The Christie NHS Foundation Trust Anticipating New Era of Radiotherapy Speed and Precision with Elekta’s New Versa HD System

Elekta’s new Versa HD™ system will help clinicians at The Christie NHS Foundation Trust (Withington, Manchester) maximize the precision of therapeutic beams on the tumor target, while also accelerating radiation delivery to new levels.

Versa HD is designed to be the most sophisticated, high-versatility treatment system. The system offers clinicians the flexibility to deliver conventional therapies to treat a wide range of small and large tumors throughout the body, while also enabling treatment of highly complex cancers that require extreme targeting precision. Treatment of the most challenging cases is addressed by ultra-conformal beam shaping, working in concert with an innovative High Dose Rate mode – a potent combination that delivers both high precision and high treatment speeds.

“Other linear accelerators have high dose rates, but only Versa HD combines High Dose Rate mode with a multileaf collimator [Agility™] that offers the industry’s highest leaf speeds,” says Carl Rowbottom, Ph.D., head of radiotherapy physics at The Christie. “With high leaf speeds we will be able to modulate the field shape fast enough to achieve the required dose distribution, while also treating at the fastest delivery speed.”

With highly conformal, rapid beam shaping and the High Dose Rate mode of Versa HD, Dr. Rowbottom predicts significant increases in treatment speeds, improving the patient experience.

“Right now our VMA1 technique for head-and-neck [squamous cell carcinoma] cases requires two arcs of about 90 seconds each,” he says.

“With the high leaf speed and increased dose rate, we should be able to treat using just one arc of about 60 seconds.”

www.VersaHD.com

Versa HD is not available for sale or distribution in all markets.

One Solution. Unlimited Possibilities.
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Challenged and changed

Peter Jarritt writes as President for the last time and sums up the challenges he has faced and the rewards they have provided.

As I write I am rapidly approaching the end of my term as President of IPEM. Assessing the past 2 years from a personal, professional and IPEM perspective it is clear that we continue to live in challenging times, which inevitably results in either initiating, enduring or implementing change.

From an IPEM perspective I highlight four specific challenges that have occupied much of my Presidency. The Modernising Scientific Careers programme and its impact on the IPEM training scheme and the infrastructure to support it have been a constant presence. It has been essential that IPEM, through its members, has sought to influence and support the new infrastructure including the National School for Healthcare Science with which we have recently signed a Memorandum of Understanding. A Joint Assessment Unit at the Academy of Healthcare Science has just been agreed with the Association of Clinical Scientists through another Memorandum of Understanding. The continued engagement of members to define and implement the educational programmes at all levels from apprentice to consultant level is essential to secure the future workforce for physics and engineering in healthcare.

The challenge of the change in leadership of the Institute was known at the outset of my Presidency and required significant investment in time by the Trustees to review the needs of IPEM in a time of change and uncertainty. The resulting transition has been very successful despite the unexpected need to completely review the Articles of Association and Rules of the Institute which was yet another major challenge and time consumer. Developing the partnership between the permanent staff and the membership will be vital to sustain a vibrant Institute.

It is now a year since we faced the challenge of merging Incorporated and Member grades of membership and the impact of this is still being worked through as the structures of IPEM are changed as part of the governance review. Further work will be required to define criteria for membership of IPEM which are currently linked to the IPEM training schemes. This is clearly inappropriate particularly as we develop our links with the Bioengineering Society and the academic and industrial sectors.

The changes to the NHS structures, especially in England, have, I suspect, been a challenge to many of us as we do not know what the impact is or will be. I observe that the loss of structures such as the National Cancer Action Team and National Imaging Clinical Advisory Group, and the formation of Clinical Reference Groups (CRG), has galvanised professional bodies to fill the void and ensure that relevant CRGs receive timely and definitive advice. The RCR, SCoR and IPEM are now partners in a Radiotherapy Board and this forms a model to develop an Imaging Board. This multi-professional approach to understanding and defining high-quality, accredited, cost-effective, patient-focussed services is a key requirement for a reformed NHS and a challenge with which IPEM has enthusiastically engaged.

From a personal perspective the past 2 years have been some of the most busy and challenging but rewarding of my career. Without a strong Council and Trustee body and numerous committed members my task as President would have been impossible and I would like to record my thanks to them. The partnership with the York office has also been vital to developing and taking forward our operational plan and I must extend my thanks to them under the leadership of Rosemary Cook.

As I look back I have a real sense that there have been times when change has had to be endured but of much more importance have been the rewards of initiating and delivering change. Much remains to be done and I wish Steve Keevil well as he takes over as President and leads IPEM to continue to deliver on its charitable objectives:

To promote for the public benefit the advancement of physics and engineering applied to medicine and biology and to advance public education in the field.
Everyone wants ‘feedback’ these days. Every restaurant, hotel or public service asks you to complete a survey to let them know what you felt about their offering and what they could do to improve. Who knows how much of the feedback is read and acted on, or whether it is just a marketing ploy to make the customer feel important.

But if there was ever an organisation that really should canvass views regularly and take them seriously, it is a membership organisation – which is why IPEM is carrying out a major survey of members’ views in September/October this year. We want to find out some key information from members, including which of IPEM’s membership benefits are most useful and valued, and what IPEM does well in support of members and where we could improve. We ask what priority members would give to our various strategic objectives, and which issues are most concerning members in their work, so that we can plan how best to support them in addressing these.

The survey will be conducted electronically, meaning that a few clicks of the mouse are all that is needed from members – there will be no need to find an envelope and return a form unreliably by post! This kind of survey is not only more convenient, it is cheaper and quicker to administer, and enables a lot of the analysis of results to be conducted and presented automatically. However, we will also be looking individually at every free text comment, and doing the more valuable (and interesting) cross-referencing of answers by hand. We really do want to understand, for example, whether different kinds of members want different things, how much variation there is in views, and whether level of seniority, geography or any other factor is linked to members’ satisfaction with IPEM’s services.

The purpose of this, of course, is not just to learn but to react. A previous member survey in 2011 highlighted a number of issues on which respondents felt strongly, and we have acted on these. We have moved from a paper newsletter to an electronic one, following a strong message that using paper was wasteful, old-fashioned and inconvenient. We have introduced ‘President’s Updates’ on the website to meet the need to keep members up-to-date with national developments. And we have made a major investment in a new database, linked to the website and the finance system, in response to members’ problems with the old site, and the inconvenience of requiring manual payments and paper applications for conference places.

There are several key opportunities to act on the findings of this autumn’s member survey. One is the major review of membership that is in the business plan for this year – we need to review the definitions of eligibility now that the IPEM courses cannot be used as entry requirements. We will also look at the membership benefits packages for each type of membership, to see if we can improve the ‘offer’ to attract new members, as well as improving what current members receive. And the review of IPEM committees, begun but by no means completed, is an opportunity to respond to members’ views about how they want to engage with their professional body and what strategic objectives the various groups and panels should be focussed on.

As always, a successful and useful survey depends on a high response rate. It would be good to have a very substantial percentage of the membership completing this autumn’s survey, so that we can have confidence in acting on the information we receive. So please ignore any hotels, restaurants or phone companies that want to know what you think of them – but do look out for the IPEM member survey and give us your honest and valuable views.
This is our last President’s column from Peter Jarritt, as he comes to the end of his role.

Gemma Whitelaw EDITOR-IN-CHIEF
A non-invasive method of imaging glucose uptake in vivo to show the metabolism of tumours

FUNCTIONAL IMAGING
Changes in glucose metabolism are associated with a number of pathological conditions. For example, solid tumours exhibit increased glucose consumption relative to normal tissue – a feature that is exploited for tumour detection, monitoring disease progression and evaluating response to therapy.

The current method of assessing glucose uptake uses 18F-fluorodeoxyglucose ([18F]FDG) PET, which necessitates the introduction of radio-labelled glucose analogues to the patient. This limits the ability to perform multiple repeat scans, and precludes its use in certain patient populations, for example young children or pregnant women.

A team of researchers at University College London (UCL) has developed an alternative MRI-based method for imaging glucose uptake and metabolism in vivo. Their approach, called glucoCEST, does not require the use of ionising radiation, but rather images unlabelled glucose at physiologically reasonable quantities.

GlucoCEST works by measuring glucose uptake through the chemical exchange of protons between glucose hydroxyl groups and water. By selectively saturating the magnetisation of protons in the hydroxyl groups, using radiofrequency pulses, this exchange of protons causes a reduction in the MR signal from water. This change in MR signal is visualised using the asymmetric magnetisation transfer ratio curve. The researchers defined a new parameter for this study: glucoCEST enhancement (GCE), the change in area under this curve from baseline to post-injection of glucose.

The researchers assessed the technique in vivo by glucoCEST imaging mice transplanted with two types of human colorectal cancer cells (with markedly different phenotypes). Images were acquired at baseline and 60 minutes after an intraperitoneal injection of glucose. The images revealed a significantly increased GCE in tumours compared to muscle and a significant difference in the median GCE between the two tumour types indicating that glucoCEST can discriminate between differing tumour phenotypes.

The researchers later administered 18F-FDG to the mice and performed autoradiography on tumour slices corresponding to the MR imaging slices. They saw a statistically significant correlation between the median tumour GCE and FDG uptake, providing a clear validation of the glucoCEST technique.

Scaling the dose used in the study to a 70 kg human would correspond to 14 g of glucose, and the authors note that oral administration would be easier to implement in the clinic. The team is now testing glucoCEST in a number of patient groups to evaluate its sensitivity on clinical scanners.

Statistical assessment of proton treatment plans

PROTON THERAPY
Understanding and accounting for systematic and random setup errors as well as range uncertainties is vital when evaluating proton treatment plans. A recent study, which takes a statistical approach to the issue, has shown that while target coverage for most patients was acceptable even when uncertainties were taken into account, the dose received by organs-at-risk varied significantly.

The research team from the University of Texas MD Anderson Cancer Center in Houston, TX, had previously developed a fast dose calculation method (Phys Med Biol 2012; 57: 3555) that is applicable when a dose distribution has already been calculated, and you require to know how this dose distribution changes as a function of changes to setup or proton range. The team used this fast dose calculation method to evaluate the treatment plans generated for 20 lung cancer patients, 10 prostate cancer patients and one brain cancer patient, all of whom received a course of proton therapy. The resulting uncertainties in dose were then visualised spatially on planning CT images as probability maps, which show the likelihood of not meeting a plan’s dosimetric goal for an individual voxel.

For the 31 treatment plans evaluated, the team found that the expected target coverage when uncertainties were considered was consistently lower than the nominal value determined from the original treatment plan. Mean differences of –1.1 per cent [−0.9 per cent for breath hold], –0.3 per cent and –2.2 per cent for the lung, prostate and brain cases were observed. While these values were deemed clinically acceptable, the team notes that changes in dose to organs-at-risk were significant.

The team will now use this technique to re-evaluate some dosimetric studies that compare IMRT with proton therapy.

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# MEDICAL PHYSICS

CPD is seen as being vital for medical physicists to keep up with current clinical practice. It consists of a range of learning activities through which medical physicists maintain and develop throughout their career to ensure that they retain their capacity to practice safely, effectively and legally within their evolving scope of practice. Therefore, keeping the CPD up-to-date benefits not only the individual, but also the institution that they work for and its patients. CPD can be categorised into various activities relevant to the functions carried out in employment, such as:

- Attending courses and conferences;
- Independent study (e.g. reading journals and books);
- Research activities (e.g. journal/book publications, presentations, supervision);
- Professional activities (e.g. participation in national and international working groups).

A systematic way of assessing and recording activities that a medical physicist undertakes is used in a number of countries. Currently, there are 27 countries that have these systems.

This work involved a survey of CPD systems currently operating around the world, as there is little literature on this matter in relation to medical physicists. It provides recommendations on what is required to construct a useful medical physics CPD system.

The survey was carried out by sourcing CPD systems from various medical physics professional organisations (MPPOs)/direct representatives and Internet sites. Documents and sites not in English were translated with the Google language translator. A drafting process was undertaken to provide in-depth information on CPD systems from relevant geographical areas and to ensure the information in the constructed tables was accurate. Table 1 describes the points systems as they were at the end of 2011 and summarises activities that are commonly accepted by a number of countries as valid CPD activities.

CPD systems are common in Europe and North America, and more are being established in Asia/Oceania. All systems are points based apart from that in the UK. Points-based systems award a certain number of points to individuals for the completion of defined CPD activities, and there is a requirement that a certain number of points must be achieved within a defined period of years. In most countries, medical physicists are expected to achieve 40–60 points per year. The value of a point can vary considerably depending on the activity although typically it is equivalent to one point per hour of activity.

In general, CPD systems between countries have many common elements and conform to the 2001 Policy Statement No.10 of the European Federation of Organisations for Medical Physics (EFOMP), although there are a few countries where there are significant variations in this respect. Discussion points in the article were based around how much CPD is required, balances in the system, issues of remotely located staff, administration and auditing, non-compliance and resource requirements.

Quantifying CPD in a systematic and fair way that practising medical physicists can reasonably comply with is challenging. The administration of such systems must not become a burden to the participants. CPD can take many forms and can vary between countries and cultures, and thus there will not always be universal agreement.
| Table 1: The CPD points systems used in different countries and the points allocated for attending courses, seminars, lectures and other learning activities. Units are a = activity, d = day, e = exercise, h = hour, j = journal, m = month, s = study, t = test, w = week. Table 1 kindly supplied by Howell Round, School of Engineering, University of Waikato, Hillcrest Road, Hamilton 3240, New Zealand. © Elsevier, ‘Continuing professional development systems for medical physicists: A global survey and analysis’, W. Howell Round, Physica Medica (2013) 29, 261-272. |
Software for quantitative analysis of radiotherapy planning data: overview, analysis and solutions

Figure 1: General architecture of the RTToolbox. Figure kindly supplied by Lanlan Zhang, Software Development for Integrated Diagnostics and Therapy, German Cancer Research Center (DKFZ), Heidelberg, Germany. © Elsevier. 'Software for quantitative analysis of radiotherapy: overview, requirement analysis and design solutions', L. Zhang, M. Hub, S. Mang, C. Thieke, O. Nix, C. P. Karger and R. O. Floca, Comput Meth Prog Bio 2013, 110(03): 528–37.

RADIOThERAPY PHYSICS

Quantitative analysis of radiotherapy data can improve the success of the treatment and support the prediction of outcome. Typical data includes images, dose distributions, structure sets and radiotherapy plans existing in the form of DICOM RT objects. The data from a treatment plan is evaluated retrospectively or prospectively. Dose-volume-histograms (DVHs) together with statistical parameters such as mean dose and minimum/maximum dose, which characterise the dose distribution within an organ at risk, the tumour or any other volume of interest (VOI), are essential to summarise and analyse the 3D data. Predictors such as tumour control probabilities (TCP) and normal tissue complication probabilities (NTCP) are extensively used to predict the outcome based on radiobiological models. This requires powerful software systems for data analysis. Several systems have been developed and published, but none of the available systems match all the requirements as in table 1 (as of November 2011).

The primary aim of this work was to identify functional, conceptual and general requirements on a software system for quantitative analysis of radiotherapy. The secondary aim was to present software design solutions and recommendations to meet the stated requirements. Limitations of existing software applications is highlighted. As a proof of concept, an RTToolbox software library was developed.

The requirements and design consideration stage included the following items, with the first three items also forming parts of the analysis software:

- Functional requirements (dose statistics and DVH calculations, comparison of dose distributions, geometric and radiobiological analysis) – an evaluation engine supports this. Abstraction and encapsulation principles were used to build models.
- Versatility and extensibility of the software (e.g. with respect to DVH calculation and other dose evaluation methods; extensibility of radiobiological models) – a data abstraction layer separates data, methods and user interface. Easy extension to new models would be possible using polymorphism and generic programming.

- Data management (e.g. using analysis database and database interface which is essential for large-scale studies) – an analysis database part-uses PostgreSQL.

- General requirements on the software (e.g. open source, platform independence) – C++ was chosen for the RTToolbox implementation, as it met this last requirement.

