

The background features a dark field with vibrant, multi-colored light trails in shades of blue, green, red, and purple, creating a sense of motion and energy. A semi-transparent grid pattern is overlaid on the scene, adding a technical or digital aesthetic. The overall composition is dynamic and modern.

# IMAGING & ONCOLOGY

For imaging and therapy professionals

2009

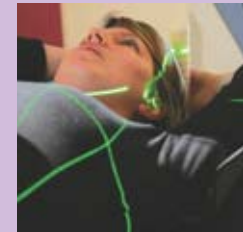
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# IMAGING & ONCOLOGY

## 2009

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### Imaging & Oncology is looking for a new editor for 2010

Imaging & Oncology is celebrating edition five this year and, having held the reins as managing editor for the past five years, Professor Audrey Paterson is stepping down. She says, 'It's been immensely rewarding and I'm very grateful indeed to all those who have contributed over the past five years but it's time for some fresh ideas and thinking to take it forward.'

If you would relish the challenge of producing at least the next two volumes of Imaging & Oncology (2010 and 2011), then please do get in touch with Audrey (020 7740 7208 or [audreyp@sor.org](mailto:audreyp@sor.org)); the appointment is an honorary one and, at this stage, informal expressions of interest are being sought from imaging and oncology professionals.

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# Foreword

## Welcome to the 2009 edition of Imaging & Oncology

Launched at UKRC in 2005, this annual publication has become an integral part of the Society and College of Radiographers publications' portfolio.

Widely acclaimed in previous years for the quality of its content, Imaging & Oncology 2009 once again sets the bar at a high level. This year's offering covers a range of topics and provides some insight into the way the various professions in clinical imaging, radiotherapy and oncology are challenging conventional thinking.

The current momentous economic events have brought into stark focus the many challenges the professions face in providing high quality services for patients. How in these challenging times, we ask, can we sustain and develop the excellent services the public deserves? Certainly, money will become ever tighter but that is no reason to step back from service development.

On the contrary, it is a compelling reason to push forward with new developments and new ways of working; to embrace change and to take on new and demanding roles that will deliver cost

effective, high quality care for patients.

Regardless of how the roles of professionals in clinical imaging, radiotherapy and oncology change in the future (and change they surely must), quality, safety and effectiveness of care must become ever more central to what we do; this centrality must be and feel real to patients, their families and carers and, of course, to medical and non-medical colleagues who refer those patients into our care.

I think there is something for everyone in Imaging and Oncology 2009. I hope you enjoy reading it - and find something thought provoking (or annoying, irritating, or outrageous) within its pages.



**Michael Graveling**  
**President**  
**The Society and College of Radiographers**





A photograph of a stone wall made of dark, irregular stones. On the left side, there is a colorful, abstract object with a gradient of colors from red to blue, with some white lines and a bright light effect. The object appears to be a piece of fabric or a small sculpture.

# Demystifying the role of the consultant therapy radiographer

Natalie Howes

## Introduction

There is now an increasing amount of literature about what constitutes consultant practice in radiography, and the debates that surround implementation of a '4-tier' staffing model in radiotherapy. This article aims to bring together external and personal perspectives of consultant radiographic practice within oncology services in the United Kingdom (UK).

The UK National Health Service (NHS) is one of the largest organisations in the world, with ever increasing demands and expectations of its employees and patients<sup>1</sup>. Recent years have seen improvements in patients' experience of care, but more must be done to empower patients through their cancer journey<sup>2</sup>. A major driver in cancer service developments is the delivery of a personalised service for people with cancer<sup>3</sup>. Historically, research into cancer has tended to focus on the clinical aspects, albeit essential, of causation and treatment rather than the processes of care in general, or healthcare professionals' patterns of working in particular<sup>4</sup>. In the UK, considerable work has taken place and is ongoing to determine the future of cancer service provision. Areas under scrutiny are prevention, diagnostics, treatment and care continuation, as well as the changes required within the UK cancer workforce.

The main instigating factor for setting up new roles and ways of working was, undoubtedly, the NHS Plan and the NHS Cancer Plan published in 2000. A key driver for the introduction of consultant radiographic posts was the need to retain clinical expertise and professional leadership in the NHS, a growing need to improve career prospects, to properly recognise and reward new and expanding roles and, most importantly, develop new ways of working to improve patient care<sup>5</sup>. Major shifts in the way radiotherapy delivery is organised need to occur, and new ways of working need to be introduced to bring about more efficient working systems and practices<sup>6</sup>.

## Consultant therapeutic radiography practice – the UK scene

The title of consultant allied health professional (AHP) or therapy consultant was introduced in 2001 and supported by Department of Health guidance<sup>7</sup>. Kelly et al reported 31 consultant radiographer posts in the UK<sup>8</sup>, and two consultant trainee posts towards the end of 2008. Five of these consultant posts are in radiotherapy and oncology services, with one of the trainee posts also in radiotherapy and oncology. The numbers speak for themselves and warrant further investigation into therapeutic radiography consultant practice provision at national level. Constituted in 2006, the UK consultant radiographer group 'provides leadership in the development of and support for the consultant radiographer role'. The group meet biannually and sets key objectives and yearly targets to ensure that consultant practice in radiography

# Major shifts in the way radiotherapy delivery is organised need to occur

is continually promoted and maintained at all levels. Beneficial aspects of this are raising the profile of consultant radiographers across the profession; raising the profile of the radiographic profession across the broader healthcare team; promoting links with other professional bodies and national forums; providing a communication link and advice resource for members; and providing a link with the Society and College of Radiographers' research group to assist in progressing research into practice<sup>9</sup>.

