of policy decisions.
The event that started the modern era of medical physics is, by common agreement, the discovery of x-radiation by Wilhelm Röntgen, in Würzburg, in December 1894. Nevertheless, medical physics was a known discipline well before Röntgen’s discovery. For example, Adolf Fick’s *die medizinische Physik* was published in 1858, and Neil Arnott’s highly popular *Elements of Physics or Natural Philosophy, General and Medical* was first published in 1827. However, as far as I can discover, a history of the formative days of medical physics has never been recounted. This article is the first of a planned series in which this gap will be filled.

The first published use of the term ‘medical physics’ (or to put it more accurately, *Physique Médicale*) was in Paris in 1779. The intellectual, political, scientific and medical environments of late eighteenth-century France were uniquely appropriate for the creation of this new discipline, and a few initial remarks may help to set the historical context.

Francis Duck will bring us a series of articles on the history of medical physics. In this first issue he covers the start of the subject and covers the period from 1779 to 1794.
context. In 1774, Louis XVI (1754–1793) succeeded his grandfather to the French throne, placing him in control of the most populous nation of Europe (with three times the population of Britain), with a strong (but doomed) political structure, balancing a powerful monarchy against the provincial parlements. The ideas of the age of enlightenment were now well developed, and the accession of the young king promised a real opportunity to alter the principles on which the nation was governed. Enlightenment thinking saw reason as the primary source of legitimacy and authority, emphasising science as the source of truth and progress. In this context, the status of the medical profession was under scrutiny, with the aim of reforming and modernising it to meet the needs of society.

**FÉLIX VICQ D’AZIR AND THE SOCIÉTÉ ROYALE DE MÉDECINE**

The term medical physics was first used in the publications of the Société Royale de Médecine (referred to here as the Society) by the permanent General Secretary of the Society, Félix Vicq d’Azir (1748–1794) (figure 1). The son of a Normandy doctor, Vicq d’Azir came to Paris in 1765 to study medicine. He found the lectures at the Paris Medical School somewhat dull, and instead attended lectures on anatomy, physiology, pharmacology and botany at the Jardin du Roi. He passed the medical examinations brilliantly, but in spite of evident talent was not accepted as a lecturer within the Faculty of Medicine, nor did he ever practise medicine. However, his research into comparative anatomy gained him a seat in the prestigious Royal Academy of Sciences when only 26, initiating a life-long association with senior members of French science, amongst whom were the mathematician and educator, the Marquis de Condorcet (1743–1794) and the doctor François de Lassone (1717–1788). He was described as being tall, imposing and handsome, with a sweet sonorous voice, charming and persuasive. His only wife died young. He became known as an outstanding anatomist, making contributions to the comparative anatomy of the brain, but overall his contributions to medical science arose less from his personal scientific talents than from his ability to inspire others, both within and outside government, to believe in the importance of rational science to medicine.

In 1774, Vicq d’Azir was appointed by the Minister of Finance, Turgot, to report to the government on an epidemic of cattle-fever that was then causing great concern in southern France. He quantified carefully the extent and development of the epidemic, investigated possible causes, and controlled the spread of the disease by prohibiting movement of animals, demanding stringent hygiene and calling on the army to destroy and bury all infected animals. This established his reputation in government. It also made him aware of the parallels between the spread of disease in human epidemics and the comparable situation for domestic animals. In 1776 he set up, by decree of the Council of the King, a medical board with the purpose of corresponding with provincial doctors on animal and human epidemics. Throughout the rest of his life he maintained a voluminous personal correspondence with these doctors, many of whom felt greatly honoured to gain the personal attention of such an eminent man. Within a month of its first meeting in August 1776, the medical board on epidemics was calling itself the Société de Correspondance Royale de Médecine, with Vicq d’Azir signing himself as its General Secretary. But he had his sights set higher, nothing less than to restructure the sclerotic, inward-looking medical establishment, and to open medicine itself to rational and scientific scrutiny. With his friend Lassone, now the Chief Physician to both king and queen, he wrote the terms of reference of a new medical body, which became the Société Royale de Médecine. This new Society combined the functions of the board on epidemics with the Commission for Consideration of Secret Remedies and Mineral Waters. Perhaps not surprisingly, gaining royal letters patent to establish a new medical society met with significant opposition from the medical establishment, not least because it would be so close to the centre of political power. Realising the threat to its status, the medical faculty first proposed incorporation of the upstart society within its own establishment. When this failed, they appealed to the Parlement of Paris to refuse registration of the letters patent, and also gave the 28 doctors named as members of the new society 7 days to resign or be expelled from the Faculty. They again failed, and the letters patent were granted in August 1778. The first meeting was held on 1st September. Vicq d’Azir became the first and only permanent General Secretary. The membership consisted of 30 medical doctors and 12 free members, including scientists and senior government ministers. There were 150 corresponding members from the French provinces and up to 60 foreign scientists and doctors, amongst whom were Benjamin Franklin (1706–1790), at this time American envoy to the court at Versailles, and the British chemist Joseph Priestley (1733–1804).