The general architecture of the RTToolbox is shown in figure 1. This toolbox can currently handle radiotherapy data from DICOM-RT compatible treatment planning systems. The open source library DCMTK from OFFIS was used in the toolbox to parse and generate the DICOM data. MeVisLab (a platform for image processing research developed by Fraunhofer MEVIS and MeVis Medical Solutions) was used as a 2D/3D visualisation tool for RTToolbox as it met this last requirement.

Using a well-designed data abstraction layer, the developed software can be integrated easily in different radiotherapy evaluation applications. RTToolbox is an object-oriented C++ library supporting the full range of radiotherapy evaluation for different use cases. The current version is v2.0 rc and has been released as open source code under GPL v3.0 (http://sourceforge.net/projects/rttb or http://www.dkfz.de/en/sidt/projects/rttb/info.html).

MORE INFORMATION


EDITOR’S NOTE

Yiannis Roussakis highlighted this paper in our discussion on automated DVH data extraction and analysis in radiotherapy treatment planning. Yiannis is a PhD student at the Physical Sciences Doctoral Training Centre, University of Birmingham, UK. Lanlan Zhang, the author of the paper, would like to inform IPEM Scope readers about the applications of RTToolbox (private communication). The DKFZ group has developed a new visualisation method for TCP/NTCP using the RTToolbox. Please refer to A method to visualize the uncertainty of the prediction of radiobiological models, Yiannis & Phys Medica, http://dx.doi.org/10.1016/j.jmp.2012.11.003.

Readers may be interested in other recent software in Radiotherapy such as the paper on SlicerRT. Radiation therapy research toolkit for 3D slicer (http://dx.doi.org/10.1186/1746-4876-5-49), the paper on semi-automatic tool for treatment plan quality evaluation and clinical trial quality assurance (http://dx.doi.org/10.1088/0031-9155/58/13/N181) or the ‘Accel-RT collaboration between Universities of Cambridge and Oxford on improving radiotherapy planning through open source software tools (www.accelrt.org). Interaction with the RTToolbox libraries is currently by way of using C/C++. However, RTToolbox was created using ISO-C++, so one can use wrapper tools (e.g. SWIG) to interact with RTToolbox libraries using other programming languages.

Although there are some applications available for radiotherapy data analysis and have been publicised, there may be in-house developed software that haven’t been publicised or currently under development. I would be very interested to hear from centres/individuals that have not yet publicised their in-house data analysis tools/software for radiotherapy treatment planning purposes. If you have a comment on this article, or would like to share your experiences, then please get in touch with me via email Usman.Lula@uhb.nhs.uk. We hope to publish selected comments in the next issue of IPEM Scope for the benefit of the medical physics community.

<table>
<thead>
<tr>
<th>Tools</th>
<th>DVH calculator (req.1a)</th>
<th>Dose comparison (req.1b)</th>
<th>TCP/NTCP (req.1c)</th>
<th>Independence from GUI (req.2)</th>
<th>Analysis database (req.2)</th>
<th>Technology/realisation (req.4)*</th>
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<td>BIPLAN [25]</td>
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<td>x</td>
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<td>Computational platform from Liu [31]</td>
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<td>✓</td>
<td>✓</td>
<td>C++, OpenGL, MATLAB, JAVA, ASP, HTML and SQL</td>
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<td>✓</td>
<td>x</td>
<td>x</td>
<td>MATLAB</td>
</tr>
</tbody>
</table>

* Most important to meet requirement 4. x = feature not included; ✓ = feature included.
MEDICAL STATISTICS AND EXPERIMENTAL DESIGN COURSE

16 - 20 December 2013

This is a one-week course organised jointly by the Royal Liverpool University Hospital and the University of Liverpool. The aim of the course is to understand how statistical analysis and decision theory can be applied in medicine.

Registrants can choose to attend the course only for CPD purposes or attend and complete the assessment for 10 transferable credits at masters level.

Venue: The University of Liverpool
Fees: Assessment: £600.00
Non-assessment: £400.00

To find out more, please visit www.liv.ac.uk/cpd/course/medical_statistics
Or contact: Tel: +44 (0)151 706 4202
E-mail: office@clineng-liverpool-nhs.com

ImSimQA™
Fusion QA for advanced IGRT

Atlas-based auto-contouring, deformable image registration, and adaptive RT are growing fast. How do you use hard phantoms to test these systems? Answer: You can’t.

ImSimQA is an essential software toolkit that generates DICOM test images to validate clinical software systems (such as OnQ rts®, MIM Maestro™, Velocity, ABAS, SPICE and Smart Segmentation®), and then runs quantitative analyses to measure results.

DICOM image data can be created from a library of phantoms and importing images of any DICOM-3 modality is possible. Images can be transformed, deformed, contrast enhanced, manipulated by filters (e.g. CBCT or MVCT) and DICOM edited to create an infinite range of test data.

When Adam Powell, a renowned video director, contacted us in 2012 to acquire speech MRI data for a music video, we thought it would be a great idea to do something a bit different and highlight the work done by CLEFT, one of the charities that is funding our research.

The first official video from SiVU (real name James Page) became a small Internet sensation with over 600,000 views on YouTube and Vimeo combined, and generated much interest, with many comments and questions.

The real-time data was acquired using a protocol derived from our research programme into imaging the vocal tract during normal speech in patients with a repaired cleft palate (see boxes for details).

This article summarises the steps that were required to create the music video. Videos of unprocessed and processed datasets and of the recording sessions can be seen at https://vimeo.com/user16213628/videos.

**Imaging set-up**

Our work is performed on a 1.5T Philips Achieva scanner (Philips Healthcare, Best, The Netherlands) with either a standard head coil (8-element) or a head-and-neck coil (16-element). The choice is mainly dictated by the size of the patient: children’s necks are often too short to fit in the second coil.

As size was not an issue in James’s case, we opted for the head-and-neck coil as it covers most of the vocal tract. The head-and-neck coil, affectionately nicknamed the Darth Vader helmet, is not the most spacious coil around and once you add the earphones and the fibre optic microphone, the already restricted space becomes quite claustrophobic.

The microphone has to touch your lips, making it quite an uncomfortable way to sing. On the images you can clearly see that James was stretching his neck backwards creating a small lump of fat at the bottom of his neck (figure 1). You can also see the large headphones pressing into his cheeks on the 3D renderings (figure 2). The track was played.
Through the headphones during the scans to help James match the timing of his singing with the studio version of the song.

These were not ideal conditions for singing, which might explain why James looked so relieved at the end of the session (figure 3).

As our hi-fi is quite old, we had taken the precaution of asking for an audio CD. Unfortunately, James arrived with MP3 files burned on a CD, and Sam had to rush to the local electronics shop to buy an auxiliary audio cable to connect James’s iPod instead!

Audio recording

Audio recordings of James singing during acquisition were made using a FOMRI II dual-channel MRI-compatible fibre optic microphone system (Optoaoustics, Or Yehuda, Israel) with a real-time digital processing system (figure 4). Further details of the system can be found in several articles.1, 2

The processed, noise-cancelled speech recording and an audible trigger signal, corresponding to the beginning of each imaging frame, were recorded digitally using Quicktime on a MacBook Pro (Apple, Cupertino, CA, USA). The scanner provides a 0.5 μs top hat pulse and the digital signal processing system requires a pulse of around 1 ms or more to create the audible signal. Rather than compromise the temporal resolution of the sequence, we built a pulse lengthener (shown in figure 4).

In-house processing software was written in Matlab (The Mathworks Natick, MA, USA) with scripted audio processing in SoX (http://sox.sourceforge.net) and audio-video synchronisation in FFmpeg (http://www.ffmpeg.org). The software extracted the audible trigger signals using a cross-correlation based algorithm and these triggers were used to ensure that the audio and video were synchronised.3, 4

You can hear an example of noise cancellation in this video: https://vimeo.com/59239179. You can see where we got it slightly wrong and played the wrong track to James.

These were not ideal conditions for singing, which might explain why James looked so relieved at the end.

Image acquisition

The plan for image acquisition was pretty simple: first we acquired a 1mm³ isotropic 3D T1-weighted sequence for use in creating some pretty volume rendering and a ‘fly-through’ sequence for the video. You can see some rendering and a ‘fly-through’ of the 3D sequence at https://vimeo.com/59239659 and https://vimeo.com/59238870.

Then, we performed our regular shim tests to optimise the quality of the real-time images and, finally, we recorded two takes of James singing the full song. For our patient work, we typically use a balanced steady-state free precession sequence at 10 to 20 frames per second. Our usual shim covers the mouth and sinus region in order to minimise artefacts around the soft palate. However, this typically results in the classic banding artefact in the brain (figure 5); not the prettiest picture of your head! In order to obtain images more or less free from artefacts across the field-of-view, we had to increase the size of our shim to cover the head and neck. To boost the signal-to-noise ratio, we also increased the slice thickness to 8 mm.

All seemed to go to plan until we finished the first take and James told us that he found it next to...
impossible to sing in sync with the music as he could hardly hear the track through the headphones. This shouldn’t have come as a surprise as we often have to shout instructions into the microphone for the patients to hear us during real-time studies as the sequences we use are particularly noisy.

We tried increasing the sound volume to maximum, using the in-room ceiling speakers, but still no success! Finally, we took the decision to put the hi-fi loudspeakers in the room. In theory this is not a good idea as (a) you can degrade the image quality, by bringing additional electromagnetic fields inside the RF cage, and (b) it is possibly not the best thing to do to your speakers (Figure 7).

Thankfully, our magnet room is big enough to place the speakers sufficiently far from the scanner not to damage them and, luckily, we didn’t notice any substantial artefacts as a result.

You can see our relief when we got it right in this video: https://vimeo.com/59238260. If you pay attention, you can see the real-time images of James singing in the bottom righthand corner of the screen.

Once we were happy, we recorded two takes of the full song. You can see a full data set without editing here: https://vimeo.com/59245042. It is not a very exciting video (no sound) but you can see James swallowing before he starts singing, and towards the end of the movie. With all of those ‘technical difficulties’, James ended up spending an hour in the scanner, twice as long as expected.

**Image post-processing**

The first step was to add the sound that we recorded during image acquisition to the images using the method described above. You can see the beginning of the recording with sound here: https://vimeo.com/59238029. During the first few seconds you can clearly hear the music.

**SPEECH AND PALATE RESEARCH AT BARTS**

Our programme of research in the development and implementation of MRI protocols for the management of cleft palate patients is funded by Barts Charity (www.bartscharity.org.uk) and CLEFT (www.cleft.org.uk).

The research focuses both on improving the anatomical imaging of the muscles associated with speech production and on developing real-time imaging of speech.

Our first focus was on the acquisition of high-resolution images of the levator veli palatini (LVP), the muscle responsible for the primary up-down motion of the soft palate.

A typical slice through the LVP, acquired at 1.5T (proton density TSE), is shown in figure 6.

The second arm of the project centres around real-time imaging of the soft palate during speech. In the first phase of the research, we have focussed our efforts on a mid-sagittal imaging plane, leading to a view similar to x-ray video fluoroscopy and optimised sequences at 1.5T and 3T. We are now also working on an en face view of the palate like that seen in nasendoscopy; the acquisition plane is similar to the plane used for anatomical imaging of the LVP. Example movies can be seen at:

http://www.mriphysics.net/pages/Research/field_strength.shtml

We have also developed post-processing techniques to increase image quality.

Although most of our development efforts focus on standard acquisitions and commercial clinical equipment, we also work on more advanced sequences that require pulse programming.
Approximately 450 babies are born every year in the UK with an orofacial cleft, 7 the majority of which include the palate. 8 A cleft palate is usually repaired surgically at around 6 months, 9 however, residual velopharyngeal insufficiencies require further surgery in 15–50 per cent of cases. 10 This residual defect results in an incomplete closure of the velopharyngeal port that leads to hypernasal speech. Assessment of velopharyngeal closure in speech therapy is performed using x-ray videofluoroscopy or/and nasendoscopy. 11, 12 Nasendoscopy is only minimally invasive but it can be uncomfortable and provides only an en face view of the velopharyngeal port. X-ray videofluoroscopy is non-invasive and produces an image which is a projection of the target anatomy and, consequently, anatomical structures may overlie each other. The technique also suffers from poor soft tissue contrast, such as that from the soft palate, although it may be improved using a barium contrast agent coating at the expense of making the procedure more invasive and unpleasant. Arguably, the greatest drawback of x-ray videofluoroscopy is the associated ionising radiation dose, which carries increased risk in paediatric patients.

As MRI can provide tomographic images in any plane with flexible tissue contrast, such as that from the soft palate, although it may be improved using a barium contrast agent coating at the expense of making the procedure more invasive and unpleasant. Arguably, the greatest drawback of x-ray videofluoroscopy is the associated ionising radiation dose, which carries increased risk in paediatric patients.

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REFERENCES


In the developing countries of Africa cancer is of alarming concern:
- The World Health Organization predicts that by 2017 cancer’s death toll in Africa will exceed that of HIV/AIDS, tuberculosis and malaria combined.
- Cancer rates in Africa are expected to double by 2030.
- Most African countries have less than 5 per cent of the total radiotherapy provision necessary.
- Africa has a population 17 times that of the UK yet only has twice as many trained healthcare workers.
- 80 per cent of cancer patients in Africa are diagnosed at such a late stage that only palliative treatment is possible and many die before the treatment is complete. Many receive no treatment.
- Over half of all cancer patients require radiation treatment during the course of their disease. Only a few countries in Africa have any facilities for radiation therapy, and in many cases these are grossly ill-equipped and lack adequately trained personnel.

In response to this upcoming crisis, the Department of Medical Physics and Bioengineering at UCL along with the Radiotherapy Departments at the Royal Berkshire Hospital (RBH) and UCL Hospital have formed a global health initiative called paRTner. Our aim is to apply the resources and expertise for cancer treatment that we have in the UK to accelerate the development of radiotherapy services in developing countries. In May 2012 a team supported by UCL Friends visited Ghana to identify both short- and long-term needs in their radiotherapy service. On this trip we found a small group of radiotherapy staff who were hard working and dedicated but who lacked the necessary level of training to optimise the service or to develop it in the future. A particularly significant area is a shortage of skilled engineers, leading to severe delays in commissioning of new equipment and in the development of future services.

Kate Ricketts and Gary Royle reflect on the first year of the paRTner project, a global health partnership for radiotherapy between the UK and Ghana.
to significant downtime in service provision; a fact strongly expressed by Dr Joel Yarney, the head of Ghana’s oncology programme. There is no routine preventative maintenance, meaning that there are frequent breakdowns that take on average 3 weeks to fix. This is largely because departments do not stock spare parts, and need to request funding from management for each repair. At the time of our visit one of the two cancer centres had been unable to treat breast cancer patients for the previous 3 weeks due to a relatively minor equipment fault and insufficient local knowledge to repair it. This will have had a catastrophic impact on the patients about to embark upon or part-way through their treatment regime, estimated to be in the region of 100 patients.

They have dedicated staff who are constantly battling officialdom as well as local beliefs. Meeting with Ghana’s two senior medical physicists was a humbling experience and makes me realise what relative luxuries we have in the health service here. The challenges we face pale into insignificance compared to what they see every day. They still have some enormous problems to overcome but their attitude and approach acts as an example to us all. Derek D’Souza, Head of Radiotherapy Physics, UCLH

Cancer landscape in Ghana

Cancer in Ghana is largely diagnosed at a late stage and viewed as a death sentence. Survival rates are estimated to be in the region of 30 per cent for most cancers, compared to 80–90 per cent for the same cancers in the UK. Sixty per cent of Ghanaian women diagnosed with breast cancer are in stage III or IV. This is in great discrepancy to English rates, where a 2012 study found that only around 14 per cent of cases were this advanced. Ghanaian cancer centres also treat cancers not typically seen any more in UK centres. Many of the cancers presented in Ghana are caused by viruses and thus could be prevented with national vaccination programmes. For example, cervical cancer is highly prevalent due to the lack of a cervical screening programme and no nationwide HPV vaccination programme in Ghana. Hepatitis B and C vaccines can protect against the ~80 per cent of liver cancers attributable to the hepatitis virus; the geographical variability of the virus maps precisely to the prevalence of liver cancer globally. There is also a relation between the incidence of Epstein Barr virus (EBV) and the mortality rates of Burkitt lymphoma, the most common childhood cancer in Ghana. Introduction of screening programmes could also impact on early detection rates; advanced screening techniques requiring specialist equipment could be replaced with solutions more suited to the developing world.