A question that seems to be in many minds is: 'what does a consultant therapeutic radiographer do?' It is stressed that consultant practitioners do not exist to simply substitute for medical colleagues when needed, or to be purely responsible for a specific patient caseload. The changing face of radiotherapy and healthcare as a whole demands roles to be much more diverse than that. Essentially, the nature of consultant radiographic practice in radiotherapy has many manifestations and possibilities, advantageous to most clinical settings. It has been stated that a consultant radiographer is not beholden to a consultant oncologist but will create partnerships with a vast range of clinicians including medical and non-medical consultants<sup>10</sup>.

Diversity of roles is essential to meet the demands of increasingly diverse UK oncology services. It is encouraging to see this diversity in the small number of consultant therapeutic radiographer posts that have been established to date in the UK. These include:

- palliative radiotherapy for patients within the lung cancer pathway;
- a Macmillan post encompassing complete pathway care for gynaecological patients;
- an oncology service improvement/modernisation post responsible for radiotherapy technique and technical developments;
- a consultant practitioner specialising in neuro-oncology and developing radiographer led pathways; and,
- another radiotherapy service development post with an additional specialism of working with the head and neck team.

These brief descriptions cannot possibly demonstrate the impact that each post brings to their respective centres but, undoubtedly, all have been instrumental in bringing improvements to patient pathway experiences and outcomes, as well as oncology service developments.

The National Radiotherapy Advisory Group (NRAG) report<sup>11</sup>, published in 2007, has, at least potentially, improved the prospect for the creation of further consultant radiographer posts within radiotherapy and oncology, and general role development opportunities are increasing. The NRAG report recognises the impact of consultant roles in post as follows:



## What does a consultant therapeutic radiographer do?

*"...Where these roles [consultant therapeutic radiographers] have been introduced they have demonstrated the potential to drive efficiency, reduce waiting times and refocus radiotherapy services around the needs of the patients"*

### Consultant qualities and associated benefits

It is now well documented that at the heart of consultant practice are four core functions, or behaviours, together with the duty of bringing strategic direction, innovation and influence<sup>12</sup> to the role. The four core functions are expert practice; clinical and professional leadership; education and training; service development and research.

There must, of course, be evidence in every post that the core functions of consultant practice are being fulfilled, and all functions are of high significance. However, leadership qualities and the ability to form meaningful interprofessional relationships are vitally important; without this ability individuals are unlikely to make 'good' consultants. Leadership is not simply about organisation or position power<sup>13</sup>. It is also about behaviour; consultant radiographers must be excellent role models, motivators, decisive and influential. As Greenwood-Haigh<sup>14</sup> stated: "consultant radiographers must be self-motivated, self-directive, innovative, willing to challenge and pushy". To this can also be added the need for peace negotiation skills, broad shoulders, and perseverance as essential pre-requisites for consultant radiographic practice.

For all consultant radiographers, each day presents new challenges and problems that can be transformed into new opportunities. The often stressful and sometimes isolated nature of the job is far outweighed by the benefits it brings. There is the honour of working with fantastic teams, patients and carers; being influential at the forefront of technology; pushing the normal professional boundaries, and making new alliances with a multitude of disciplines. From the definition of consultant practice alone, it is readily apparent that teamwork is critical for the delivery of high quality healthcare. No one healthcare professional can know everything or do everything needed by an individual cancer patient<sup>15</sup>. Working in teams makes a critical contribution to the delivery of effective and innovative patient care<sup>16-18</sup>. The importance of team work is ever increasing as the delivery of patient care, particularly oncology care, becomes progressively more complex, requiring interactions that involve staff, technology and medication<sup>19</sup>. It is increasingly apparent, too, that future improvements will depend ever more on the ability to encourage excellent teamwork and effective communication across the spectrum of the clinical care provision<sup>20</sup>. Healthcare professionals must collaborate and co-ordinate their activities to ensure the delivery of safe and efficient services. Consultant led, team based collaboration in a multidisciplinary and multi-professional way offers opportunities to integrate and share knowledge, practice and experience<sup>21</sup>.

Consultant radiographic practice brings autonomy and, most importantly, the time to initiate and drive developments and change. As an entity, consultancy encompasses the provision of advice to other healthcare colleagues, including medical staff; providing direction to service and clinical developments; external evaluations, and the contribution to strategic organisational decisions<sup>22</sup>. It also requires not insignificant elements of political awareness and, ultimately, political tact to set direction and so shape the future with a shared vision.

Law<sup>23</sup> suggests that allied health professional consultant practice may be considered, "the ultimate accolade associated with role development".

While this may be true, holding a consultant title should not be associated with self-glorification. Consultants must be transformational and effective leaders, and as such, should be happy to share the limelight of success, or step back from it themselves, working in the background and facilitating others in leading roles<sup>13</sup>.

Paterson<sup>24</sup> quite rightly points out: "Consultant radiographers have no inherent right of existence. Rather, they have a responsibility to demonstrate that they add value to healthcare delivery and to patients."