**MEDICAL PHYSICS AND THE SOCIÉTÉ ROYALE DE MÉDECINE**

The events outlined above are well known to historians of medicine. Their importance for medical physics arises because physics was explicitly included in the work of the Society alongside the other basic sciences such botany, natural history and chemistry. This was made clear in both of its regular publications, L’Histoire de la Société Royale de Médecine (referred to here as L’Histoire) contained general information on activities, together with short scientific reports from the members. Here, a separate section was reserved for ‘Observations of general physics applied to medicine’, specified by Article XII of the terms of reference of the Society (figure 2). The second publication was more explicitly named Les Mémoires de Médecine & de Physique Médicale (referred to here as les Mémoires), and contained longer reports by the members. L’Histoire and les Mémoires were bound together. But whilst the new subject now had a name, medical physics was not yet clearly defined. During the next...
decade or so, it slowly gained meaning through the content of the Society’s publications. Looking through the papers, it is possible to see a few particular areas of activity start to emerge, for example in the physical therapies. The effects of static electricity had caught the imagination of both scientists and the leisureed classes, and had become part of the social scene. Its value as a curative or therapeutic agent was less clear, however. The Society agreed to examine the matter, and the director of the Society, Pierre Mauduyt de la Varenne (1732–1792), carried out perhaps the first critical evaluation of medical electricity, publishing several studies in Les Mémoires, the concluding work also being published as a separate volume. Mauduyt reviewed 12 different methods of applying electricity, and reported his own experiences of the electrotherapy of 82 patients (figure 3). About 50 had paralysis, of whom 32 showed some improvement. Full or partial relief of symptoms were reported for a number of other conditions including constipation, gout, rheumatism and menstrual irregularity. In addition, l’Histoire included correspondance on medical electricity, with case reports from Toulon, Caen, Lyon, Boulogne and other centres, and overseas correspondence from Joseph Priestley and Tiberius Cavallo. Whilst the outcomes may now seem overly optimistic, the critical method of evaluation demonstrated a real attempt to give evidence on which to base judgements on the use of this new technique.

The second physical therapy to be evaluated was the use of magnets. Interest arose primarily because of the arrival in Paris from Vienna in late February 1778 of Franz-Anton Mesmer (1734–1815). His methods for the treatment of nervous conditions, based originally on the placement of magnets at strategic positions on the patient’s body, and subsequently on his own claimed power to control animal magnetism, polarised opinion in Vienna. Forced out by the medical establishment there, he rapidly re-created a highly successful clinic in Paris, treating mostly neurotic, well-financed young ladies of Paris society. Mesmer failed to gain endorsement from the scientific and medical establishment, but this did not stop him from creating a huge public following in Paris and throughout France. Finally, 6 years on, the scientific establishment decided to act, perhaps because there were some in the medical world who wanted a slice of the action if animal magnetism really did work. Several commissions were established, one of which reported its results in Les Mémoires. The fields of magnets of a variety of shapes were plotted using iron filings (figure 4), the magnets were strapped onto the skin, and their therapeutic effects were assessed mostly on various types of nervous disease. The results, not surprisingly, were entirely negative. Mesmer left Paris in 1784, a disillusioned but much richer man, leaving the phenomenon of mesmerism, heightened suggestiveness during the hypnotic state, to retain its interest through until the present day.

Some medical physics papers explored more fundamental science. The physicist Mathurin Jacques Brisson (1723–1806) reported measurements of the specific gravity of substances used in medicine, including warm and cold saline solutions, oils, gums, milk, spirits, sulphur, bitumen, amber and metals. The professor of anatomy from Toulouse made some observations on the eye and on the propagation of sound. The chemist Antoine-Laurent Lavoisier (1743–1794) reported quantitative evidence that oxygen is the agent of respiration, although he wrongly assumed that combustion in the lungs is the source of body heat. At this stage in the development of scientific ideas, physiology was still in its earliest years, and had yet to be accorded independent status as a science in its own right. Later parts of this history of medical physics will explore its intertwined development with physiology in more detail. But, as yet, physiology was still in its infancy, and medical physics was only just born.