Ghana has a population of 25 million people and has a cancer treatment catchment population of nearly 50 million which includes the dependent neighbouring countries of Burkina Faso and Togo. According to international guidelines this population requires >100 radiotherapy treatment units. Currently Ghana can boast of only two cobalt-60 units, one in each of the publicly owned radiotherapy centres: the National Centre for Radiotherapy and Nuclear Medicine, KBTH’s laminar flow hood for chemotherapy preparations from scratch.
Placing cancer services within cultural context

The attitude of the Ghanaian population towards cancer is very different to that in the UK, and high importance should be placed on understanding cancer in its cultural context in order to tackle the root causes of late presentation. Within a populous which subscribes to traditional African religious beliefs where practising ‘magic’ or ‘juju’ is commonplace, cancer is perceived as the result of a curse, or a punishment from God, thereby attaching a huge stigma to cancer sufferers and their families. Understandably many people do not want to admit to having cancer as they risk social rejection, and seek treatment too late. Within the local belief system, it is logical to fight ‘magic’ with ‘magic’ and many therefore opt to seek help from traditional healers (a cheaper and more discrete alternative to hospital treatment); one study found that herbal medicine or attending prayer camps was the reason for 40 per cent of patients delaying treatment.1 Some typical responses in a study about the Ghanaian public’s view of cancer were:

- You get treated and still die.
- By saying the word ‘cancer’ you are ‘inviting’ or ‘bringing’ cancer into your life.
- Breast cancer is caused by violence, injury and sex.3

It is widely believed that cancer is an incurable disease, which has contributed to Ghana’s National Health Insurance Scheme (NHIS) not covering cancer treatment. Cancer treatment in Ghana typically costs £300–500, a typical annual income for most of the population; 27 per cent are living on less than £1 per day.

There is a surprising lack of awareness of cancer amongst the population. There is almost no cancer information available and very limited education.

In Ghana there is a need for more staff with specialised hands-on training in radiotherapy. Many staff have a theoretical understanding but very little practical knowledge. A training programme will enable Ghanaian professionals to update their skills to the international professional standards in order to confidently handle different areas of radiotherapy. James Annkah, paRTner coordinator in Ghana

The Ghanaian government, under the recommendations of the International Atomic Energy Authority (IAEA), is starting to address the situation and is investing over £10 million to buy a further three treatment machines. Two of these machines will be linear accelerators, although at present there is no linac expertise in the country.

Ghana can expect about 62,500 new cancer patients per annum. According to the International Agency for Research on Cancers, more than 35,000 of these cases would require radiotherapy. The three centres altogether annually treat less than 5,000 new cancer cases, leaving a shortfall of more than 30,000 incidences. There is therefore a huge gap that should be filled by government and stakeholders with support from international bodies and a need to build human capacity in radiation oncology such as oncologists, medical physicists, radiotherapists and therapy radiographers.
inform the public about symptoms, but the materials produced only display very late effects of cancer and so early symptoms continue to be missed.

Work has started to address late presentation within this cultural context and to remove the social stigma placed on cancer patients; Eric Addison and his co-workers at KATH visit churches on Sundays to educate the congregation about the medical causes of cancer. Pastors are encouraged to help disband erroneous beliefs and attitudes towards cancer and those afflicted with it. Medical physicists have also hosted training sessions aimed at traditional healers to assist them in diagnosing cancer and to set up working partnerships between the traditional and Western medicine techniques to allow for a more holistic, workable solution to cancer treatment. paRtner is also supporting efforts to boost cancer awareness; Mary Neal from UCL has established an educational link with Ghanaian high schools and will tour Ghana this summer to teach 15–17 year olds about the causes and symptoms of cancer.

Hurdles to overcome
There are groups who dispute the introduction of linac technology to developing nations; concerns of unstable power supplies and incapacity to deal with machine breakdowns are but a few reasons that development has been quashed so far. Indeed, access to spare parts and engineers sufficiently trained to deal with day-to-day issues must be addressed (the closest linac support centre to Ghana is a 5-hour flight to South Africa). However, remaining with cobalt-60 units is just not an option. There are severe clinical disadvantages to using such a low x-ray energy; dose cannot be deposited at deep sites such as for cervical and prostate treatments, particularly when considering the larger size of Ghanaian patients, and such units do not provide the skin sparing effect. Staff in the public centres expressed their concern at the quality of equipment available at the public hospitals, with staff morale being greatly affected. Providing them with the opportunity to overcome these issues was met with great interest, and they have made a running start to address issues that have so far held them back: climate (extremes of both humidity and dryness), environment (an incredible amount of dust) and power (they now boast a highly stable power generator). We hope that this cultural context and to remove the social stigma placed on cancer patients; Eric Addison and his co-workers at KATH visit churches on Sundays to educate the congregation about the medical causes of cancer. Pastors are encouraged to help disband erroneous beliefs and attitudes towards cancer and those afflicted with it. Medical physicists have also hosted training sessions aimed at traditional healers to assist them in diagnosing cancer and to set up working partnerships between the traditional and Western medicine techniques to allow for a more holistic, workable solution to cancer treatment. paRtner is also supporting efforts to boost cancer awareness; Mary Neal from UCL has established an educational link with Ghanaian high schools and will tour Ghana this summer to teach 15–17 year olds about the causes and symptoms of cancer.

The paRtner programme
We have learnt a lot and forged important individual, hospital and governmental links during the first year of paRtner; we are now in a position to transfer practical support from UK medical physics and engineering to Ghana. paRtner has secured a 2-year medical equipment grant from the Tropical Health and Education Trust (THET) to establish a training and equipment maintenance programme in Ghana, and has secured further funds from UCL Friends to improve African cancer service provision. Following our fact-finding trip we hosted the two senior medical physicists, Eric Addison and Theophilus Sackey at RBH and UCLH, in order to establish the steps needed for the introduction of linac technology to Ghana. This UK visit also enabled our Ghanaian colleagues to gain first-hand experience of linac management and protocols, and to meet with the Royal College of Radiologists to start a dialogue for improvement of oncology services.

Consideration of the most effective method of training is key. The current training method, where suitable candidates have to be sent abroad, has now outlived its objective due to many reasons:

- The cost of training adequate staff in a dedicated centre abroad to support a medium-sized radiotherapy centre is enormous.
- Trainees do not receive the training designed to equip them for work on return to their home countries, in terms of using equipment they will routinely encounter, rather than the sophisticated equipment in developed countries, and focus on the diseases/situations encountered locally.
- Trainees are not successful at the end of their training, due to language and other cultural difficulties.
- Successful trainees are more likely to stay behind or emigrate to other countries where they are likely to obtain better career prospects than they would otherwise obtain in their home countries.

The above can be overcome through organisation of local intensive training programmes, purposely designed to be more relevant to the needs of individual countries. Such an approach will be cheaper to run, provide more training opportunities for many African professionals and be likely to encourage personnel to stay in their countries to develop local services.

With this in mind paRtner is offering help in the form of mentoring and hands-on training in conjunction with development of e-learning and distance learning tools. A step-wise transfer of knowledge will help them get to a position where they are self-sufficient and have enough staff to provide a service that is sustainable and successful. We will join our Ghanaian colleagues in commissioning their first linac and introducing their first quality system. For the moment the treatments do not have to be of a complex nature due to the late stages of cancer that are presented but, in time, and with local education for the population, they can develop into departments that can otherwise obtain in their home countries.

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- Sending a team of skilled UK workers to Ghana for 2–4 weeks in the next 6 months to counter the most
critical shortcomings in the cancer treatment delivery; partnering Ghanaian radiotherapy medical physics and engineering staff with UK counterparts who will remotely assist with planning complex treatments, advise on quality assurance testing and equipment faults, and advise on procurement of new equipment; and put in practice an engineering programme for preventative maintenance whereby we aim to increase equipment uptime at each centre to 90 per cent within 2 years (it is currently about 60 per cent).

This is an opportunity for experienced UK cancer professionals to take part in something that has the potential to have huge impact on patients and staff and to be exposed to patient numbers and pathologies that are increasingly rare here (e.g. cervical cancer), along with the opportunity to learn the basics of radiotherapy in a challenging environment. Dr Matt Williams, Clinical Oncologist, Imperial College Healthcare NHS Trust

Equipment donation practices
As far as delivering a good radiotherapy service in Ghana, the team require help in the form of equipment. Many UK departments may well have old equipment that they simply do not use any more but which could greatly benefit the Ghanaian departments. pArTner will be regularly touring the UK to collect any donated equipment, big or small.

THET is currently preparing a good practice toolkit for medical equipment donations to low-resource settings. The primary audience for the toolkit is health partnerships and other UK organisations that donate medical equipment as part of their activities. The toolkit includes good practice guidance for each stage of the donation process, from initial discussions between donor and recipient about what is required after donated equipment arrives, is installed and ready for use. It includes in-depth case studies, practical information about shipping and customs logistics, and templates for donations paperwork. Most importantly, it highlights what both donors and recipients need to do to ensure that a donation will be appropriate and useful for the recipient, as opposed to burdensome. The toolkit will be formally launched in the autumn of 2013. For more information visit http://www.thet.org/hps/resources/articles.

The Ghana Society for Medical Physics
As Dr Francis Hasford, Assistant Secretary of the society explain, Medical physics training started locally in Ghana in 2004. The programme has since produced 25 medical physicists who are serving in the country’s radiotherapy, nuclear medicine and diagnostic radiology, research and tertiary institutions. The programme includes two semesters of didactic education followed by 1 year of research and clinical training. This is followed by a 1-year internship covering radiation oncology, diagnostic radiology and nuclear medicine at KBTH and / or KATH for local graduates. The Medical Physics Department of the Graduate School of Nuclear and Allied Sciences in the University of Ghana is gradually becoming the hub of medical physics training in the sub-region, attracting a number of foreigners from some African countries. The department currently hosts five IAEA fellows for academic and radiotherapy clinical training.

An infrastructure is in place at the Ghana Atomic Energy Commission (GAEC) campus for academic training of the medical physics students. In addition to the research programmes of the individual lecturers, GAEC’s Radiological and Medical Sciences Research Institute (RAMSRI) has an active research programme in place and students benefit from the Institute’s programme with the research team leaders as supervisors to deal with the research component of the academic programme. RAMSRI is being nurtured into a complex, composed of a hospital with a radiation emergency medical facility and research centres promoting indigenous research with the main research activities in medical diagnostic imaging and cancer treatment. This project, when completed, would immensely contribute to the training of medical physicist students since the facility, which is to be cited very close to the medical physics department, would serve as the official training facility for students. Currently, some of the lecturers in the department double as clinical medical physicists in the oncology and nuclear medicine centres in the country. This arrangement promotes good structure in conducting clinical training with the lecturers having access to facilities for training.

“ It highlights what both donors and recipients need to do to ensure that a donation will be appropriate and useful ”

The Medical Physics Department has been an indispensable and strategic stakeholder in educational and training programmes in the radiation sciences in the country. Resource persons from the department have been the backbone of the training programmes for radiologists, radiographers, oncologists, dentists, nuclear scientists and health physicists in addition to their core business of providing training for medical physicists. The faculty is staffed with competent, qualified and highly motivated lecturers. There is a culture of continuing education and skills upgrading in place, including refresher courses and long-term training leading to PhD degrees to promote research and clinical skills to offer the best services.

The pArTner project is important to Ghana in the sense that it would aid in improving radiotherapy services by training of personnel, development of techniques and protocols, and increasing capacity of equipment. This objective would be achieved through (a) provision of resources in terms of training, teaching, personnel and provision of equipment, (b) location of funding for training support and assistance to help Ghanaian radiotherapy departments secure funding internally, (c) practical training courses tailored to local needs, (d) collaborations between Ghanaian universities and hospital departments, and between UK and Ghana universities. Ghana Society for Medical Physics
The journey ahead

The road ahead for Ghana’s developing radiotherapy service is a challenging one. To reach the ultimate goal of three to four treatment machines per million of population requires not only huge investment but a huge growth in qualified personnel and expansion of the necessary infrastructure and nationwide organisation.

Those currently in the profession face an intensive period of lobbying for further investment to meet future demand, at the same time as increasing the number of referrals through cancer awareness campaigns and referral networks in order to create that future demand; it’s a fine balance. But it is one that the UK and many other countries have faced before, and look how far we’ve come; so the road ahead need not be quite so challenging because the template for development has been set. Solutions to most of the future issues already exist and this is where we see the potential benefits of a UK–Ghana partnership, or a UK–any developing nation partnership for that matter.

In the short term we can assist with the expansion of the service through the arrival of the first linacs in the public sector. In the medium term we can assist with cancer awareness and education, training of future workers to expand provision even further to meet the predicted growth in demand, the integration of IMRT, IGRT and other state-of-the-art methodologies into the clinic, career development, and so on. And in the long term we can assist with lobbying for further investment to expand the service even further. There are large parts of the country without any cancer service and only a very small minority live within 1 hour of an oncology department. Imagine if we could help to plant a radiotherapy centre in the north of the country, with its catchment population in excess of 10 million. The north is a deprived region with no access at present to cancer treatment, and it will also offer provision to Burkina Faso.

The scope for a partnership of this type is vast because of the multidisciplinary nature of the field, and so, given the breadth and depth of UK expertise around this area, we should be ambitious and aim high. For a fledgling service with limited numbers of qualified personnel the road ahead is challenging, as indeed it was for the pioneers of the UK radiotherapy service. But, in partnership with experienced, enthusiastic, UK colleagues, who all have the benefit of hindsight, the journey can become quicker and smoother.

The paRTner project has proven to be a great success and is a superb example of developing professional links to hospitals and organisations beyond our traditional spheres of operation. Perhaps of greater relevance, though, our success either in terms of clinical guidance or the creation of professional standards. Perhaps of greater relevance, though, is the improvement of healthcare for the population of Ghana who was not only able to identify immediate benefits of the exchange but also is enthusiastic to maintain an ongoing relationship. Such an exchange of staff or ideas can only provide benefits to all concerned including the Royal Berkshire Hospital Cancer Centre and Medical Physics, and as Departmental Director I am extremely enthusiastic for my staff to reach out nationally and internationally to assist with improvements in patient outcome. Professor Malcolm Sperrin, Director of Medical Physics, RBH

REFERENCES


TABLE 1.

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<tr>
<th>Case</th>
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FOR FURTHER INFORMATION

For more on the paRTner programme please contact k.ricketts@royalberkshire.nhs.uk or visit http://www.ucl.ac.uk/medphys/international/homepage

THE PARTNER TEAM

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3 Ghana Society of Medical Physics
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7 National Centre for Radiotherapy and Nuclear Medicine, Korle-Bu Teaching Hospital, Accra
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<tr>
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<tr>
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Introducing Professor Stephen Keevil

Steve Keevil follows Professor Peter Jarritt as President of IPEM. This short article introduces his life and work and highlights challenges he will face.

Born into 1960s south London, Steve grew up with keen interests in science and avoiding cross-country runs on rainy afternoons. He stood out academically and received accelerated maths tuition, but even so going to read physics at Oxford from a comprehensive school background was a shock to his system academically, culturally and personally. His very first maths lecture was on complex numbers (easy), the second on partial differentiation (more difficult), and after that it all became a frantic blur trying to keep up. An important lesson was not only to go through the right analytical and mathematical process but also to check whether the answer seemed to be about right. Watching a fellow student being (politely) demolished for answering ‘millions of degrees’ to a thermodynamics problem about calculating the temperature rise in a block of copper as it was compressed was both salutary and satisfying (Steve’s answer was ‘fractions of a degree’).