This statement cannot be emphasised enough. Consultant practitioners' obligations and responsibilities go far beyond their job titles. They must be influential in leading the way to constant review and improvement of the radiotherapy and oncology services, ensuring seamless care pathways and much improved patient experiences and outcomes; and, after all, the title is not protected currently so every opportunity should be seized to prove its value and worth.

### Does one size fit all?

Radiographers in the UK have been encouraged to expand and develop their roles to meet service needs<sup>25</sup>. There needs to be careful 'tailoring' of roles around the needs of service, this being a rigorous process in itself. They should be shaped to complement a service, creating one that is truly patient centred. Paterson<sup>24</sup> has warned recently of the potential danger that the current consultant posts are local solutions to local problems. This was also highlighted by Law<sup>23</sup> who suggested that, due to the diverse nature of roles undertaken by the relatively few consultant radiographers, posts may remain local appointments fulfilling local needs only. There is validity in the arguments of Paterson and Law but there is nothing inherently wrong in this local approach and provision, particularly if the development of consultant posts and job descriptions respond to a particular identified service needs<sup>12</sup>. Recent research has shown that many radiography consultants and managers believe the best way for these posts to be developed is customisation around the needs of each site according to their differing





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requirements<sup>26</sup>. A 'one size fits all' approach would be naïve, but it is important that the potential of a consultant radiographer appointment and the value such a post may bring to any service development, or improvement to a patient pathway, should be explored seriously.

### What does the future hold?

Consultant radiographers have developed a united vision<sup>27</sup>: "Pushing back the boundaries of conventional thinking to create the service of the future"

Whether or not the existence of consultant radiographers is supported, there is no doubt that the existing posts are paramount in influencing the cancer patient's care pathway and experience. Historical factors, professional prejudices and individual preferences should be cast aside to give new ways of working much greater consideration and attention; the traditional mindsets of hierarchy and professional boundary need to be challenged. If service delivery can be improved by crossing professional boundaries, role demarcation should not be an issue<sup>23</sup>. Consultant radiographer posts are not there to threaten existing ones but to complement and enhance services; they bring the added benefit of new team structures and multiprofessional working and collaborative practice. Price & Edwards<sup>10</sup> believe the vision of a consultant led radiography profession will become a reality. The debate surrounding the future management of oncology services continues, with discussions on manager or consultant led services. The 'or' should become redundant; these two roles have great value in their own right and a place for both should be incorporated in all plans for the future of oncology services provision. Greater partnership working will be essential for delivering UK oncology services in the future and this must be dynamic and innovative if cancer patients are to receive the care they require. A key message<sup>6</sup>, therefore, is 'collaboration, not competition'.

It has been highlighted that the strategic role of the consultant practitioner seems to be under-developed at present, reducing the potential to improve patient experience and increase knowledge about radiotherapy in the wider community<sup>28</sup>. Ultimately, there is a vital need to increase the number of consultant radiographers in post and evidence the nature of those posts<sup>24</sup>. Great professional and practice advancements have been made in radiotherapy in recent years, and this must continue. The development of consultant roles is undoubtedly one of the major advancements. For the therapeutic radiography profession it is acknowledgement, finally, of the contribution that radiographers can make to modernisation of oncology services and also the NHS as a whole. There are complex yet exciting times ahead for UK oncology services and, with the Cancer Reform Strategy and NRAG recommendations in mind, therapeutic radiographers have the opportunity and the ability to drive change<sup>29</sup> that will be beneficial to cancer patients. The question still remains, however, why are radiographers not wholly embracing this opportunity?