Several medical physics papers presented work associated with the Society’s interest in public health and hygiene. Here, the possible association between epidemics and the weather was a major theme. Vicq d’Azir invited all his French corresponding doctors to take on the role of weather observers, and to provide regular weather reports in addition to those on medical matters. Such was the enthusiasm with which they took to this new role that this
period is remarkable for its detailed weather records. The correspondents were invited to purchase standard meteorological instruments with which to make their measurements. A comparison between mercury and alcohol thermometers was reported in the first medical physics section of l’Histoire. Other studies associated with public health were on the toxicity of noxious gasses, on the stench of latrines, and on heath effects near sites for the manufacture of antimony. Some work seems rather far from medical physics as it is now understood, including a study into water preservation on long voyages and another into the adulteration of cider.

But, taken overall, the number of medical physics papers was very small indeed, and in later volumes they get lost within the much larger volume of other papers. So it is reasonable to ask why the Society’s journal was misleadingly named Les Mémoires de Médecine & de Physique Médicale, when self-evidently it published so little physics content. It is only possible to speculate on the true reason. Part of Vicq d’Azir’s plan was to align the Society with the Academy of Sciences and we have seen that he also intended to distance it from the Faculty of Medicine. By creating, naming and declaring the new subject of medical physics, perhaps he was deliberately trying to give scientific status to his Society, staking a political claim to new intellectual territory in order to establish a completely new approach to medicine and health.

THE FRENCH REVOLUTION

During the confident 1780s, three scientists were dominant as advisors to the King’s government – Lavoisier, Condorcet and Vicq d’Azir (figure 5). All three met their deaths in 1794, victims of the revolution that engulfed the country. The storming of the Bastille on 14th July 1789 was the starting shot for events that saw France spiral into bankruptcy, chaos and terror, when everything and everyone associated with the old regime was swept away. Established scientists were initially hopeful for creative change, but progressively feared for their lives, whilst new politically-acceptable scientists became increasingly powerful. One of the latter was the Comte de Fourcroy (1755–1809), a doctor and chemist, and Lavoisier’s collaborator, who became highly placed in the Jacobin revolutionary government. In 1791, as the Society waned in importance, he launched a new journal, La Médecine Éclairée par les Sciences Physiques. Whilst it lacked the mission that underpinned les Mémoires, and so failed to make any important contribution to medical physics, Foucault himself helped to ensure that science remained central in post-revolutionary medicine.

A law passed on 7th August 1793 (20th Thermidor Year 1 in the new calendar) closed down all French academies and literary societies, including the Société Royale de Médecine. On 14th November the arrest of Lavoisier was ordered, charged with offences from his brief period (1789–1791) as a royal tax farmer. (The tax farms were a system of privatised tax collection, set up to help France’s finances as the costs of war and of international debt escalated.) Whilst in prison, Lavoisier heard of the death by suicide of his old friend Condorcet, following his arrest simply for being an aristocrat.

In one letter written from prison, Lavoisier remarked on his support for physics in medicine, perhaps being aware of the growing threat to his friend, Vicq d’Azir, and his legacy: ‘The physicist … can hope that his labours can lessen the mass of ills that afflict mankind … and if, by the new researches open up, he does no more than extend human life by a few years, even a few days, he may aspire to the glorious title of benefactor of mankind.’

In a much-quoted retort, the presiding judge at his trial asserted that ‘the Republic has no need of scientists’. Lavoisier was executed by guillotine on 8th May 1794, together with 27 other tax farmers.

Vicq d’Azir was by now suspected of intelligence with the ‘enemy’ and, with both Lavoisier and Condorcet dead, he could have been in no doubt about the threat to his own life. Hoping to give him the protection that he was unable to give Lavoisier, Fourcroy arranged for him to be named Head of the Saltpetre Commission, responsible for the collection of this essential ingredient of gunpowder. In this role, Vicq d’Azir was obliged to attend Robespierre’s Festival of the Supreme Being on 8th June, which he did in spite of an already fragile health condition. Seeing Robespierre’s self-aggrandisement, a friend of Danton’s has been quoted as saying: ‘Look at him – it’s not enough for the bugger to be king, he has to be god as well’. Subsequently confined to bed and in a permanent state of terror, Félix Vicq d’Azir died on 20th June at the age of 46, the cause of death being variously attributed to tuberculosis, aneurism, suicide, or just fear. He could not have anticipated that, by the end of July, Robespierre himself would have been taken to the guillotine, ending the terror that had engulfed France.