Educational work
Steve found the physics fascinating and was attracted by particle physics and astrophysics. When looking for something interesting to do between his second and final years that would earn more money than his previous job stacking shelves in his local library, and be relevant to physics, he happened to read about a job in south London that was available at KCARE, the King’s Centre for Assessment of Radiological Equipment at King’s College London. He got the job and spent the summer doing hands-on testing and development work, using a jig to implement an IEC standard for testing anti-scatter grids for x-ray applications. This first experience of medical physics was fun and led to his very first maths lecture in Physics in Medicine and Biology, written as distraction therapy whilst revising for his final exams.

After graduation Steve looked for jobs in medical physics and obtained a place as a South East Thames Regional Health Authority Supernumerary Basic Grade Trainee – the longest job title and lowest status scientist in the organisation. Based in Brighton, the post was a great introduction to medical physics and offered a chance to rotate through different departments over 2 years whilst studying for a part-time MSc in medical physics at the University of Surrey, a structured training opportunity that was unusual at the time. Towards the end of his initial training Steve was looking for an MSc project and went to the IPSM conference in 1987, equivalent to the IPEM MPEC now. There he heard a talk on MR spectroscopy by Mike Smith, who at that time was an academic medical physicist at Guy’s Hospital. Steve was immediately smitten by the subject, wangled a seat next to Mike at the conference dinner and asked whether he had anything suitable for an MSc project. Steve then spent the last 3 months of his training post working at Guy’s and never left!

Gaining in experience
Guy’s found some research money and did a deal with Bart’s Medical School which had a low power 0.08T water-cooled resistive magnet MR system, one of a few made by an Aberdeen medical physics spin-out company started by Professor John Mallard. Mike’s deal was that Steve would spend half his time supporting the Bart’s scanner, including repairing circuit boards and mopping up water leaks, and the other half in the Medical School at Guy’s working on spectroscopy on an early 1.5T MR scanner installed at the end of 1985. So successful was Steve’s project that an MSc became a part-time PhD on spatially localised spectroscopy. Steve also supported a range of clinical projects on spectroscopy in the brain, heart and liver, working with Dr (now Professor Sir) Mike Richards, ex-cancer tsar and now CQC Chief Inspector of Hospitals. In 1993 St Thomas’ Hospital put in a 1T MR system just as it was earmarked for a merger with Guy’s. Steve was involved in setting up a joint MR centre across the two hospitals and the link between medical school and NHS has been a recurring theme in his career.

Steve had a role in helping to run the centre that lasted until 2000 when new clinical and research scanners were put in. He then concentrated on getting these systems working and on winning a major award from the HEFCE Joint Research Equipment Initiative to set up and work with a system that is still running at Guy’s. This was particularly notable as it was the largest award from that fund at the time, the previous record being held by Stephen Hawking for a grant to help work out the wave function of the Universe. Steve carried on in research, with a growing role in teaching within the Radiological Sciences group in the Medical School. This group then split, with the majority of staff moving to University College London, leaving Steve to transfer back to the NHS whilst keeping a senior role in the new Division of Imaging Sciences at the King’s College London Medical School.

NEW PRESIDENT FEATURE

Steve Keevil relaxing with his family

SCOPE | SEPTEMBER 2013 | 25
He hopes to forge closer links to bioengineers working in areas such as imaging in the academic world.

Steve is now Head of MR Physics for Guy’s and St Thomas’ NHS Foundation Trust. He also has a lead role across the King’s Health Partners Academic Health Sciences Centre, which has 18 MR systems and several more planned. Alongside this responsibility he has four other jobs: Joint Director of the King’s ITEC (son of KCARE) doing work for NICE; research and development lead for his directorate in the Trust; education and training lead for the Imaging Clinical Academic Group in King’s Health Partners; and Postgraduate Coordinator for the Division of Imaging Sciences and Biomedical Engineering covering five departments and over 100 PhD students. His roles in IPEM have included being a member and chair of MR SIG, chair of what is now Science Board and Vice President for External Affairs. He should have plenty of time to be President of IPEM since earlier this year he finished 2 years as President of the UK Radiological Congress!

One of Steve’s recent formative experiences was being involved in the redrafting of the EU Physical Agents Directive on EMF. He never expected a physics degree would take him in front of a Parliamentary Select Committee or behind all kinds of doors in Brussels, including the EU Parliament and strange places in Luxembourg. He discovered he was able to cope with all this and it was a great stretching experience.

Steve’s vision for the next 2 years is to complete the IPEM restructure to meet changes to technologist, engineer and scientist training and revised governance arrangements, moving authority and responsibility further down the structure to allow decisions to be made closer to where expertise resides rather than taking everything up to the trustees. Steve is keen on developing links to academic physics and engineering, and extending existing provision for technologists and non-NHS staff. He hopes to forge closer links to bioengineers working in areas such as imaging in the academic world. Personal demands on the President have grown to such an extent that there is a clear need to spread the load and better connect IPEM Boards to external developments. Steve is working with Rosemary Cook, IPEM CEO, to build a Presidential team that includes the President Elect, Vice Presidents and Directors of Boards, to help pick up all the different challenges. Keep an eye out for what’s coming!

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*Siochi RA, Molini, A. Patient-specific QA for IMRT should be performed using software rather than hardware. Med. Phys. 40 (7) July 2013

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International Medical Physics Day: 7th November 2013

To raise awareness of the profession, IOMP is inviting you to participate by organising activities for the wider public to celebrate this meaningful day.

The International Organization of Medical Physics (IOMP) is proposing to the international medical physics community to start the ‘International Day of Medical Physics (IDMP)’ to raise the profile of our profession to the public. 7th November, the birthday of Marie Sklodowska-Curie (born on 7th November 1867 in Warsaw, Poland), has been named by IOMP as the International Day of Medical Physics. As we all know, Marie Curie is famous for her pioneering work on radioactivity. She was the first woman to win a Nobel Prize, the only woman to win Nobel Prizes in two fields (in 1903 for physics and 1913 for chemistry).

Professor John Damilakis of the University of Crete, Greece, the Chairman of IOMP’s Education and Training Committee, is leading a task group in planning and coordinating a series of professional, educational and scientific activities to mark this meaningful day in 2013. The theme of IDMP 2013 is ‘Radiation exposure from medical procedures: ask the medical physicist!’

IOMP is working to create webcasts on ‘Roles and responsibilities of MPs’, ‘The life of M. Curie’ and ‘Radiation exposure from medical procedures: ask the medical physicist’. Some are now available to view at IOMP: http://www.iomp.org/?q=content/webcastsvideos.

The Polish Medical Physics Association is planning to organise the main IDMP event in M. Curie’s birthplace in cooperation with the Polish Academy of Sciences. IDMP is now on Facebook and Twitter. Please see and like(!) on Facebook: https://www.facebook.com/InternationalDayOfMedicalPhysics?fref=ts and Twitter profile: https://twitter.com/IntDayofMedPhys.

IOMP hopes that the 7th November 2013 event will draw the attention of the global community and generate sufficient momentum to ensure its continuity in the future.

IOMP is requesting all of us to plan and implement activities that promote the theme of IDMP, such as:

- invite the public to a lecture on the professional services provided by medical physicists;
- hold a press conference on the role of medical physics in healthcare;
- organise lectures related to the IDMP 2013 theme;
- send emails to colleagues and friends to promote IDMP;
- download and print a poster for the IDMP. IDMP posters can be downloaded in printable format at: http://www.iomp.org/?q=content/poster-international-day-medical-physics.
IPEM is working hard to keep you informed of its activities and wants you to be involved by getting in touch and spreading your news to other members.

We regularly offer our members a wide range of opportunities and information: whether it is a chance to get more involved with IPEM, a survey or consultation that can help you get your views heard, discounted CPD events and publications, prizes and bursaries, or news of the latest developments in your sector. We do our best to keep you informed, so stay up-to-date and be sure you do not miss out by keeping an eye, not just on Scope, but also on our other member communications. Do not forget, our communications can also be a route for you to get your news out to a community of over 4,000 medical physicists and biomedical engineers. So, if you have a development to share, or a subject you think needs covering, get in touch with us at ipemnews@ipem.ac.uk.

The IPEM newsletter
Our monthly e-newsletter is an important route for us to communicate with you. It features updates on our activities, special reports on current issues, forthcoming meetings and other events and news. All members should automatically receive a newsletter alert by email every month. If you don’t, make sure you let us know at ipemnews@ipem.ac.uk. For those few members who do not use email, we provide a paper copy of the newsletter, so that you don’t miss out.

The IPEM website
The IPEM website (www.ipem.ac.uk) is the most comprehensive source of IPEM information. News items appear on the homepage and are updated regularly. These are often about our policies or external work, keeping you in touch with your Institute’s activities in the wider world. All of IPEM’s latest policy documents can be found on the website for instant reference. You can also find out about the latest publications, conferences, prizes and opportunities. We are currently working on improving the homepage to make it more instantly informative and easier to navigate.

In the members pages, you will find an under-used feature of the website: the workspaces that allow IPEM committees and groups to hold discussions and share documents – much easier than finding documents attached to old emails! The President’s Update, keeping you up-to-date with key issues in which the President is involved, is also included in this section of the website.

Twitter
For instant updates, you can subscribe to our Twitter feed @ipemnews. This will keep you informed of events as they happen. If you are on Twitter, do let us know, we would also love to follow you.

Updating the database
The implementation of the new customer relationship management (CRM) database, which began in January this year, has greatly improved the ways that you can interact with the Institute. In spite of a few teething troubles, the vast majority of members renewed their membership online for the first time this year. You can also book places on events or order publications online via the website, which is now linked to the database. You can view your own membership record and keep track of your orders, payments and activities. Remember to use it if you want to update important information such as your email address directly.

We want you to get the most out of your membership of IPEM, so we hope that you will keep in touch through these methods – the best kinds of communication are always two-way!
ack in October 2012 I was fortunate to have been granted a bursary from the Institute of Physics and Engineering in Medicine (IPEM) to attend the Christmas markets in Bonn between the 3rd and 7th December. Bonn is a quiet city on the banks of the river Rhine with a population similar to that of Manchester. It was the capital of West Germany from 1949 to 1990 and the birthplace of Ludwig van Beethoven (figure 1). As anticipated, there was no shortage of snow-covered wooden huts selling glühwein, currywurst and festive decorations. On the understanding that Christmas markets are significantly less fun as a solitary event, I had arranged to meet a friend from Cologne (a mere 20 minutes away by train). After taking in the sights we settled into the local Bonnsch Brauhaus (microbrewery) to catch up.

Of significance that week in Bonn was the international conference taking place where 535 delegates from 77 countries gathered to set the scene for radiation protection for the next decade (figures 2–7). The four-and-a-half-day programme was jam-packed with presentations, roundtable discussions, poster displays and exhibitions. Nearly all of the presentations are available on the IAEA Radiation Protection of Patients website.1

This was not the first meeting of this kind organised by the IAEA. There was an international conference in Malaga in 2001, out of which came the first International Action Plan for the Radiation Protection of Patients.2 There have been significant developments in the field since that time, against a backdrop of rising population doses due to medical exposures and an exposed workforce greater in number than in any other profession. It was felt that a further conference should be held to develop a new international action plan for the next decade.

Safety culture
The first talk I want to bring to your attention was by William Hendee (Medical College of Wisconsin, WI, USA), who spoke about safety culture. He said that it is widely accepted that mistakes happen but that we need to minimise these through instilling a safety culture. This takes leadership, communication and accountability. The medical sector can learn from the culture within the airline industry and within nuclear power stations. ➤

![Figure 1. Bonn was the birthplace of Ludwig van Beethoven. This is an image of the musician from the wall outside his former home](https://www.ipem.ac.uk/ConferencesEvents/Conferencereportsandabstracts.aspx)
Evidence suggests that 80 per cent of errors are system derived and therefore shouldn’t be attributed to the individual who gets caught with the ball. Professor Hendee talked about three levels of accountability for errors. If through investigation you find human error to be the cause, then console the individual. It is likely that they are a competent, caring professional and will be punishing themselves. If you find at-risk behaviour then provide training to re-establish standards. If you find reckless behaviour then it should be punished.

**Justification**

There has been a lot of effort devoted to the optimisation of exposures over the last decade. Jim Malone (Trinity College, Dublin) said that it has become apparent that this is not the case for justification of exposures. Justification considers the benefits and risks associated with a procedure. The IAEA point out that the benefits from the Ionising Radiation (Medical Exposure) Regulations this includes the referrer, practitioner, operator and patient.

Indication of the dose is useful for those making referrals. An example of this is the pictorial system used in the Royal College of Radiologists (RCR) referral guidelines which are now freely available to all NHS professionals in the UK.

Not all practitioners (those professionals charged with justifying exposures) are aware of radiation risk. This affects their ability to choose the lowest dose modality and optimise the procedure. Clinical scientists may have a better understanding of radiation risk and should play a role in educating other professionals.

A point that was brought up time and again throughout the conference was that medical exposures are vilified in the media and this puts professionals on the back foot when talking about risk with patients. We need to make it clear that there are benefits to medical exposures that outweigh the risks (assuming justification and optimisation have taken place). The reason that the dose to the population from medical exposures is increasing is because there is access to more medical equipment. This should be seen as positive. We need to ensure that those receiving medical exposures actually need them and that the procedures take place with the lowest possible dose, consistent with the intended purpose.

Patients are required to consent to medical exposures and in order to do that they need to be informed appropriately about risk. The level of consent required increases with associated dose. There was no consensus on a dose level below which consent could be neglected (maybe less than 1 mSv). Consent could be assumed for low dose exams if the patient turns up for the procedure, provided there is information made available and the opportunity to ask questions. Higher dose procedures (maybe greater than 10 mSv) should have standard forms which require written consent records.

**Appropriateness (of procedure)**

It is believed that as many as 50 per cent of all medical exposures are inappropriate. This includes interventional procedures as much as general radiography exams and is a massive drain on health systems. It is important to note that these figures are worldwide and not specific to the UK.

There was discussion about the problem of ‘self referral’ where those who own equipment refer patients to their facility and gain financially. Whist this is possible we cannot expect a fall in inappropriate justification. There were calls to make people declare any conflict of interest to each other and gain legitimacy. Mixed messages on when to make a referral. Evidence suggests that around 30 per cent of examinations are ‘defensive medicine’ as doctors fear litigation if they do not make a referral.

Referral guidelines should be evidence based and universal in order to gain credibility. Mixed messages on when to make a referral and for what procedure reduces enthusiasm to comply. The RCR is currently looking into how outcomes are affected by referral guidelines.
Audit (of justification)

There is very little evidence of justification audit in the literature and there was a call for people to address this. The IAEA have provided guidance on audit of justification.7

Radiotherapy (RT)

Tommy Knöös (Lund University, Sweden) gave a talk on tools needed and tools available for safety improvement in RT. He highlighted a number of requirements:
- evidence-based delineation and prescription guidelines;
- independent dose calculation to ensure the correct planning parameters are transferred to the treatment planning system (TPS) or treatment unit. The environment should be as integrated as possible;
- greater understanding of ‘black boxes’ such as your TPS. Errors can be introduced by something as simple as leaving out inverse square law correction or performing it twice;
- more than one person commissioning linacs. It can be easy to make human errors when under pressure and often this work is performed outside ‘normal’ working hours;
- a system of internal and external audit to help prevent systematic errors, as a result of miscalculation, from the start of the equipment life;
- treatments personalised to individual radiosensitivity;
- lessons to be learned from incidents.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)

UNSCEAR assess and report levels, effects and risks of radiation from all sources, including medical exposure. Its reports to the General Assembly are used internationally to establish radiation protection policy and are available for free online.

Ferid Shannoun (UNSCEAR, Vienna, Austria) gave a talk on the findings of the UNSCEAR surveys and set out their future strategy. He showed that medical exposures are the greatest artificial source of population exposure. This continues to grow due to the increase in CT exams, high-dose cardiac imaging in nuclear medicine and the use of hybrid imaging. Note that this does not consider doses from RT because the effective dose concept used in their work applies only to dose levels encountered in radiology and nuclear medicine.