## Role development opportunities are increasing

**Natalie Howes is a consultant radiographer at the Northamptonshire Centre for Oncology.**

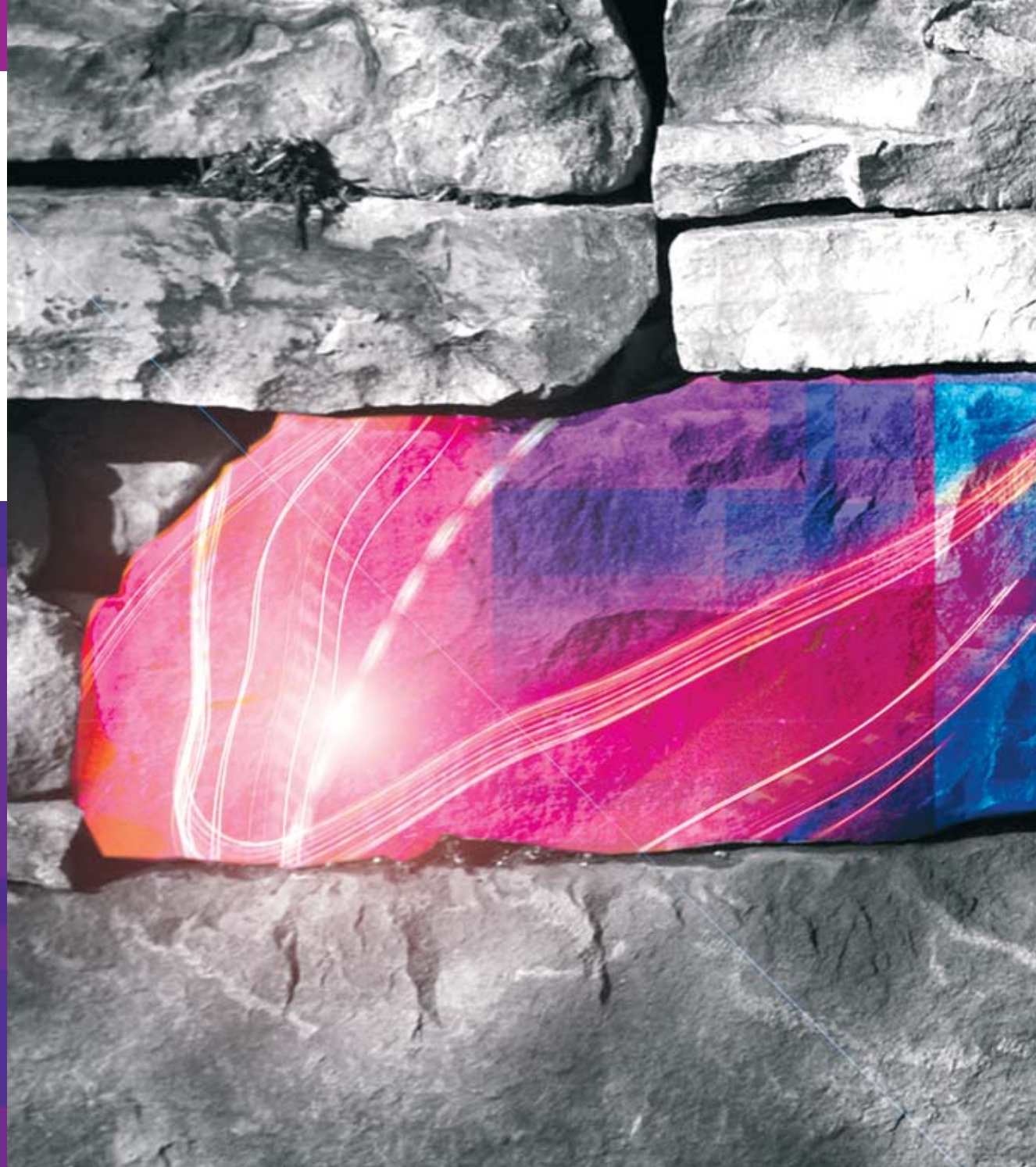
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**Peace negotiation skills, broad  
shoulders, and perseverance are  
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# A risky business: implementing emerging technologies into radiotherapy

Donna Routsis



## Introduction

Radiotherapy in the United Kingdom (UK) is lagging behind the rest of the world. A recent article entitled 'Cancer patients missing out on best treatment because of cost' stated that only seven per cent of UK patients were getting care that was commonplace in the United States and Europe<sup>1</sup>; the reason given was that "the NHS is struggling to invest in staff and technology". In this particular report the technology in question was intensity modulated radiotherapy (IMRT) but the same statement could be made about many others, including image guided radiotherapy<sup>2</sup> (IGRT) and proton therapy. The primary cause given for this gap in access to advanced care is the lack of investment in, and slow adoption of, emerging technologies in the UK compared to North America and Western Europe.

Delays in developments are not a new phenomenon. Historically, the UK has been a slow adopter of new technologies in radiotherapy as shown by the take up of technologies such as electronic portal imagers and multi-leaf collimators – years behind the US. Why is this? Why is the UK particularly slow at implementing emerging technologies? And are there strategies that would improve the rate of implementation and uptake?

## Safety first?

The UK radiotherapy community has a reputation for providing good quality evidence for new procedures, and is amongst the world leaders in the production of evidence. The community thinks and checks first, and there is a culture of playing safe and waiting for proof of effectiveness. This risk aversion translates into poor investment in technology; with competition for National Health Service (NHS) funds, purchasers prefer to have evidence of cost-effectiveness or value for money before committing to new technologies. But this practice may well be contributing to the gap in provision of advanced practice.

Whilst the UK spends time waiting for 'best evidence', those that risk the uncertainty of early adoption of new technologies are able to offer advanced, if not totally proven, treatments to their patients. This is not necessarily bad as, for certain technologies, the concept behind the technology is so robust that the risk of using it is minimal. Indeed, the greater risk may be to withhold the intervention. The question, therefore, is about whether the UK is right to wait for technologies to be validated, or could more patients benefit by increasing the speed at which developments are taken up?

## Risk/benefit balance

Recent reviews of cancer services<sup>3,4</sup> have deemed that the balance needs addressing; that the UK should, perhaps, implement emerging technologies more quickly. Currently, there are many initiatives aimed at increasing speed of technological adoption<sup>5,6</sup> but there appear to be difficulties in the way decisions are

made about when technologies are ready to be adopted.

The conventional measure of risk has been to assume that the randomised controlled trial (RCT) is the gold standard against which decisions about likely effectiveness of interventions should be assessed. In radiotherapy, full evidence of effectiveness is not gained for many years post intervention; and the overall risk to the population of withholding a potentially beneficial intervention is not factored in. Is a new measure needed, therefore; one by which the risk/benefit balance can be determined for emerging technologies? And if so, what measure could be used?

This problem isn't unique to radiotherapy. Rather, it is common in other technology based practices and radiotherapy may have something to learn from some of these.

## What does radiotherapy really want?

Initial consideration of the question 'what does radiotherapy really want?' leads to another – what are the fundamental purposes of radiotherapy provision and services? While that may appear a big question at first blush, it helps to clarify and focus on the end points. This is important given that the effort and resources deployed in radiotherapy, including new technologies, are paid for by taxpayers who, without necessarily having detailed understandings of how the end points may be achieved, certainly expect to obtain some benefit from their contributions.