The tenth and last volume of Les Mémoires de Médecine & de Physique Médicale was published in 1798, 5 years after the Society was closed down. It would not be until the middle of the twentieth century that a journal would again use ‘medical physics’ in its title. But medical physics had been created, and had identified itself with specific topics in physical therapy, in physiology and in public health. What happened next will be the subject of the next essay in this series.

ABOUT THE AUTHOR

Francis Duck is part-time Consultant Medical Physicist in the Department of Medical Physics and Bioengineering at the Royal United Hospital Bath NHS Trust and visiting professor at the University of Bath.

REFERENCES

1 L’Histoire de la Société Royale de Médecine, année MDCCCLXXVI, avec les Mémoires de Physique Médicale pour la même année, 1779.
3 www.bium.univ-paris5.fr/histmed/medica/vicq.htm
Keith Boddy, an exceptional medical physicist and former President of IPSM, has died from cancer aged 72. His achievements ranged widely but, above all, he was a personality who was for most people once met, never forgotten. His career started in radiation safety, an interest that continued for the rest of his life, but his work developed over many other areas. By the time he retired he was a celebrity within medical physics, recognised internationally as a very significant leader. With his passing, medical physics has lost a great leader, a colourful personality and a true statesman.

Probably the most significant step of his career came in April 1978 when he returned to his native north-east of England (which he always called ‘God’s chosen country’) to become the second head of the Regional Medical Physics Department (RMPD) and Professor of Medical Physics at the University of Newcastle upon Tyne, following the retirement of Professor F.T. Farmer. This appeared to some people to be an unusual appointment, as he had never previously worked in a hospital nor in a medical physics department, although he had for many years worked with clinicians and accumulated an impressive record of multidisciplinary research.

**AMBITIOUS PLANS**

His mandate from the Northern Regional Health Authority was to develop medical physics services across the whole region (and thereby help redress the relative underfunding at that time of the NHS in northern England). He made ambitious plans and set about implementing them with determination. From a department on just two hospital sites in Newcastle making visits to a few others, he transformed the organisation into a truly regional, comprehensive medical physics service, extending into almost every branch of medicine and including scientific, clinical and technical work, and teaching and R&D. Growth was initially fairly rapid, and then continued throughout the 20 years of his term, resulting in a ten-fold increase in size, and clinical services running at 13 different hospitals throughout the region which extended from the Scottish border to Teesside and Cumbria. This enabled services such as radiotherapy and nuclear medicine to be delivered at national standard levels of provision.

Achieving all of this was a substantial feat. He attracted high-calibre staff who enhanced the reputation of RMPD and, of critical importance, maintained the required flow of new funding as the NHS went through almost continual reorganisations. These, and the many changes in senior NHS personnel involved at regional level, resulted in the very existence of RMPD being questioned several times.

From a later perspective, his achievements seem yet more impressive, as maintaining a consistent direction of development in a changing environment has proven very difficult. Earlier in his career he had shown evidence of important qualities, including the ability to attract funding for projects, and to engage in spirited dialogue with fellow scientists. Now he had a clear and consistent vision of where he wanted to take RMPD and was a compelling speaker about the role of physics and engineering in medicine and its importance to clinical services and innovation. He was a serious and tough negotiator but used humour often, and a series of colourful expressions and homely analogies to make his points, and usually won any argument. Perceptive of those confronting him, he provided solutions rather than problems, and was a skilled advocate in gaining their acceptance. He exuded confidence, inspired it in those he dealt with, and in those he led.

**SIGNIFICANT PROGRESS**

The regional organisation of RMPD was often cited as a model for its scientific and clinical work and innovation by its staff, which ranged from novel methods for assessing blood supply to the skin (important in plastic surgery) to the risks from exposure to light, the efficacy of sunscreens and the establishment of a regional technical aids service to provide bespoke assistive technology, which became a service delivery model that others would copy.