Peter Jacob (UNSCEAR, Vienna, Austria) summarised the UNSCEAR report to the General Assembly’s 67th session on attributing health effects to radiation exposure and uncertainties in risk estimates.8 The conclusions were:
- an observed health effect in an individual could be unequivocally attributed to radiation exposure if the individual was to experience tissue reactions.
- Stochastic effects cannot unequivocally be attributed to radiation exposure of an individual.
- An increased incidence of stochastic effects in a population could be attributed to radiation exposure through epidemiologic analysis provided the increased incidence was sufficient to overcome statistical uncertainty.
- An increase in the incidence of hereditary effects in human populations cannot at present be attributed to radiation exposure.
- UNSCEAR does not recommend multiplying very low doses by large numbers of individuals to estimate numbers of radiation-induced health effects within a population exposed to incremental doses at levels equivalent to or lower than natural background levels'.

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There are a number of factors that can dominate uncertainty in projecting risk:
- transfer of risk estimates between populations;
- extrapolation from acute to chronic and fractionated exposures;
- extrapolation from high-dose to low-dose exposure;
- extrapolation to different radiation types;
- absorbed dose values in the population of interest.

The Committee estimates that the uncertainty bounds of its calculations are approximately a factor of three larger, or smaller, than the best estimate.

UNSCEAR want people to understand the science behind their work so that it is not misused. The linear no threshold (LNT) model describes stochastic risk and uses effective dose which was created by the ICRP in its system of radiation protection. It was developed by looking at exposed populations and is not accurate when calculating risk to individuals.

International Electrotechnical Commission (IEC)

Norbert Bischof (Siemens AG, Munich, Germany) gave a talk on the role of manufacturers in radiation protection from the IEC perspective. The information in his presentation may be useful as a reference so I have identified the basics below and urge you to access his talk if you are interested.
IEC standards series 60601 lays out the technical requirements for the safety and effectiveness of medical electrical equipment. There is a general standard, approximately 10 collateral standards and approximately 60 particular standards. The numbering system works as follows:
- IEC 60601-1: General requirements for basic safety and essential performance.
- Collateral standards (numbered 60601-1-X) define the requirements for certain aspects of safety and performance, e.g. Radiation Protection (IEC 60601-1-3).
- Particular standards (numbered 60601-2-X) define the requirements for specific products, e.g. MR scanners (IEC 60601-2-33).

**EU Basic Safety Standards (BSS)**
The Euratom Treaty established the European Atomic Energy Community (Euratom) in 1957. Euratom acts in several areas connected with atomic energy including the drawing up of the BSS. The BSS, which are binding law, set objectives which individual member countries can implement however they wish. A revised version which will incorporate protection of staff, patients and the public in the one document is expected to be adopted in July 2013. It will integrate five current radiation protection Directives including the Medical Exposures Directive. The UK will then have a number of years to implement the requirements in law.

Georgi Simeonov (European Commission, Luxembourg) highlighted a number of expected changes; however, these may change during negotiations in the run up to adoption:
- particular requirements for justification of asymptomatic individuals;
- stronger emphasis on dose reference levels, especially in interventional radiology;
- patients to be given information on radiation risk;
- protocols specific to categories of patients and greater involvement of the medical physics expert (MPE);
- legislative framework for training and recognition of the MPE;
- all CT and interventional equipment in use must have dose indication. Any other new equipment must have dose indication;
- incidents to be analysed systematically, lessons must be learned and disseminated;
- staff dose to be included in the justification and optimisation process;
- no averaging of dose limits over 5 years.

**Asymptomatic individuals**
Jürgen Griebl (Federal Office for Radiation Protection, Germany) gave a talk about asymptomatic individuals as a specific feature of the revised EU BSS. He introduced the 2012 statement from the Heads of the European Radiological protection Competent Authorities (HERCA). The statement explains that there are three medical exposure scenarios. ‘Healthcare’ deals with an individual patient who has symptoms. In ‘screening’ there is a target asymptomatic population with a high disease prevalence. ‘Individual health assessments’ (IHA) fall somewhere between screening and healthcare scenarios and relate to exposures of asymptomatic individuals who will typically have a low prevalence of disease.

The most common IHA are screening CT scans for lung cancer, colorectal cancer and coronary artery calcification. ‘Whole body’ CT scans are also offered, as are mammograms. There are problems identified with IHA:
- they are usually a result of patient choice;
- there is a lack of evidence to support use;
- examinations are not necessarily embedded in a care pathway;
- isolation of service providers may affect their quality assurance (QA) programme;
- there is potential for a large number of people to be exposed to a greater detriment than benefit.

HERCA states that there should be special requirements for these types of exposures. They say there should be consensus guidelines from professional and scientific bodies. Those expected to benefit should be clearly defined. Information should be available making clear the risks and benefits to allow individuals to make an informed decision. There should be a demanding QA programme including equipment and image evaluation. Education and training requirements should also be set at a demanding level.

The Committee on Medical Aspects of Radiation in the Environment (COMARE) 12th report recommended to the Department of Health that whole body and lung CT scanning of asymptomatic individuals is not justified. Colorectal and cardiac scans are justified for certain defined cohorts.

**Radiation protection outside radiology**
There are a large number of places that make use of medical exposures outside of the radiology department; for example, vascular surgery, gastroenterology, urology, cardiology and dentists/oral surgery. Cécile Etard (Institut de Radioprotection et de Sûreté Nucléaire, France) said that the problem here is the potential that radiation protection has not been integrated into routine practice. There is a need to ensure that education and training are addressed adequately. Attention should be given to equipment and protocols used and how staff and patients are protected. Special care is required for paediatric exposures, especially when they have to be repeated many times, such as in neonatal units and dentistry. Medical physics departments should be involved to guide these processes.

One area that was covered in detail by Michael Maher (University College Cork, Ireland) was gastroenterology, where there is the possibility for patients to get excessive cumulative doses. Fifteen per cent of Crohn’s disease patients get >75 mSv cumulative dose as a result of imaging and 15 per cent of gastro disorder patients get >100 mSv. This is in part due to the increase in CT scans and a reduction in barium imaging. There are also potentially high doses that can be delivered during single procedures such as bile duct drainage (10–38 mSv effective dose). Therapeutic endoscopic retrograde cholangio pancreatography (ERCP) has an associated effective dose of ~20 mSv and transjugular intrahepatic portosystemic shunts (TIPS) have an associated effective dose of between 19 and 87 mSv.

For more information on the subject you could look at ICRP Report 117 and a report from the World Gastroenterology Organisation.

**Incident databases**
The revised BSS is expected to have greater emphasis on incident management systems and learning from mistakes, as highlighted above. There were a number of incident databases brought to our attention throughout the week which may play a useful role.

- RADEV: for radiation accidents/near misses involving staff/patients/public (IAEA project);
- ROSIS: Radiation Oncology Safety Information System (European Society for Radiotherapy and Oncology project);
- REACTS: Radiation Emergency Assistance Centre/Training Site;
- SAFRON: a voluntary reporting registry of radiation oncology incidents and near misses (IAEA project);
- SAFRAD: a voluntary reporting registry of incidents in fluoroscopically guided diagnostic radiology and interventional procedures (IAEA project).

The conference proceedings are currently being prepared for publication along with the conclusions and the call for action. One
action for conference delegates was to make professionals in their home countries aware of the meeting and of the work taking place at a global level. It is up to the scientific community to advance knowledge and develop international systems that can be applied even in resource-challenged regions of the world.

Acknowledgements
I would like to thank IPEM for the funding that allowed me to attend this conference and encourage others to apply for the bursaries that are available.

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2 IAEA. International action plan for the radiological protection of patients.

12 ICRP. Radiological Protection in Fluoroscopically Guided Procedures Performed Outside the Imaging Department. ICRP Publication 117, 2010.

2013 GASTROINTESTINAL CANCERS SYMPOSIUM: SCIENCE AND MANAGEMENT

CHARLOTTE HALLE Queen Elizabeth Hospital, Birmingham

From 24th to 26th January 2013, a diverse group of professionals involved in the prevention, detection and treatment of gastrointestinal (GI) cancers attended the 2013 Gastrointestinal Cancers Symposium at the Moscone West Building in San Francisco, California. The interactive setting facilitated a forum for networking and discussion to exchange ideas, best practices and science that aimed to lead to future progress in this area. The symposium was targeted at physicians and researchers interested in the prevention, screening, evaluation and management of GI cancers. The 2013 GI Cancers Symposium celebrated its 10th anniversary, ‘continuing its tradition of putting the latest scientific information into the context of a multidisciplinary perspective, as well as incorporating new sessions and interactive opportunities for attendees’. Nearly 24,000 people from 109 countries have attended the symposium since it began; 5,306 abstracts have been submitted, with 275 oral presentations and 4,652 posters. This year’s symposium housed 2,980 registrants (2,775 professionals), with 53 per cent being international attendees. The top three attending countries were the USA (1,312 attendees), Japan (332 attendees) and Canada (135 attendees). There were 68 professionals from the UK; this was in sixth place out of a total of 62 countries. The majority of attendees were physicians (64 per cent); of the remaining 36 per cent, 21 per cent were from medical oncology and 3 per cent from radiation oncology.

The symposium was co-sponsored by the American Society of Clinical Oncology (ASCO), founded in 1964. ASCO is the world’s leading professional organisation that represents physicians who treat people with cancer. ASCO has more than 30,000 members and strives to lead the way in carrying out clinical research to improve the prevention, diagnosis and treatment of cancer. Other co-sponsors included the American Gastroenterological Association (AGA Institute), the American Society for Radiation Oncology (ASTRO) and the Society of Surgical Oncology (SSO).

Meeting overview
Over the three days, the meeting followed a similar daily programme with each day covering different cancer sites. Thursday was dedicated to cancers of the oesophagus and stomach; Friday included cancers of the pancreas, small bowel and hepatobiliary tract; and Saturday covered cancers of the colon and rectum. The days started with a complimentary breakfast and welcome session followed by a general session about the prevention, screening and diagnosis of the cancers to be discussed for that day. Following a short break, talks focussed on the progressions made over the past 10 years in ‘A decade in review’ session. These sessions were added to mark the 10th anniversary of the symposium and aimed to identify the major advances and challenges that each tumour had brought over the past decade. The lectures were delivered by international experts, covering advances made in genetics, targeted therapies, radiation protocols and surgical techniques in addition to highlighting what the next
The final afternoon sessions focused on multidisciplinary treatment.

On the first two days of the meeting, the Daily News newspaper was given out which included articles related to several talks for that day. In addition, it covered information about the co-sponsors of the symposium, instructions and information about the symposium resources available and further articles covering current topics relevant to the day’s cancer sites. Further meeting resources included the iPlanner website and mobile app – these allowed attendees to access supplementary information about each session, create a customised itinerary and keep track of tweets about the symposium. Computers were available for those who did not bring their own laptops.

The order of the proceedings enabled the daily theme to be suitably introduced before giving an overview of the key advancements made in the past 10 years in the ‘A decade in review’ sessions. Personally, I found these sessions of particular interest since they highlighted the main focus points for each cancer site to which the following research presentations could be compared. This also emphasised how diverse and progressive the subsequent trial and research presentations were, which I found fascinating. For example, Friday’s session was delivered by Margaret A. Tempero (University of California, USA) who discussed the vast difference between the broad treatment options available today for patients with pancreatic cancer compared to 10 years ago when only one drug, gemcitabine, was approved for use in pancreatic ductal adenocarcinoma. She delved into detail about the particular outstanding clinical trials that provided further and superior treatment options for patients. On the other hand, she reported that seemingly little progress has been made with regards to developing a strategy for early detection in sporadic disease, which was highlighted as an area that needed further attention.

The translational research sessions were interesting, although being a clinical scientist some of the work done was slightly lost on me, but my colleagues (physicians) were able to fill in some of the gaps! The subsequent oral abstracts were of more familiarity and relevance and I particularly enjoyed the presentation about the UK selective chemoradiation in advanced localised pancreatic cancer (SCALOP) trial, as this is what my research projects were in relation to, from a radiotherapy physics perspective. The results of the trial were presented by the chief investigator of SCALOP, Somnath Mukherjee (Gray Institute for Radiation Oncology and Biology and NIHR Biomedical Research Centre, Oxford). He discussed the background of locally advanced pancreatic cancer (LAPC), highlighting that the

> 10 years could bring. A translational research session concluded the morning’s proceedings.

During the lunch break, there was a general poster session which enabled attendees to browse the numerous posters covering a wide scope of research projects and trials for the respective cancer sites for that day. The afternoons kicked off with further translational research talks followed by oral abstract sessions. To round up the latter, the audience was able to take advantage of the eQ&A sessions using the Audience Response System via the Internet, Twitter, text or by asking questions directly using the microphones available. All speakers for that session sat on stage enabling the meeting participants to direct questions at them in relation to their presentations. After a short break, the final afternoon sessions focused on multidisciplinary treatment. Another general poster session finalised the first two days, encouraged by a complimentary cheese and wine reception. This session was somewhat more relaxed compared to earlier lunchtime sessions, mostly due to clashing luncheons/sessions for some; but also due to the beverages available for others!

To mark the 10th anniversary of the symposium, there was a ‘Fellows, residents, and junior networking luncheon’ on Thursday and additional ‘Meet the professor sessions’ on Friday, which opened and ended the day. These added sessions required ticketed entry and were quite topic specific, thus most suitable for professionals directly involved in these specific areas.
standard of care in the UK is chemotherapy alone with a typical survival of around 10 months. The objectives of the trial were to evaluate the activity, safety and feasibility of two chemoradiation (CRT) schedules in LAPC: capecitabine-radiotherapy (Cap-RT) and gemcitabine-radiotherapy (Gem-RT), as well as establishing a nationally agreed CRT protocol in the UK. Recruitment occurred between December 2009 and October 2011 with 114 patients being recruited from 28 centres across the UK, making it the largest randomised CRT trial in LAPC from the UK. The primary outcome showed 62.9 per cent progression free survival at 9 months in the Cap-RT arm compared to 51.4 per cent in the Gem-RT arm. The conclusions of the trial were that following induction chemotherapy, Cap-RT was significantly less toxic than Gem-RT, with no compromise in local control and an improvement in overall survival (median overall survival 15.2 months compared to 13.4 months for Cap-RT and Gem-RT, respectively).

Perusing the posters was another highlight for me as it was a good opportunity to seek out further information from the oral presenters plus appreciate a variety of work exhibited by other attendees, which covered a vast scope of subjects. The poster boards were arranged such that those at the front showcased the posters for the abstract speakers of the day, followed by the remaining posters which were divided into topics: prevention, screening and diagnosis; translational research; and multidisciplinary treatment. Over the 3 days there were a total of 595 posters, which is a lot to get your head around! However, many presenters printed copies of their posters for onlookers to take and written abstracts were included in the proceedings book and USB drive supplied to all attendees. These sessions were of particular interest to me as I was able to fully appreciate the research, trials and projects that are going on internationally, as well as comparing it to our work individually and as a country.

The posters my colleagues and I were fortunate to present were related to the ‘test case’ patient sent out to participating centres of the SCALOP trial, as part of the pre-trial quality assurance (QA) programme. The work involved undertaking a retrospective quantitative analysis of the tumour volume delineations submitted by the investigating centres and comparing them against a gold standard reference contour. A variety of conformity indices were used to quantitatively evaluate the variation that was found across the centres and these results were compared to the qualitative analysis observed. Recommendations based on these findings included the possibility of using PET-based planning information in addition to radiotherapy trial workshops and on-trial real-time central review of tumour volumes. Based on those conclusions, further work we completed (and presented) included making comparisons of tumour contours delineated on computed tomography (CT) and positron emission tomography (PET) scans by a small number of centres, in order to evaluate the potential that PET scans have at reducing the inter-observer variability of delineations, as reported for other cancer sites. We undertook statistical analysis of the results which revealed that the standard deviation improved for the delineations using the PET scans compared to those using CT alone. These findings will directly impact the radiotherapy trials QA that will be undertaken for the SCALOP II trial.