This somewhat unfocussed taxpayer expectation of 'some benefit' is crystallised by various standing committees<sup>7</sup> that are tasked with setting out clear objectives for radiotherapy services<sup>8</sup> – in other words, to turn a rather generalised expectation on the part of the taxpayer into a set of specific objectives and strategies for delivery.

Review of the various policy documents that have been issued shows clearly that the prime expectation of taxpayers is a service that addresses their cancer problems quickly and effectively. Both of these terms are, of course, relative: quickly implies faster than previously, and effectively means with improved success/survival rates.

Acceptable success rates are nearly always under ever-upward pressure; society seems to expect both a better job in terms of delivering on the existing list of cancer treatments, and the continual addition of new treatments to that list. These dual pressures inevitably force the radiotherapy community to constantly seek new ways to deliver yet more from within existing resources, whether measured in human terms or in strictly financial ones. Inevitably, in this quest, there is an expectation that new technologies can play a part in satisfying ever-increasing demand in a resource limited environment.

Radiotherapy is not alone in facing pressures for ever-improving results from a fixed (or even contracting) resource base. Historically, technology development

.....  
**The current  
system is very  
'safe' but it is  
too slow**  
.....



.....

## It cannot risk adopting technology that proves to be fundamentally flawed

.....

has been one of the biggest contributors to meeting these expectations as new processes, physical resources and generally reducing unit costs have been delivered by the technological industries. Arguably, the greatest manifestation of this in recent years has been the development of knowledge management and data processing – both utterly dependent on, and driven by, the pace of development of the disciplines loosely referred to as the computer sciences. The rate of change in this sector was characterised by Gordon Moore in 1965. He observed that the number of transistors that could be placed inexpensively on a silicon die would double approximately every two years. This observation has proved remarkably accurate and is now a ‘law’ named after the Intel co-founder. The significance of this law is that it defines the rate of growth of the underlying processing power of the micro-processors that have become so ubiquitous and, hence, the rate of development of many current technologies.

Countering the pressure for rapid process change is a natural (and wholly proper) conservatism – after all, no-one wants to deploy technologies or practices that may have unexpected and unwelcome side effects. Adherence to the need for RCTs has been the defence against rapid process change on the basis that this robust scientific process ‘guarantees’ that a new process delivers the expected benefits without undue or unexpected adverse side effects.

Here then, lies the first clue as to why radiotherapy may be struggling to get to grips with deploying new technologies: the goalposts are always moving; the rate of technological development is high, but validation processes are such that by the time there is certainty that a new technique or process is robust, so much time has elapsed (up to 20 years in extreme cases) that many interim developments have been missed. There is also the risk of ‘paralysis by analysis’: a new development is identified, trials are undertaken, then the decision to deploy is made. By that point, the technological base has moved on so far that the technology deemed ‘safe’ to deploy is out-of-date or, worse, obsolete. The pressures to start again and assess the newest, latest technology without deploying the now out-of-date option are often irresistible (in particular, if this point in time coincides with a low point in the capital expenditure cycle). The end result can be a near endless assessment and validation cycle that fails to provide general access to the ‘better treatment facilities’ expected by weary taxpayers.

The second clue that radiotherapy is struggling to deploy new technologies may be found by considering the spread of radiotherapy research work undertaken by various centres in the UK. This ranges from fundamental research into new technologies and processes such as carbon ion therapy, to applied research that is focussed strongly on the development of efficient delivery methodologies, for example, how best to use IGRT. Undoubtedly, all are very well-intentioned research studies aspiring to improve the lot of the patients. However, a clear understanding

of exactly how the research will lead to this outcome is, sadly, nowhere near as common. Research programmes that fall into the category of fundamental research are often accompanied by a defence of ‘increased knowledge’ in the belief that this alone is sufficient justification for the programme.

Here, then, is the nub of the problem. Underpinning technology is moving on at a rate that out-strips the validation processes. This has given rise to a number of research initiatives within the NHS that are ‘scatter-gun’ in their scope. In turn, this has stemmed from the fact that there is no general understanding of the overall technology strategy. This combination of circumstances raises the real risk that radiotherapy will fall short in its duty of care to deliver the most effective and practicable treatment technology and processes that may be available to its supporting taxpayers.

Sanctioning research programmes that do not have robust linkages between the output of the work and improved patient care, exacerbates this risk. If the argument above is accepted, it is clear that a much greater understanding of the technology road-map must be developed, and the approach to technology validation must be modified so that the validation process has a time-cycle better matched to the underlying technology development cycles.

### Viewing things differently

Useful insights can be gleaned from considering others that have faced similar problems; what have they done to address the problem, and can their approach read across to radiotherapy to a greater or lesser extent?

The ‘problem’ radiotherapy faces could be characterised as the need to speed up the adoption of relevant, new technologies while avoiding dreadful technology selection mistakes. The current system is very ‘safe’ but it is too slow. It also has a second order effect in that it drives a fragmented research effort that is poorly co-ordinated with industry and academia.

One organisation that has faced a very similar problem is the UK Ministry of Defence (MoD). This entity is under clear pressure to adopt new technology early if it offers material benefit over that in use by opposing forces. Equally, it cannot risk adopting new technology that proves to be fundamentally flawed.