After just a few years in Newcastle there had been very significant progress, which gave him considerable authority on the national scene. He was elected President of the Hospital Physicists’ Association and Institute of Physical Sciences in Medicine in 1986. At this time there was concern about the future of the profession, arising from some medical radiation over-exposure incidents, and low salaries resulting in difficulties in recruiting new graduates of sufficient calibre. Working with colleagues nationally and with those in parallel professions he set about raising the profile of medical physics with the government, getting to know senior figures and ministers, inviting them to visit his own department, emphasising that his staff were working on the clinical frontline, or as he put it ‘at the coalface’ of medicine and were not just backroom staff. He generated a sense of momentum, and within a few years there was a new NHS grading...
Early Education and Training

Keith Boddy was born in Stockton-on-Tees. He excelled as a sportsman at school, also playing under-15 rugby for Durham County and cricket for the local town. From Grangefield Grammar School in Stockton he went to Liverpool University, from which he graduated in 1959 with a BSc in chemistry. He was then appointed as a Radiation Protection Officer and later Head of the Health Physics Section at Associated Electrical Industries Research Laboratory at Aldermaston Court. While there he completed an MSc in Radiation Physics at St Bartholomew’s Hospital Medical College, London University.

In 1963 he moved to the Scottish Universities Research and Reactor Centre at East Kilbride where he developed his own research programme, for which he was awarded a PhD from Glasgow University in 1967 and a DSc from Strathclyde University 10 years later. He designed and built high sensitivity whole-body radioactivity monitors for use in clinical studies for body composition and metabolism and for radiation protection. Study of human metabolism using radioactive tracers was an established method which he applied to vitamin B12, among other topics, collaborating with Glasgow clinicians. Assessing body elemental composition by irradiation with neutrons to activate elements so that they could be measured using the radiation emitted was a new concept at that time. First he used a neutron beam from the centre’s nuclear reactor to assess iodine in the thyroid gland, and later studied the use of radioactive neutron sources (Cl-252). However, assessment of whole body composition was potentially more useful. He realised that 14 MeV neutrons from D-T generator tubes, then recently available and developed primarily for cancer treatment, would enable a greater number of elements to be activated than was possible with radioactive neutron sources, as used in the only competing centre at Brookhaven, USA. A concrete block shield surrounding two generator tubes with a moving couch for the subject between them were built and, with an adjacent whole body monitor, enabled measurement of whole-body Ca, P, N, Na, Cl and O, in addition to K from natural radioactivity. This facility was used in studies of renal disease, hypertension and arthritis and other conditions.

He also had an interest in environmental radioactivity, beginning in his first post when he established the first environmental survey programme and off-site emergency scheme outside the UKAEA, and was the first to report radioactivity in rainfall following atmospheric Soviet nuclear weapons testing in 1961. In 1986 the fire at the Chernobyl nuclear reactor released radioactivity over much of Europe. In the UK, those hospitals that had suitably sensitive radioactivity monitors were able to make assessments of affected people, but there was no overall picture of the risk to the general population. Keith obtained government funding to build a whole-body monitor in a large van (a repeat of an undertaking at East Kilbride) and send it around England and Wales to establish the pattern of human uptake of radioactive caesium (Cs-137).

Committee Membership

He had numerous other activities within the radiation protection field. He served on several government committees: the Radioactive Waste Management Advisory Committee, the Committee on the Medical Aspects of Radiation in the Environment (COMARE) and the Ionising Radiations Advisory Committee of the HSC, and chaired a working group of the Watt Committee on Energy. He was a consultant on whole-body monitoring.

Without his efforts and leadership, this would never have happened.
to the International Atomic Energy Agency and advised the World Health Organization. On the Sellafield Local Liaison Committee, he chaired the Environmental Health Sub-Committee, where his abilities both to get to the core of a problem, and to express scientific information about nuclear radiation and risks in terms accessible to the layman, were particularly valuable. On COMARE, he worked on reports of cancer in the locality of Sellafield and of Greenham Common. This work continued after his formal retirement, recently involving investigation of radioactive particles found on the beaches near the Dounreay nuclear site. He chaired the Dounreay Particles Advisory Group, liaising with the Scottish Environmental Protection Agency, and was still working on this until shortly before he died.

Despite all his work with government agencies, he was also willing to take on the establishment in the interest of fairness and commonsense. Thus in 1992, one of his staff reported to the Environment Department details of disposal of a small amount of radioactive waste material, which their inspector then viewed as contravening the site authorisation. The inspectorate then prosecuted the NHS health authority responsible for the premises. Since the incident was a technicality with no consequence for safety or health, Keith persuaded the authority to fight, and appeared as a defence witness. The result was a token fine and costs to be paid by the prosecutor. It was noted that after this event, there seemed to be a much more moderate approach taken by the inspectorate to similar incidents.