Location, location, location!
The symposium was held in the Moscone West Building located in the heart of San Francisco, California. The exhibit hall on the first floor housed boards for the posters and a large number of tables for attendees to sit at whilst lunching, networking or working on their laptops. The 44 companies exhibiting information about their products and services also lined the room. The presentations took place on the second floor in the 100,000 square foot meeting room, which had a 28,261 square foot pre-function lobby! The vast expanse of the meeting room was filled with a stage for the presenters and rows upon rows of chairs for those attending. There were at least eight big screens positioned beside the stage and halfway across the room showing a real-time recording of the presentations and associated slides. Upon entering this room it suddenly became clear why they encouraged questions for presenters via Twitter and the Internet, otherwise we could have been waiting for a long time whilst people walked to the microphones!

Fortunately, it was not all work and no play as I was able to take advantage of the time I had before and after the symposium.
to discover the city. San Francisco was beautiful and interesting, best showcased via the open-top buses which tour the popular tourist destinations, including a very windy but phenomenal ride across the Golden Gate Bridge! The island of Alcatraz also offered some of best views of the city and its iconic bridge, as well as providing a very fascinating guide to the history of the famous island. If only I had a little more time to explore the city and its vast culinary experiences too! However, I did get the opportunity to sample the seafood chowder served in a loaf of sourdough bread at Fisherman’s Wharf, which is definitely an experience not to be missed!

Final remarks

The meeting aimed to provide a forum for the assessment and increase of competency in the research and treatment developments for GI cancers, since to date there have been few educational opportunities that have addressed the need for the diagnosis, treatment and management of patients with GI cancers in a multidisciplinary forum. And with the location and set up, it did just that. My overall experience was a good one – personally, the symposium provided me with an incredible opportunity to showcase the work that I have been and am still involved in; I was able to expand on my knowledge and understanding of GI cancers and the current breadth of research being undertaken in numerous departments on an international level; and finally, I was able to appreciate the value and importance that a wide scope of professional input brings to this nature of work which is vital to ensure future progression. This is of course always the ultimate goal for all areas of patient care and the same principals apply across them all!

The sights of San Francisco: (left) the skyline and (right) seafood chowder

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known and with hardware improving all the time spatial resolution is continuously increasing.

**Purpose of the visit**
A few months previously, I had a long conversation with John Greenhalgh (figure 1), Director of MRI Applications Research at FONAR since 1985, about how to get the best out of his 0.6T resistive MR scanner. We wished to scan people’s bottoms (BTM) sitting down in the ‘upright’ MR scanner. To be more precise, we were interested in how soft tissues behave around the ischial tuberosity (IT) (that’s the boney protuberance we sit on), in unloaded and loaded conditions. At the end of the phonecall John said, ‘Why don’t you come over and we’ll try a few things’, just like that – so I did!

The FONAR 0.6T resistive magnet requires up to 100 kW for both the main magnetic field and associated RF, gradient and computer cabinets. It weighs in at a mighty 145 tons, requires 47 m² installation space and a height clearance of 3.35 m. The patient aperture is 46 cm wide with a usable maximum field of view slightly less than this. It has a range of fixed and flexible quadrature volume and surface RF coils. There are a couple of systems in the UK and about 140 installations worldwide. This is a niche magnet with a wide range of applications, just about perfect for our needs. Figure 2 shows a subject seated on a surface coil (I think he means peace!). Because our subjects sit on the RF coil or are separated by a cushion, the coil is very close to the anatomy and provides good SNR.

**Research programme**
Stephen and I met on the Saturday to do some grant planning and writing. There is an Ireland–US funding initiative where researchers from Northern Ireland, the Republic of Ireland and the United States form a partnership and jointly apply for funding from the three regions (Health Research Board, Health and Social Care Research and Development Office and National Institutes of Health, respectively). We are seeking funding for a programme of research to: (a) identify anatomy of the IT in spinal cord injury patients and normal volunteers (with expertise from John Cathcart, Lecturer in Radiography, University of Ulster), (b) develop models of the IT and surrounding soft tissues, (c) measure the deformation resistance brought about by a range of...
wheelchair seating configurations and (d) develop finite element analysis to determine the biomechanics of sitting (with the expertise of Laoise McNamara, Mechanical and Biomedical Engineering, National University of Ireland, Galway).

On Sunday, Stephen, John and I met at the Sweet Hollow Diner for breakfast and to plan our day’s scanning. We began imaging with a sagittal plane and large field of view (28 cm) centred on the ischial tuberosity. We used a fast spin echo T1-weighted sequence (echo train = 3), TR = 576 ms, TE = 20 ms, matrix 280 × 280 and slice thickness of 3 mm. We could only get eight slices per acquisition and needed 64 to cover the anatomy from the mid-line of the body to the lateral edge of gluteus maximus. Acquisition time came in at just over 7 minutes. This scan time is fine for someone with good core stability who can hold themselves upright; however, it may be too long for someone who has a spinal cord injury.

Figure 3(a) shows a T1-weighted image of the IT and surrounding structures. This was acquired whilst the subject was seated on a 5 cm-thick foam support that had a large hole in the middle. The support was provided around the outer edges of the BTM (greater trochanter, coccyx and under the thighs) so that the buttocks were suspended without being compressed and not loaded by the volunteer’s weight. Figure 3(b) demonstrates what happens to the gluteus maximus when it comes under load due to the subject’s weight. In this case the subject was seated on a multi-air cell cushion. On initial inspection of the images, the muscle appears much thinner (short white arrow) and the subcutaneous fat has been squashed or displaced (long white arrow). On further investigation we find that the muscle moves posteriorly and laterally and the same occurs with the subcutaneous fat. What we are really interested in is how to map the non-linear transformations that occur across the soft tissues, and especially around the IT. It is well established that pressure ulcers form due to shearing and pressure mechanisms causing cell damage leading to the complete breakdown of the tissue. Pressure ulcers are a very debilitating problem and costly in terms of quality of life and finance. We are intending to model the MR data to see if we can gain further insight into the mechanisms and risk factors for pressure ulcer formation.

During my career as an MR physicist I noted that in a range of MR scans large amounts of data (large FOV or large

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![Figure 3A](image1.png)

**FIGURE 3A.** (1) IT, (2) gluteus maximus and (3) subcutaneous fat

![Figure 4A](image2.png)

**FIGURE 4A.** Limited FOV focused on the soft tissues around the IT
number of slices) were acquired with only a small portion of the data being useful for diagnostic purposes. Looking at our images I felt the same.

The region superior to the femoral head (nearly half the scan time is spent collecting this portion of the data) is neither relevant or of sufficient quality. Also, the images were noisy and we intended to segment out each structure; therefore, more SNR would help. IT pressure ulcers form directly below the IT, not superior, posterior or laterally, as this is where we sit and where the pressure is generated. Given that, I wanted to reduce our field of view focusing on the area we were really interested in, and also try to get some extra signal to noise. John Greenhalgh came up trumps: ‘We have plenty of contrast here between the muscle, fat and bone and we will use fewer slices to cover the limited area. We should try a proton density’. What a revelation. Figure 4(a) says it all! Higher SNR, shorter scan time and higher spatial resolution.

The sequence we used was a fast spin echo TR = 1800 ms, TE = 20 ms, slice = 3 mm, FOV = 24 cm, matrix 320 × 320 and scan time of just over 6 minutes.

**Further work to be done**

Figure 4(a) shows subject number 2 sitting with their BTM suspended and unloaded and figure 4(b) sitting on the RF coil; that is, with the BTM loaded by the subject’s own weight. There is significant shifting of tissues between the unloaded and loaded conditions and it is this that we will begin to analyse. It is also worth noting between figure 2 and figure 3 that the weight bearing tissues are distinctly different. In figure 2 the weight is taken up by muscle whereas in figure 3 there appears to be a significant proportion of fat that is weight bearing.

We also performed some repeatability scans where the subject got in and out of the scanner and there were some significant differences (up to 10 mm), at least around the surface of the buttock, much less so internally. We need to think about how we locate the subject in the unloaded foam device more carefully (it doesn’t matter so much on the cushions as they are very uniform). There is still much work to be done with this preliminary data to support forthcoming grant applications. Thanks to IPEM for the travel bursary to support me in travelling to FONAR, meeting with Stephen and John, and I look forward very much to our collaboration further developing in the future.
Over the weekend of Friday 19th to Tuesday 23rd April 2013, 2,200 attendees from 65 different countries descended on Geneva, Switzerland, for the 2nd European Society of Radiotherapy and Oncology Forum. The biggest radiation therapy conference in Europe consists of teaching lectures, symposiums with invited speakers and proffered papers. Nine sessions ran in parallel across topics ranging from image-guided radiotherapy to brachytherapy and particle therapy. Of the 1,100 abstracts, over 200 were accepted for oral presentation, 190 for poster discussion and nearly 700 for posters or e-posters.

I am a medical physics PhD student at University College London, working in the Proton Therapy Group, which was created in response to the new National Proton Therapy Service which is due to begin treating patients at University College London Hospital in 2017. My research particularly focuses on proton treatment planning and the absolute calibration of x-ray computed tomography using proton radiography. As such I attended all particle therapy sessions, as well as the session on Monte Carlo (MC) in radiotherapy.

**Proton beam therapy**

Proton beam therapy offers the potential for better sparing of critical organs because of the sharp distal fall off of the characteristic Bragg peak in the depth dose curve. However, this greater precision of proton therapy cannot be fully utilised because it is more sensitive to range uncertainties (caused by patient positioning, organ motion, anatomical/physiological changes) than traditional photon therapy. Additionally, there is an uncertainty when converting between Hounsfield units (from planning x-ray CT) and stopping powers. As such there is a great need for methods to assess the proton range in vivo, with real-time measurements required for dose-guided or adaptive therapy. One potential solution, presented by Guntram Pausch (Oncoray, Dresden, Germany), is prompt gamma imaging (PGI), the physics of which is detailed in figure 1.

The short timescales mean that PGI is not subject to the washout effects that make quantitative positron emission tomography imaging difficult. However, prompt gammas have a wide energy spectrum (mainly between 0 and 7 MeV) and collimation is a challenge. Feasibility of the technique was impressive, with results shown in figure 2. However, question marks remain about the required signal-to-noise ratio to achieve such images.

One of the most exciting talks was Stanislav Vatniskiy’s (EBG MedAustron, Austria) overview of the CERN-MEDAUSTRON project, a new €200m proton and carbon therapy facility, 55 km south of Vienna, that will be operational for 24 hours a day, 7 days a week. This
FIGURE 2. Illustration of prompt gamma imaging feasibility for a brain patient. Planned dose distribution from treatment planning system (left). Prompt gamma emission pattern, simulated using Monte Carlo (right). The isodose colour scheme corresponds to the same dose in each image.

FIGURE 3. ESTRO poster reception, Saturday 20th April, Geneva, Switzerland

FIGURE 4. ESTRO poster discussion session
time will be divided equally between clinical work and research. With the research slots open for application it will offer a facility for researchers without a beam line, in an approach similar to the CATANA proton therapy beam line in Italy. Clinical energies will range from 60–250 MeV for the proton beam line and 120–400 MeV/u for the carbon beam line, with 800 MeV proton beams available for radiobiology research. They intend to commission their first horizontal fixed beam line by the summer of 2015, with clinical operation starting 6 months later. The centre will be fully operational (all treatment rooms functioning) by 2020. One interesting novel feature was a ring imaging system attached to the patient couch rather than the gantry. It is hoped this will be subject to smaller errors as it is not dependent on the gantry maintaining a perfect rotation about its isocentre.

Planning and plan comparison
During the ‘Proton treatment planning and plan comparison’ session, a very informative talk was delivered by Stephen van de Water (Erasmus MC – Daniel den Hoed Cancer Center, Rotterdam, The Netherlands). The work aimed to improve the quality of intensity modulated proton therapy plans, by modifying the optimisation algorithm in an in-house developed planning system, Erasmus iCycle.2 In inverse planned proton treatment planning the first step is to define the grid size, which determines the available spot positions. Typically smaller grid sizes increase the optimisation time and plan quality, but it is difficult to know what size this should be before starting the optimisation. Van de Water’s ‘pencil beam resampling’ method therefore works using two principles: (a) instead of optimising once with all the pencil beams, the optimisation process is repeated with relatively few beams in each optimisation; (b) the few beams in each optimisation are randomly sampled across a very fine grid. The method was tested in five head and neck patients, and it was able to provide equal quality plans (based on final size of the objective values) in shorter optimisation times. With comparable optimisation times, median doses to the organs at risk could be reduced by ~2 Gy, with maximum dose reductions of up to 15 Gy.

Monte Carlo applications
The ‘Monte Carlo applications in radiotherapy’ session was well attended, with topics ranging from kV backscatter factors to proton dose calculation. One particularly interesting talk was from Marta Bueno (Universitat Politècnica de Catalunya, Spain). Her work looked at the need for clinical MC dose calculations for small proton therapy fields. Complex heterogeneities in the beam path are known to pose a challenge to proton dose calculation algorithms, with multiple Coulomb scattering rarely modelled correctly. MC algorithms therefore act as a benchmark in radiation therapy; however, their long calculation times mean they should only be used when necessary. The question is, when is it necessary? Bueno’s work correlated the error in the standard analytical dose calculation algorithm (compared to MC) with a heterogeneity index (HI) of tissue in the beam path, for 14 patients treated at Massachusetts General Hospital. A threshold HI could then be imposed (user choice), above which MC algorithms need to be employed. The most impressive result was the time to calculate this parameter. The HI could be calculated in approximately 3 minutes, compared to 12 hours for a full MC dose calculation. The HI could act as a new metric to determine when MC dose calculations are required.

My abstract4 was accepted for a poster discussion, a unique format that provides dedicated discussion sessions for selected posters. In addition to the traditional poster reception (figure 3), this allows authors to present their work, directly, to a small audience.

The format is similar to an oral presentation, except that instead of slides the author uses sections of their poster. In a 10-minute slot, each presenter spends 5 minutes highlighting sections of their poster followed by 5 minutes of discussion from the floor. The session in which I presented was well attended (figure 4), with interesting discussions arising after each poster presentation.

The ESTRO conference was an excellent opportunity for researchers in radiation therapy to present their work, become aware of the latest research and to network with colleagues. European research has a strong collaborative emphasis compared to other regions around the world, and it is with conferences such as these that this can continue to be the case. I am very grateful to IPEM for providing the funding to allow my attendance.

REFERENCES
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T and VMAT both provide highly conformal plans. This paper looks at a comparison of dosimetric results for the treatment of high-risk prostate cancer with prophylactic whole pelvic radiotherapy (WPRT) using these two methods of delivery.

The overall goal was to deliver 95 per cent of the prescription dose to 98 per cent of the volume as homogeneously as possible. The primary goal was to achieve similar planning target volume (PTV) coverage with the two techniques, while the secondary goal was to reduce the organs at risk (OAR) dose as much as possible. Both techniques used 6 MV photons.

WPRT dose to PTV1 was 46 Gy and this was boosted by using PTV2 with a dose of 76 Gy. PTV1 was delineated using RTOG-0521 and the usual protocols at Radiotherapie Centre Oscar Lambert in France. The difference in protocol was the amount of seminal vesicles contoured and the 7 mm uniform margin. PTV2 included prostate and proximal seminal vesicles (10 mm) plus a 7 mm uniform margin. Bladder and rectum OAR were contoured as per ICRU Report 83.

The HT and VMAT planning was done by two physicists in two different centres who were blinded to the dosimetric results for the other technique except in the first case.

In compliance with ICRU 83 the respective D98 per cent, D50 per cent and D2 per cent were reported for PTV1 and PTV2 (table 1). The homogeneity index (HI), dice similarity coefficient (DSC) and delivery times were also noted. Comparisons

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**FIGURE 1.** Representative VMAT (left) and HT (right) dose distribution for pelvic nodal radiation therapy. The bladder and rectal walls are shown in pink and yellow, respectively. Nodal and prostate PTVs are shown in red, with isodose lines from 20–51 Gy. Figure kindly supplied by David Pasquier, Department Universitaire de Radiotherapie, Centre Oscar Lambret, 3 rue F. Combemale, 59020 Lille, France. © Elsevier, ‘A dosimetric comparison of tomotherapy and volumetric modulated arc therapy in the treatment of high-risk prostate cancer with pelvic nodal radiation therapy’, D. Pasquier, F. Cavillon, T. Lacornerie, C. Touzeau, E. Tresch and E. Lartigau; Int J Radiat Oncol 2013; 85(2)
were made using DVHs and dose distributions (figure 1).