The MoD’s approach to the problem has been to formalise the common steps through which any new technology evolves – from the first spark of intuition from an inventor, through to the state when it is fully proven, understood, and in general use. This model is referred to as the ‘technology readiness levels’<sup>9</sup> (TRL), and reduces the problem to a set of nine non-dimensional numbers that refer to the readiness state: One is at the ‘spark of genius’ stage, while nine is



allocated to a technology that has been properly proven. The thinking is that risk of deployment is highest at TRL 1, and lowest at TRL 9. The formal definitions are in Figure 1.

<b>TRL 1</b>	Basic principles observed and reported.
<b>TRL 2</b>	Technology concept and/or application formulated.
<b>TRL 3</b>	Analytical and experimental critical function and/or characteristic proof-of-concept.
<b>TRL 4</b>	Technology component and/or basic technology subsystem validation in a laboratory environment.
<b>TRL 5</b>	Technology component and/or basic technology subsystem validation in a relevant environment.
<b>TRL 6</b>	Technology system/subsystem model or prototype demonstration in a relevant environment.
<b>TRL 7</b>	Technology system prototype demonstration in an operational environment.
<b>TRL 8</b>	Actual Technology system completed and qualified through test and demonstration.
<b>TRL 9</b>	Actual Technology system qualified through successful mission operations.

Figure 1.

There are formal processes to assess the TRL of any given technology to ensure a degree of uniformity in the categorisation of quite diverse subject technologies. The result of these categorisations, apart from formalising risk, drives both procurement decisions and decisions as to the type of organisation that should undertake the assessment work. While there are, of course, always some exceptions, TRL 1 to TRL 4 are generally delegated to academia, TRL 5 to 7 sit with key suppliers, and TRL 8 and 9 is where it gets to the 'sharp end'.

This approach allows informed decisions about the risks of early deployment to be taken without the need to validate all technologies before deployment. If a technology has significant operational benefits and has reached TRL 6 (for example) a deployment decision may be taken in advance of the completion of steps 7 to 9.

Radiotherapy would be well advised to take this basic model and develop and refine it to suit its own purposes. The benefits that could flow from such an approach would be:

- A formalised methodology to assess the relative risk of purchasing technology offerings from competing vendors (who will always present their goods in the best possible light);

- A quantitative method for assessing the risk/benefit of introducing new technology earlier than would be the case currently;
- A framework against which requests for research programme funding can be assessed to understand where in the technology development cycle the programme would fit.

### Summary

Development of an evaluation methodology similar to that used by the MoD would, without doubt, consume some resource in the near-term. Nevertheless, it would be money well spent as a robust framework would become available against which the risks associated with the adoption of new technology could be assessed, together with the benefits promised. It would also provide a framework against which research activity can be positioned, and to properly co-ordinate this with academia and industry.

In the final count, if radiotherapy succeeds in co-ordinating its efforts in this manner, it will have taken a great step forward in ensuring that it discharges its responsibilities to its 'owners'. Patients can be assured that they are being offered the best available technology at an acceptable level of risk. Effectively, the radiotherapy professions will be in control of the deployment of new technology, and the current problem of being controlled by, or overtaken by, new developments will become a thing of the past.

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Prime expectation is addressing cancer problems quickly and effectively



# Implementation of an immersive virtual reality training system for radiotherapy: early lessons and insights

Rob Appleyard and Louise Coleman





## Introduction and background

The National Radiotherapy Advisory Group (NRAG) report to the United Kingdom (UK) Government in 2007<sup>1</sup> identified a potential crisis in England in relation to radiotherapy education and training, with a need to reduce urgently the attrition rate of student therapeutic radiographers. The report recommended the introduction of hybrid virtual environment skills training facilities across the 10 radiotherapy higher education providers in England and 51 associated clinical sites. These facilities would aim to improve retention through enhancing the student learning experience and providing learners with the opportunity to develop knowledge and skills in an engaging and 'safe' environment without further impacting on already stretched clinical resources.

A suitable virtual reality platform was readily available – the Virtual Environment for Radiotherapy Training (VERT) system – utilising immersive visualisation technology and software developed by Vertual Ltd<sup>2</sup>. The VERT system provides a life sized virtual radiotherapy treatment room and allows the user to interact with the virtual room, control the equipment and set up radiation treatments as if in the real world.

In response to the NRAG recommendation, the Department of Health and Cancer Action Team made £5 million available to fund:

- the purchase of the VERT software and the necessary associated hardware;
- refurbishment costs to support installation; and,
- an 18 month project to manage the implementation of the VERT technology and assess its impact.

The VERT project commenced in April 2008, ends in October 2009, and is being led by the Society and College of Radiographers. It aims to assess the potential use of the technology and its effect on the student experience; the impact upon curricula, and the impact upon student recruitment and retention. Figure 1 illustrates the focus of the desired project outcomes. Figure 2 provides an overview of how the project structure is developing.

This paper will, first, review the VERT system and the rationale for its use. It will then report on how VERT has been implemented to date. Finally, it will discuss the early insights being gained in terms of the use of VERT for radiotherapy education and training.

## The VERT system and a rationale for its use

### The technology

The VERT system and its functionality has been fully described elsewhere<sup>2-4</sup> but, essentially, it comprises high resolution stereoscopic projection on to a large screen, providing a realistic virtual environment of a radiotherapy treatment room.