RECOGNISING ACHIEVEMENTS
He received many honours including the OBE in 1989, CBE in 1998, the Institute of Physics Glazebrook Medal (for leadership in physics) in 1992, an honorary DSc from De Montfort University and the IUPESM Award of Merit in 2000. He was a Fellow of the Royal Society of Edinburgh and of the Institute of Physics, an honorary member of the British Nuclear Medicine Society, the Royal College of Radiologists and the British Institute of Radiology, and an honorary Fellow of the Institute of Physics and Engineering in Medicine and of the Society for Radiological Protection. He gave the Annual Lecture to the British Nuclear Medicine Society, the Walker Lecture to the Royal College of Physicians and Surgeons in Glasgow, the Association Lecture to the Hospital Physicists’ Association and the first Jack Meredith Memorial Lecture of the Institute of Physics.

His wife Sylvia was a fellow pupil at the same school as Keith in Stockton and also went to Liverpool University. They married in 1960 and had two sons, Christopher and Graham. We and many friends and colleagues extend our deepest sympathy to his family.

“Keith persuaded the authority to fight, and appeared as a defence witness”
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Theo was born in 1918. He completed his secondary education in Brighton before graduating in 1942 from Imperial College London with a BSc. Then for 6 years, a period which included the HPA’s 1943 Inaugural Meeting and its early years, he worked as Assistant Physicist at the Royal Cancer Hospital in London under Professor Mayneord. Then he moved to Hull.

Although ‘deep 180kV x-ray therapy’ had been used in Hull since 1930, at the end of the Second World War it was decided that a radiotherapy centre should be developed for the city and its surrounding areas and that a medical physicist should be appointed. Theo applied and became the first medical physicist in Hull in 1948, the year the NHS was formed, initially to commission and support the new centre at Hull Royal Infirmary. The centre opened in 1949 with two state-of-the-art x-ray 250 kV treatment machines and from this base he was instrumental in developing new services, including nuclear medicine and radiation protection. Theo continued to push for better technology to enable advances in patient treatment and by 1957 was promoting the need for high energy 60Co teletherapy, though a machine was not installed until the construction of a new radiotherapy centre on the edge of the city in 1966. Theo was able to persuade the hospital to support many major developments and oversaw the expansion of medical physics at both sites. By the time he retired in 1981, after 33 years as head of department, he had broadened its scope to include medical electronics, renal dialysis, bioengineering and audiology. The department he set up and nurtured has now grown into a comprehensive medical physics, academic and biomedical engineering service with over 100 staff.

GUEST OF HONOUR
Theo kept in touch with his medical physics colleagues throughout his career and was Secretary of the Northern Medical Physics Group from 1957–1959 and a member of the HPA Executive Committee from 1965–1967. He remained interested in medical physics and bioengineering after his retirement, particularly as both his sons Mark and Nicolas followed him into the profession. He visited the departments in Hull on many occasions and it is an indication of the esteem in which he was held that, when a dedicated Medical Physics building was opened in 1999, it was named the Tulley Building. Theo was guest of honour and visited every scientific and technical display, questioning all the presenters until he thoroughly understood their research work.

Theo remained in Hull after his retirement and was active in the community up until the night before his death. Retirement from hospital physics gave him time to devote to other interests which included the encouragement of world peace, with roles including Secretary of the Hull Quaker Association, Treasurer of the Religious Society of Friends and school governor. As well as being a committed Quaker, Theo was a very practical man. For example, he went to night school at the age of 14 to learn how to rewire the family home. In Hull he was involved in setting up a home for abused women and continued to contribute his time and abilities by helping with its maintenance, and even into his late 70s could be found working up ladders to the consternation of his friends and family.

LEGENDARY ENERGY AND INDEPENDENCE
Theo was a strong family man who always supported his wife Alice in her profession as a teacher and as a city councillor. She had refused to marry him until ‘he had a proper job’, so he took her at her word and chose that job in Hull! Besides their two sons, Alice and Theo had two daughters, Deborah and Eleanor. Theo’s passion for medical physics led to frequent late hours and once, to keep Alice happy, he resorted to painting his house windows at night, up a ladder and by torch light, which led to a discussion with the police who suspected he was a burglar. His energy and independence were legendary and at the age of 90 he travelled on his own from Hull to the IPEM meeting in Bath to be awarded Honorary Fellowship, walking the 2.5 miles and climbing the 650 feet up the hill to the university campus in his sandals and multicoloured shirt.

Theo was always enthusiastic, questioning, keen to understand and to innovate. All those who knew Theo professionally or through his voluntary work speak with great fondness of his ability to inspire and of his kindness. He is remembered by those who knew him as a wise, supportive and caring man who lived his ideals and his life to the full.
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