This study is one of the first to report on WPRT using dose to target volumes, OARs and calculations for HI and DSC as recommended by ICRU 83. The OAR dose sparing was very similar for both these techniques where VMAT showed better sparing at higher doses for the rectum, and HT better bladder sparing except at lower doses. Various papers show opposing results with some showing better results for VMAT, some for HT, some for bladder sparing and others for rectal sparing. Overall, the delivery time was slightly shorter for VMAT than HT, but HT showed better homogeneity than VMAT. Both achieved OAR sparing.

### Table 1

<table>
<thead>
<tr>
<th>PTV1</th>
<th>VMAT</th>
<th>HT</th>
<th>P value</th>
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<tr>
<td>D98% (Gy)</td>
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<td>D50% (Gy)</td>
<td>47.0 ± 0.5</td>
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<td>D2% (Gy)</td>
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<td>47.3 ± 0.3</td>
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<td>Homogeneity index</td>
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<td>0.07 ± 0.01</td>
<td>0.000</td>
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<td>Dice similarity coefficient</td>
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<td>0.89 ± 0.009</td>
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<th>VMAT</th>
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**Abbreviations:** HT = helical tomotherapy; PTV = planning target volume; VMAT = volumetric modulated arc therapy; SD = standard deviation; D0% (Gy) = dose (Gy) absorbed by 0% of the evaluated PTV; NS = not significant.

**Table 1** Summary of the dosimetric results for PTV1 and PTV2. Table kindly supplied by David Pasquier, Department Universitaire de Radiotherapie, Centre Oscar Lambret, 3 rue F. Combemale, 59020 Lille, France. © Elsevier. A dosimetric comparison of tomotherapy and volumetric modulated arc therapy in the treatment of high-risk prostate cancer with pelvic nodal radiation therapy, D. Pasquier, F. Cavillon, T. Lacornerie, C. Touzeau, E. Tresch and E. Lartigau; Int J Radiat Oncol2013; 85(2)

**More Information**

This work was published in *Int J Radiat Oncol* 2013; 85(2): 549–54. [http://dx.doi.org/10.1016/j.iorbp.2012.03.046](http://dx.doi.org/10.1016/j.iorbp.2012.03.046)

**Editorial Note**

This paper showed that the constraints to OARs were easily complied with and the minor differences in dose coverage / homogeneity could be set against the increased efficiency & reduced QA time of the linac and commissioning time of the RTPS.
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The History of Radiology

When I learned that these authors were producing a book with this title I thought that I should be in for a treat. When I read it, I was not disappointed. Adrian Thomas is probably the greatest living authority on the history of x-rays, and Arpan Banerjee has enormous enthusiasm for all radiological history. This comes over in what they have written.

Radiology is considered to have been born with Roentgen’s discovery of x-rays in November 1895 (although various physicists had produced x-rays by accident a few years earlier without realising it) so the subject has a more limited history than many branches of medicine. The development of high vacuum, high voltage currents and the discharge tube had all contributed to the discovery, and this scientific background is well described in the first chapter. The next chapter, on early radiology, includes information about the early pioneers in the field of medical x-rays. A copy of a letter from Lord Kelvin to Wilhelm Roentgen is reproduced. Roentgen had sent information about his great discovery, plus pictures, to various eminent physicists, including Kelvin, whose response indicated that he had looked at the pictures but not initially read the paper (things don’t change, do they!). Chapter 3 shows how x-rays were helpful in military radiology when searching for bullets acquired by soldiers in battle and bones broken in war, and the previously unperceived threats from radiation are discussed with details of the early radiation martyrs.

Godfrey Hounsfield’s invention of cross axial tomography is rightly given a chapter of its own, as this provided a great leap forward in the diagnostic use of x-rays. Chapters on MRI and ultrasound come next, after which the reader is brought rapidly up to date with digital imaging and PACS, interventional radiology and techniques such as angiography.

Mammography, using very low x-ray energies from molybdenum anodes, and breast screening programmes are described as are newer techniques. A chapter on nuclear medicine follows and then there is a summary and a look into the future.

The appendices give lists of radiological journals, past and present, radiological and physics societies and a comprehensive reading list to supplement the references at the ends of the chapters.

This is a delightful book that informs and entertains the reader. There are lots of good illustrations – all in black and white, as befits a book on history – and I recommend it strongly.

Professor Angela Newing is a retired Director of Medical Physics for Gloucestershire.

**TABLE 1**

<table>
<thead>
<tr>
<th>Book title</th>
<th>Reviewer</th>
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<tbody>
<tr>
<td>The History of Radiology</td>
<td>Angela Newing</td>
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<tr>
<td>The Hip Resurfacing Handbook</td>
<td>Julian Minns</td>
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<td>Stereotactic Body Radiation Therapy</td>
<td>Keri Owen</td>
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<tr>
<td>Cobalt Blues</td>
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The Hip Resurfacing Handbook

Hip resurfacing, as opposed to total hip replacement, is a modern concept introduced and developed by two orthopaedic surgeons, Mr McMinn in Birmingham (UK) and Mr Amstutz in Boston (USA), in the 1990s and two books produced by them appeared in 2008 and 2009, respectively. However, a further 13 designs have appeared since 1996 and in the introduction to this book, it was felt that hip resurfacing is still evolving and that the features of all current designs of hip resurfacing needed to be described so that all the differences could be clarified. This was the rationale for the production of this book so that the surgeon deciding to consider using this procedure will be able to refer to it to make such a choice.

Part 1 contains 16 chapters, 15 devoted to each prosthesis design with rationale, surgical technique, clinical results and references, and the last chapter on the design issues and comparison of all hip resurfacing prostheses. The small geometrical difference between each design is rigorously defined and the materials of the two components given. I found this chapter the most revealing as the descriptions of the 15 devices in the other chapters were primarily based on the individual company’s sales literature, with the obvious good points about their respective designs. In only one chapter is there a table showing the clinical results of all the designs described, highlighting revision rate, but for some the numbers are very small so it really isn’t a true comparison of long-term follow-ups. The amount of data is quite overwhelming and it is difficult to draw any conclusions about which is the best design for wear, range of movement, strength of fixation, etc.

Part 2 deals with the clinical follow-up of the various designs with many case reports described and the clinical examination one should conduct during follow-up referrals. The short chapter on rehabilitation after hip resurfacing could have been expanded as one of the areas leading to a clinical success is properly structured physiotherapy following surgery. Here, case studies using different post-operative rehabilitation programmes would add valuable information on the post-op management of these patients. The small chapter on acoustic phenomena in hip resurfacing patients found that ‘squeaking hips’ were indicative of high wear and should be followed up regularly.

All cases are anecdotal experience and give the reader a taste of the real-life experience of this very recent procedure

The next group of chapters in Part 2 will be of considerable interest to the readers of this review as it includes the use of radiography (68 pages), bone scintigraphy, ultrasound, CT, MRI, PET, DEXA and metal ion levels to evaluate hip resurfacing and could be a separate book on its own when one considers the scope included in these chapters. Nearly all the orthopaedic pathologies associated with the painful hip are described in these chapters with many case studies described and the findings discussed at length using the various non-invasive modalities used. Definitive diagnosis of loosening, infection, wear and breakage of the bone or prosthesis components are clearly confirmed by using the most appropriate modality; for instance metal ion levels correlate well with metal wear and can give indications for revising the implant before gross malfunction occurs.

Surgical technique is a major part of the success of any hip resurfacing, of which the experience of the surgeon, adequate surgical exposure and correct alignment and fixation all contribute to the longevity of any implantable device. Part 3 covers the various approaches and the associated instrumentation used with each design to ensure correct placement of the prosthetic components and the revision surgery for failed hip resurfacing procedures. Many case studies are described in the revision surgery chapter describing in detail the salvage procedure for many of the designs of prosthesis that any revision surgeon could relate to. At the end of this chapter and as a pull-out in the front of the book is a ‘follow-up hip resurfacing decision tree’ which sums up the examinations and investigations for the various failure scenarios that may occur.

Part 4 covers the failure modes in hip resurfacing and describes many case studies of failed procedures and their causes from the retrieved material. Part 5 describes the patient experience of hip resurfacing in five case studies ranging from dealing with having a revised hip resurfacing to one patient who had bilateral resurfacing procedures undertaken. All cases are anecdotal experience and give the reader a taste of the real-life experience of this very recent procedure.

Overall, this book is beautifully produced, with high-quality figures, and the publishers are to be congratulated on this. For the orthopaedic surgeon who wishes to consider undertaking hip resurfacing as part of his clinical workload, they would definitely benefit from the wealth of experience and the comparative data from the large range of designs available described in this book. For readers of this review, ‘Part 2: Clinical Follow-up’ could be a book on its own and has a considerable amount of up-to-date description of the use of various non-invasive modalities to evaluate not only hip resurfacing but hip pathologies in general.

Professor Julian Mims is a Consultant Clinical Scientist and holds an Honorary Chair in Medical Implant Design, Product Design Research (PDR) Centre at Cardiff Metropolitan University, UK.

THE HIP RESURFACING HANDBOOK: A PRACTICAL GUIDE FOR THE USE AND MANAGEMENT OF MODERN HIP RESURFACING

K. DE SMET, P. CAMPBELL, C. VAN DER STRAATEN (editors)

Publisher: Woodhead Publishing Ltd, Cambridge
Format: Hardback and online
Pages: 548
Price: £225
There has always been concern about the health risks of ionising radiation and, from time to time, reports on the subject have been issued by official bodies. This latest, published in March 2013, updates that produced by NRPB in 1999. It has been written by a group of 12 eminent scientists under the chairmanship of Professor A.M.R. Taylor of the University of Birmingham, UK.

The book starts with a non-technical foreword and introduction, which can be easily understood by laymen. There are explanations of radiation units and some scientific terms. Later chapters rapidly become complicated, but each is followed by very extensive lists of references, which will prove useful as further explanation for those requiring it.

Chapters 2 and 3 concern epidemiological studies, mostly from Japanese atomic bomb survivors, and clinical radio sensitivity. Chapter 4 deals with animal studies, mostly using mice.

Chapters 5 and 6 are, for me, where things get more interesting. Mechanisms contributing to radiosensitivity, showing that radiation leads to cell ageing, and the role of antioxidants in inflammatory processes, are well explained. Radiation workers and their susceptibility to cancer is analysed, as are familial cancers and predisposition to the effects of ionising radiation. There is much statistical data on such matters as the likelihood of cancer survivors developing further malignancies long after radiotherapy treatment. I did not know that survivors of childhood cancers who were treated with radiotherapy have a six-fold elevation of risk of a second cancer. Later chapters analyse risks and explain risk-benefit concerns and the ethics of the use of radiation.

These chapters lead to the conclusions of the final chapter with its recommendations. The first of these is, as expected, that work should continue in all areas. The increases in diagnostic exposures through CT, nuclear medicine and interventional cardiology make ALARA less easy to implement. Epidemiological studies of the effects of changing diets worldwide, and of house building in high radon areas need much further study. A further recommendation made, with implications for medical physicists, is that, at recruitment, radiation workers should be made aware of the connection between smoking and increased radio-sensitivity and cancer risk.

What I really miss with this book is an index, for which a comprehensive contents list is no substitute.

Professor Angela Newing is a retired Director of Medical Physics for Gloucestershire

**HUMAN RADIosenSITIVITY RCE-21**
**Publisher:** Health Protection Agency
**ISBN:** 978-0-85951-740-9
**Format:** e-book
**Pages:** 164

The chapters in the first half of the book give a detailed overview of SBRT. They are quite general though and I started to feel my initial pessimism was justified due to it being too vague and placing too much emphasis on certain technologies.

“Having the actual book would be preferable as it would give you more freedom to flick between chapters and cross-reference themes.”

However, it really comes into its own in the later chapters. Details are fleshed out in the site-specific chapters and much of the advice applies to technologies currently available to most centres. They give clear recommendations based on the clinical experience of the authors – it is the next best thing to visiting the departments and seeing how it is done in practice. That said, the authors are not entirely consistent with the level of information given; for example, the chapter on lung has whole sections dedicated to a discussion on IGRT, whereas the liver section just states that ‘some form of IGRT must be used’. Chapter topics include: SBRT history, technologies, treatment planning, radiobiology, immobilisation and margins. Due to the format of starting with general overviews and then becoming more specific later on, it does mean that there is some repetitiveness throughout. However, this is not necessarily a bad thing and suggests that the book has a long shelf life, with the first half being useful initially whilst the second half would continue to be referred to throughout future clinical practice.

The general style flows easily and I frequently found myself engrossed. The e-book format is not too unwieldy, although I found it quite easy to get lost despite the chapter index at the side. Having the actual book would be preferable as it would give you more freedom to flick between chapters and cross-reference themes.
Each chapter is packed full of up-to-date references – although this has worked against it somewhat because one of my main criticisms is that there are so many references squeezed into some of the paragraphs that it becomes impossible to read. I’d strongly suggest that in future they change the reference format to one which would be less disruptive to the body of the text.

Overall, despite my initial pessimism, I was very impressed with the level of detail and practical information, and I imagine it would be constantly referred to by all staff groups in a department performing SBRT – so make sure you budget for it in your SBRT business case!

**Keri Owen** is a Principal Clinical Scientist at the Medical Physics Department, Queen Alexandra Hospital, Portsmouth, UK

**STEREOTACTIC BODY RADIATION THERAPY**

**SIMON S. LO, BIN S. TEH, JIADE J. LU, TRACEY E. SCHEFTER** (editors)

**Publisher:** Springer

**ISBN:** 978-3-642-25604-2 (hardback) and 978-3-642-25605-9 (e-book)

**Format:** Hardback

**Pages:** 433

**Prices:** £215 (hardback) and £172 (e-book)

I have a copy of the *History of the Hospital Physicists’ Association* 1943–83 written for the 40th anniversary of the forerunner of our IPEM. A page is devoted to each of the founder members including Leonard Grimmett, and it praises his influence at the M.D. Anderson Hospital in Houston, Texas, to which he emigrated in 1949.

Peter Almond, himself a successor to Dr Grimmett in Houston, has written this interesting biography. He was assisted by Grimmett’s own meticulous note keeping and the fact that his secretary had kept her boss’s notebooks in a suitcase in her attic for 50 years.

While still in England, Grimmett had devoted much time to the investigation of more efficient and safer methods of treating cancer than x-rays, and he was part of the team which produced the ‘radium bomb’, a treatment head of tungsten alloy loaded with 5 grams of radium which was brought into contact with the affected part of the patient and a shutter opened to irradiate the area required. The machine was installed at the MRC Unit at Hammersmith Hospital, UK.

He describes Grimmett’s building of a physics team and the provision of a centre for the diagnosis and treatment of cancer.

The author says little about Grimmett’s work for UNESCO and UNO between 1944 and 1949, where, although suffering from radiation sickness, he did some excellent work. During this period Grimmett served on the HPA Council.

On learning that there were few radiotherapists, and even fewer medical physicists, in America he was persuaded by Dr Gilbert Fletcher, a radiologist from Houston, to go there to start a medical physics department. Dr Almond writes of Grimmett’s move and the lack of facilities which greeted him on arrival in 1949. He describes Grimmett’s building of a physics team and the provision of a centre for the diagnosis and treatment of cancer.

The Canadians and the Americans both had nuclear reactors producing quantities of cobalt-60, with a half life of 5.2 years and gamma ray energy of more than 1 MeV, as a byproduct. Grimmett saw this as a very good substitute for the more highly energetic radium. He designed and built a machine to contain 1,000 curies (37 TBq) of cobalt-60 which proved so successful that cobalt units became the staple for radiotherapy throughout the world. He did not live to see this as he died of a heart attack in May 1951.