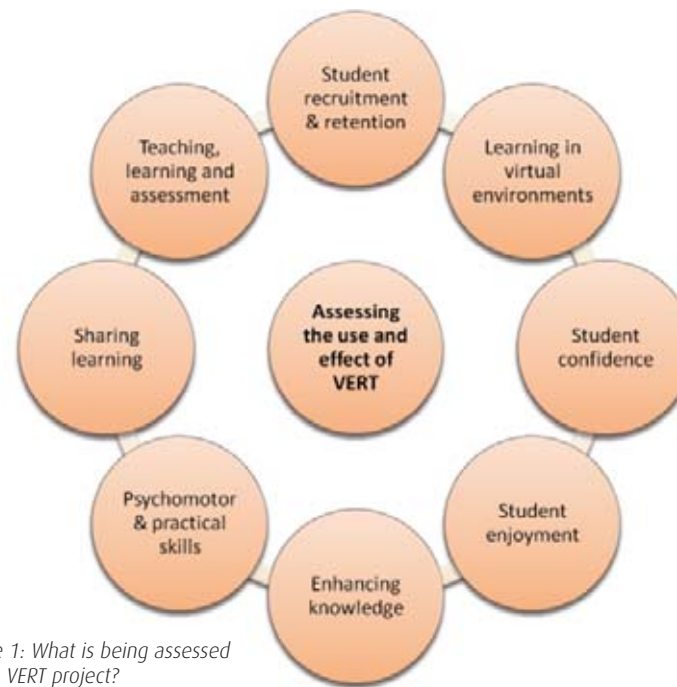
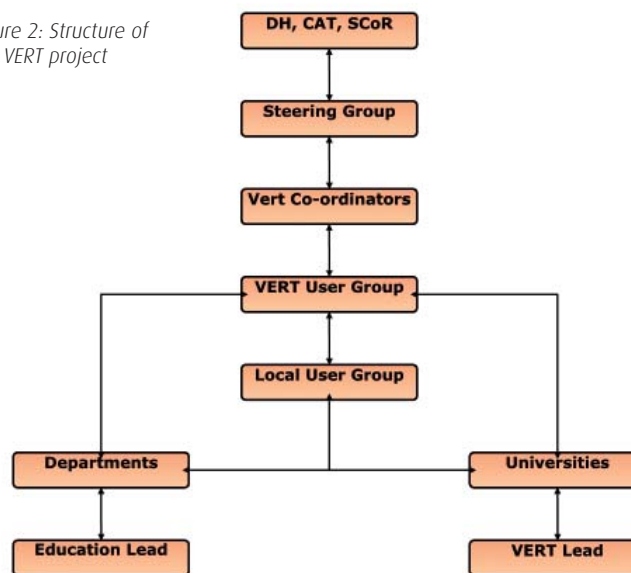


Figure 1: What is being assessed in the VERT project?

Figure 2: Structure of the VERT project



Users are convinced they are part of a 'real' environment



It provides a life size model of the linear accelerator with full functionality except for the production of radiation. Users wear special glasses that interface with the projection system so that they are immersed in a three dimensional view projected into space around them. The environment is a hybrid one in that the virtual linear accelerator is controlled using an actual hand-pendant, identical to that used in the clinical setting.

It is possible to import images and radiotherapy treatment plans (in DICOM format), thereby allowing a vast range of simple and complex treatment plans to be visualised in 3-D, as well as the related anatomical data.

Different systems are provided in universities and clinical departments. Universities use a system called Immersive VERT. These systems are housed in a purpose built bespoke auditorium and employ rear projection using active stereoscopy requiring liquid crystal display (LCD) shutter glasses. A tracking system is provided that enables the image to be projected according to the user's position relative to the projection screen thus further enhancing the degree of 'immersion'. Radiotherapy departments use a system called Seminar VERT. These systems can be situated in seminar or meeting rooms and require no significant refurbishment to install them. Seminar VERT features front projection using passive stereoscopy requiring polarizing glasses. User tracking is not provided. The cost of Seminar VERT is approximately one tenth of that of Immersive VERT.

The large screen stereoscopic projection, faithful representation of the treatment room and linear accelerators, use of real hand pendants and, in universities, use of a tracking system all contribute to a high degree of physical and psychological 'presence' – the phenomenon whereby users are convinced they are part of a 'real' environment.

The VERT technology claims to offer a number of potential advantages:

- A cost effective alternative to training in clinical environments;
- Unlimited practice opportunities without risking harm to patient or equipment;
- Radiotherapy treatment rooms become more efficient as training demands are reduced;
- A realistic insight into the experience of using the equipment, but without the stress of being in a clinic;
- Enhances the understanding of those radiotherapy concepts that are often difficult to teach in a classroom and/or placement setting;
- Student attrition is reduced as the learning experience is enhanced.

### A rationale for VERT

Although the NRAG report indicated that the crisis in radiotherapy education was substantial, it is possible to question the basis on which the Department of Health was willing to invest such a substantial amount for technology with relatively little

## Artificial environments allow learners to make errors that would not be tolerated in the real world

evidence to support its use in radiotherapy. Early prototype versions of VERT had been tested with students in particular contexts<sup>5</sup> and the potential of the technology had been championed by both the developers and early users. But, is there a clear rationale and associated evidence base underpinning the implementation and use of a virtual reality environment (VRE) in education generally, or in radiotherapy education specifically that justifies the considerable expenditure?