I recommend this fascinating book as an addition to the history of medical physics and to give new physicists an idea of the earlier problems.

**Professor Angela Newing** is a retired Director of Medical Physics for Gloucestershire

**COBALT BLUES**

**PETER R. ALMOND**

**Publisher:** Springer

**ISBN:** 978-1-4614-4923-2 (hardback) and 978-1-4614-4924-9 (e-book)

**Format:** Hardback

**Pages:** 154

**Price:** £14.97

**Just Published!**

Gamma Knife Radiosurgery by Roman Licak (Nova Science Publishers Inc.) aims to give comprehensive information on the methods of gamma knife radiosurgery. It provides thorough technical description, basic physics principles, calibration, quality assurance and standardised treatment procedures. This textbook is aimed at physicians and will be helpful to medical physicists.

Handbook of Signal Processing Systems, 2nd edition by Shuvra S. Bhattacharyya, Ed F. Deprettere, Rainer Leupers and Jarno Takala (Springer) is organised in three parts. The first part motivates representative applications that drive and apply state-of-the-art methods for design and implementation of signal processing systems; the second part discusses architectures for implementing these applications, and the third part focuses on compilers and simulation tools, describes models of computation and their associated design tools and methodologies.

**Interstitial Prostate Brachytherapy** by Gyorgy Kovacs and Peter Hoskins (Springer) provides a comprehensive overview of innovations in LDR, HDR and PDR interstitial brachytherapy. All chapters have been written by internationally recognised experts who for more than a decade have formed
the teaching staff responsible for the successful GEC-ESTRO/EAU prostate brachytherapy teaching course.

4D Modeling and Estimation of Respiratory Motion for Radiation Therapy by Jan Elekharidt and Cristian Lorenz (Springer) illustrates the increasing role of image registration and motion estimation algorithms for the interpretation of complex 4D medical image sequences. Different 4D CT image acquisition techniques and conceptually different motion estimation algorithms are presented. The book is addressed to biomedical engineers, medical physicists, researchers and physicians working in the fields of medical image analysis, radiology and radiation therapy.

Targeted Muscle Reinnervation (TMR) by Todd A. Kuiken, Aimee E. SchultzFeuser and Ann K. Barlow (Taylor & Francis) provides a template for the clinical implementation of TMR and a resource for further research in this new area of science. After describing the basic scientific concepts and key principles underlying TMR, the book presents surgical approaches to transhumeral and shoulder disarticulation amputations. It also supplies the foundation to enable improvements in TMR techniques and advances in prosthetic technology.

Achieving the Rare by I-Juliana Christy (World Scientific Publishing Co. Pte Ltd) provides a biography of a fascinating physicist, whom Oppenheimer hailed as ‘one of the best in the world’. He was the co-creator of the world’s first nuclear reactor and the first atom bombs, of which the most practical design was called the ‘Christy Gadget’. Later, he became a leader in the effort to contain nuclear proliferation, leading up to the SALT talks, and headed a study on long-term health effects of radiation crucial for medical safety standards.

Biophysics of the Failing Heart by R. John Solaro and Jill C. Tardiff (Springer) describes biophysical techniques that have been applied to determine the triggers for the heart failure process as well as the mechanisms for sustaining the disorders. Biophysical concepts and approaches are also applied to the determination of signalling and signal transduction, energetics, ionic currents, transport processes, electrochemical and chemomechanical coupling.

Equipment in Anaesthesia and Critical Care by Daniel Aston, Angus Rivers and Asela Dharmadasa (Scion Publishing) specifically follows the syllabus published by the Royal College of Anaesthetists and is the perfect guide for candidates studying for their FRCA qualifications. The text is engaging and comprehensive, relating each piece of equipment back to its basic physics, mechanics and clinical context.

Biophysical techniques that have been applied to determine the triggers for the heart failure process as well as the mechanisms for sustaining the disorders. Biophysical concepts and approaches are also applied to the determination of signalling and signal transduction, energetics, ionic currents, transport processes, electrochemical and chemomechanical coupling.

The Electronic Nose: Artificial Olfaction Technology by Himanshu Patel (Springer) provides the basics of odour, odour analysis techniques, sensors used in odour analysis and an overview of odour measurement techniques. Students and researchers who want to learn the basics of biomedical engineering and sensor measurement technology will find this book useful.
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first met Lloyd Kemp when he employed me as a junior physicist in the Medical Physics Department of The (now Royal) London Hospital. His attention to detail, his need to trace experimental results back to fundamentals and his professionalism formed the framework for all of our work together.

Lloyd gained a first class honours degree in physics from King’s College London followed by a Postgraduate Diploma in Education from the Institute of Education. By then his Christian beliefs had led him to join the Peace Pledge Union. Surprisingly, his first job was at GEC in the Television Laboratory. When World War II broke out, GEC moved over to war work and Lloyd resigned from his job. He taught for a period at the Regent Street Polytechnic and in October 1940 he took his tribunal as a conscientious objector and was required to continue teaching (or land or ambulance work). After a while he taught at a grammar school in Bristol and then at Bradford Grammar School, putting his diploma to good use. While teaching there he became fired up by a biography of Marie Curie and arranged to do some voluntary work with a physicist at The (now Royal) London Hospital. In due course Lloyd was able to find a full-time job as a medical physicist at The (Royal) London Hospital in Whitechapel and he started work there in April 1944 under Dr Frank Read with the radiotherapist, Dr Frank Ellis. He published the first of his 43 scientific papers in October on ‘Linear radium source dose calculators’ – an analogue approach to dose computation that he had had ideas about when working in Bradford.

In 1946 Dr Read left to join the research team at Mount Vernon Hospital and Lloyd became Head of Department. By December that year he had already published seven scientific papers including his development of the ionisation current comparator – a precision method of comparing two currents of the order of 10⁻¹⁸ amp which allowed a more precise measurement of the isodose contours of a radiation beam. This was important because the current ratio approach eliminated the effects of the variation of beam intensity arising from poorly regulated power sources. Following this he developed an automatic isodose plotter which enabled the isodose contours to be plotted directly instead of being laboriously plotted by hand after the comparator’s measurements had been made. This work was written up into a thesis which gained him his doctorate. Lloyd records in his memoirs his amazement when he first set up the isodose plotter and saw it at work without human intervention – a feeling that I first had when I saw my first computer programs printing results ‘all by themselves’!

The unit of dose used at that time, the roentgen, was in error by about 3 per cent

Impressive results

The next part of the story was even more extraordinary as Lloyd’s experimental work began to show that the British standard implementation at the National Physical Laboratory of the unit of dose used at that time, the roentgen, was in error by about 3 per cent. Furthermore, since it had been compared with the US standard and found to agree to within 1 per cent, then the US standard was also, in error. This was subsequently proved to be in error by 2 per cent and the paper read at the British Institute of Radiology on these issues won him the Roentgen Award in 1953. When I arrived at The London Hospital in 1954, some hospitals were using ‘new roentgens’, some were using ‘old roentgens’ and some were not quite sure what they were using! It was an impressive result of 10 years’ work in a new field of science.

Overseas trip

The next effort, with the radiotherapist Dr Geoffrey Boden, was to acquire and commission a ‘cobalt unit’ to enable The London Hospital to deliver ‘super-voltage’ therapy. This involved a 6-week trip with Dr Boden across the Atlantic to visit hospitals using cobalt units and the Canadian Atomic Energy Establishment at Chalk River. As a Quaker at the height of the McCarthy era, he had great trouble with the American Embassy in getting a visa once the idea of radioactivity and a visit to Oak Ridge was mentioned, and the delays resulted in a change from the Cunard liner Parthia to flights on a BOAC Stratocruiser and removing Oak Ridge from the itinerary.

The equipment finally chosen was a Picker unit with the special ‘Johns Collimator’ using the isotope Co60 to deliver gamma rays of 1.17 and 1.33 MeV, thus ensuring that the build-up of absorbed dose is below the skin surface and thus reducing the problems of skin necrosis. This unit was the first one to be installed in the country and it was thought of as a ‘poor man’s’ linear accelerator. The automatic isodose plotter was fully employed in the process of measuring the characteristics of equipment before it could be put into clinical use. In retrospect, it is interesting that Boden and Kemp were allowed 6 weeks to explore the cobalt units in America whereas some 15 years later Barber and Abbott only had a week to explore computer systems for the hospital!

Following this work Lloyd developed the concept of a ‘guarded field ionisation chamber’ which enabled the collection volume of the ionisation chamber to be calculated precisely. Thereafter he
devoted himself to work in solid state electronics developing equipment for displaying the characteristic curves of transistors as well as a variety of specific pieces of equipment.

The next step in Lloyd’s career was his move to the National Physical Laboratory as Head of Medium and Low Energy Dosimetry. At an early stage he decided that there would be advantages in having the caps of ionisation chambers made out of solid graphite rather than convenient but somewhat unstable plastic, and thereafter secondary standards, worldwide, were constructed in this fashion and proved remarkably stable over many years. As time went on it was realised that radiation should be measured in terms of the more fundamental concept of absorbed dose (grays – energy deposited per unit mass) rather than electric charge released in air (roentgens – electric charge released in a standard volume of air). This required a major change in physical measurement from small electric charges to small temperature rises – it required a micro-calorimeter and the delights of Laplace transforms to develop the NPL standard for the new era of absorbed dose measurement.

As an experimental physicist, Lloyd was always working things out in his head as the experiment progressed – and I would only discover what he was worrying about later when I worked out the detailed calculations. After each setback in the experiments he would bounce back the next morning with the words ‘I have been thinking about it overnight and this is what we should do now’. Lloyd was one of the outstanding medical physicists of the twentieth century – and a great credit to professional standards of The London Hospital and the National Physical Laboratory during that period. This credit was recognised in the award of an OBE in 1976 for his 33 years’ work in radiation dosimetry.

Personal life
He could have been a professional musician, a painter, a poet or a philosopher quite as well as a medical physicist, but I was fortunate in that he chose physics and trained this theoretical physicist in the requirements of the serious experimental work needed to treat patients at The London Hospital.

Throughout his life the arts were important to Lloyd, more as a contributor than a spectator (though his fine CD collection gave him great pleasure). He had played the double bass in a school orchestra, and later piano and ‘cello. He had studied composition with the late Eric Thiman, writing songs and chamber music for his family and friends. Some of his guitar music (for his son John) was published. He painted in all media, latterly mainly soft pastels, chiefly landscapes and portraits. In retirement he became a radio amateur (G4DXL), in the years before the Internet, to communicate with his friend Bruce in Australia.

Throughout his life Lloyd had written occasional poems, and this interest blossomed and took over from painting as his sight deteriorated, publishing several books of poetry and a 400-page memoir, Science isn’t Everything: Memoirs of a Scientist. There is also an unpublished novel. At the age of 97, he purchased a replacement computer (with an extended warranty to take him into his second century!), much to the surprise of the Dell salesman who had never sold a computer to such an elderly person before.

Despite the brilliance of his professional work Lloyd’s life included the tragedy of his wife Mary’s early stroke in 1968 and death in 1988, and the equally untimely death of his second son Roger (an architect) in 2005. In addition, his pace of work brought on two breakdowns, from each of which he returned to professional triumphs. He had a strong Christian and Quaker faith, with a very deep and thoughtful personal theology, which helped him overcome the many tragedies of his life, and he was always asking the question ‘Why?’ in his personal life as much as in his professional life. He is survived by his son, John, an organic chemist in the pharmaceutical industry and his daughter Rosemary, a flautist and music teacher, and Wendy and Catherine, his daughters-in-law – all now themselves retired. He is also survived by six grandchildren and nine great-grandchildren.
Ray Pope
A tribute to an international medical physicist

John Fleming, David Carpenter, Alan McKenzie and Stuart Smith

It was with sadness that the Department of Medical Physics and Bioengineering in Southampton heard of the death of Dr Ray Pope in April 2013 at the age of 77. Ray had pursued a career in medical physics, making important contributions to hospitals in three different continents, but with most of his time being spent in Southampton.

He was born in Enfield and spent his formative years in that area of north London before leaving to study physics at Bristol University. After graduating in 1958, he stayed on in Bristol to take a postgraduate course in medical physics organised by the head of the Bristol department, Dr Herbert Freundlich – this was long before the advent of any formal training scheme in medical physics. During the summer break before starting work he drove a group of students to Istanbul encountering many adventures along the way.

In 1959 he was appointed as a basic grade physicist in the Department of Medical Physics at Addenbrooke’s Hospital under Dr John Haybittle. In that year he also joined the Hospital Physicists’ Association, the forerunner of what is now IPEM. In 1962, still at Cambridge, he signed up to study for a PhD under the legendary Joseph Mitchell, Regius Professor of Physics at Cambridge University. He worked on the use of whole body counting in health and disease, obtaining his degree in 1965. Following this he stayed on in Cambridge with Professor Mitchell in the Department of Radiotherapeutics, working as a postdoctoral research assistant. His time at Cambridge was also memorable in that working in the medical field gave him the opportunity to meet up with some of the nurses at the hospital. One in particular who caught his eye was Pat who was over in the UK from Australia. Their relationship blossomed via meetings on the tennis court and they were married in 1962.

Ray had already shown his penchant for travel and marrying an Australian gave him the opportunity to carry on in medical physics abroad, gaining a post at the Royal Melbourne Hospital where he was also able to broaden his experience to cover the growing field of nuclear medicine. However, travel was still in his system and in 1968 he left for New York to take up the post of Assistant Attending Physicist back in radiotherapy with John Laughlin at the Sloane Kettering Institute. The journey with two young children was particularly memorable, leaving the summer heat of Melbourne to arrive in New York with sub-zero temperatures. The Institute provided them with accommodation in Manhattan, within walking distance of Central Park, where they spent many happy hours with their sons. Whilst working there he was also appointed Assistant Professor of Radiology (Physics) at Cornell University.

Settling down

After 2 years in New York the family were on the move again for what would be their last big upheaval, back to the UK to the newly formed Department of Nuclear Medicine at Southampton General Hospital, as senior physicist under Tony Goddard and Dr Duncan Ackery, one of the first appointments in the UK as a specialist consultant in nuclear medicine. It gave him the opportunity to work on an early gamma camera, manufactured here in the UK by Nuclear Enterprises. He worked there until 1975 when his expertise in radiotherapy was needed at the Royal South Hants Hospital where he remained until his retirement in 1997, being appointed Head of Radiotherapy Physics Services in 1982.

Under Ray’s leadership, radiotherapy in Southampton flourished. As well as being the head of the physics team, he was also a helpful ‘hands-on’ physicist who was well liked and respected in the department. Ray managed the transition from cobalt treatment to linac therapy seamlessly and safely and his calculations set the standard for upgrading cobalt bunkers to linac rooms. He would often check routine dose calculations himself and long before the infamous multiple-patient accidents in two UK hospitals that were to change the culture of radiotherapy safety in the UK and worldwide, Ray had antennae for the potential for dosimetric error. A slightly lower-than-expected output from a cobalt machine after a source change prompted him to take an x-ray film of the beam – certainly not routine practice with cobalt machines in those days. The film showed that the source had not been replaced in the correct position; Ray’s instinct had saved hundreds of patients from being wrongly treated on that machine.

In addition to his radiotherapy work, Ray was Radiation Protection Advisor and also involved with teaching radiographers. He was an active member of the Institute, being part of the Industrial Liaison Group between 1985 and 1992 and serving as Chairman between 1988 and 1992.

He is remembered fondly by his colleagues in Southampton. He was a real gentleman who was always calm and courteous but who also had a wonderful sense of humour. He was always willing to spend time with people discussing issues, giving valuable insight from his expertise and experience.

Outside of medical physics, Ray was happily married to Pat for over 50 years and was a dedicated family man with two sons, Richard and Gordon, and five grandchildren. He also had an interest in watersports, particularly canoeing and sailing, and so was well placed in Southampton to pursue these hobbies. He read widely, played chess and was an accomplished pianist and artist.

After this active and fulfilling life, Ray sadly developed Alzheimer’s dementia, finally passing away earlier this year. Our thoughts are with his wife Pat and the rest of his family.
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