Based to some extent on the work of Winn and Jackson<sup>6</sup>, Dalgarno, Hedberg and Harper<sup>7</sup> summarised neatly eight contributions of virtual reality environments (VREs) to learning. VREs can, in principle:

1. Facilitate familiarisation of inaccessible environments;
2. Facilitate task mastery through practice of dangerous or expensive tasks;
3. Improve transfer by situating learning in a realistic context;
4. Improve motivation through immersion;
5. Reduce cognitive load through integration of multiple information representations;
6. Facilitate understanding of complex environments and systems;
7. Facilitate understanding of complex ideas through metaphorical representations;
8. Facilitate exploration of complex knowledge bases.

One of the most popular applications of VREs is skills development as artificial environments allow learners to make errors that would not be tolerated in the real world and from which they can learn important lessons. It is not surprising that such applications have been developed and implemented in medical education. Laparoscopic and endoscopic skills simulators have been widely reported on and evaluated in the literature<sup>8-10</sup>. A rigorous meta-analysis of the effectiveness of VR laparoscopy and endoscopy simulators by Srinivasan, Mital and Haque<sup>10</sup> looked at transference of skills to the operating room and suggested that the results indicate VR simulators provide for skills comparable with (and perhaps even better than) those of well validated traditional techniques. Such evidence does, therefore, appear to support the use of a virtual environment for skills development in radiotherapy. The use of real life control systems in a hybrid virtual environment may further enhance the transfer of psychomotor skills. In an evaluation of an early version of VERT<sup>5</sup> students reported that the 'feel' and 'control' of the virtual machine was identical to the real one. It should be acknowledged, however, that actual skills transference to the clinical environment was not formally evaluated at that time.

VREs are intrinsically motivating<sup>11</sup> and the extent to which this occurs is linked to the degree of presence and immersion. Learners become very engaged in the learning task and usually report high levels of enjoyment; for example, Bridge et al<sup>5</sup>. Given that the VERT platform is designed to provide users with a high degree

of presence, it is reasonable to expect that the technology will perform well in this respect. Furthermore, if the learning experience is enjoyable and motivating, and skills development occurs in an environment where stress is reduced (ie away from the pressures of the clinical environment) it may be expected that this will impact positively on student retention. However, concrete evidence of this is lacking in the literature.

Conventional teaching and learning strategies can lead to over-simplification of complex concepts and this 'reductive bias' may lead to gross misunderstandings. It has been reported that learning in virtual 3-D environments can increase understanding of complex 3-D phenomena that are either not directly accessible to the senses<sup>12</sup> or demand exceptional spatial aptitude<sup>13</sup>, and it is well recognised that many concepts in radiotherapy may be so described. Appreciating spatial anatomical relationships, relating structures to radiographic features, visualising dose distributions and complex 3-dimensional treatments are examples where well designed VREs have considerable potential in facilitating greater levels of understanding. Whilst the VERT system certainly offers promise in this respect there is, once again, relatively little strong evidence to date of how effective this or, indeed, other VR applications are in enhancing understanding.

It can be seen, therefore, that the potential advantages of VERT as outlined earlier are consistent with many of the contributions of VREs to learning, and that there is some relevant evidence to support its use. However, it can also be appreciated that there is a dearth of evidence and benchmarks by which VERT may be assessed in relation to the VERT project's desired outcomes.

## The implementation of VERT

### Installations

Immersive VERT systems have been installed in each of the 10 higher education institutions (HEIs) offering radiotherapy education programmes in England. Although not directly funded by the Department of Health initiative, Immersive VERT systems have also been installed in Wales (Cardiff) and Northern Ireland (Belfast) following independent funding initiatives. Currently, no Immersive VERT systems have been installed in Scotland.

As of January 2009, Seminar VERT systems have been installed in 30 radiotherapy departments in England with no installations in Wales, Northern Ireland or Scotland. Eight clinical departments opted not to accept or were unable to accept funding for VERT and a further 13 departments are still pending installation of facilities. Of these, seven are awaiting completion of room refurbishment and four are awaiting a move to a new area or department.

All centres received initial on-site training on the VERT software by Vertual Ltd. Follow up visits by the VERT co-ordinators are ongoing and aim to explore how VERT is being used (with particular reference to the VERT project outcomes), discuss the integration of VERT into curricula and identify any specific problems.

To date, there have been only minor issues specifically associated with the physical installations. The most common problem faced by universities has been related to minor movement of the projectors. As Immersive VERT systems use rear projection on to a particularly large screen, the system utilises two projectors with an 'image blend' in the middle. A small movement of one or both projectors causes noticeable blurring of the image in this blend portion that may induce adverse visual effects. Realignment of the images is a relatively simple procedure to undertake via the system control panel and local users have been provided with instructions on how to do this. Universities have also encountered minor issues with tracking systems that have required recalibration when new versions of the VERT software have been installed. Again, this is a relatively straightforward procedure that local users have been able to undertake with guidance from Vertual Ltd.

Radiotherapy departments have faced numerous logistical issues associated with the physical installation of Seminar VERT. Not least amongst these have been the difficulties in locating and securing a suitable room in which the system can be situated and, as highlighted above, a number of departments are still awaiting installation as a result. Some centres have had to locate Seminar VERT some distance away from the radiotherapy department and many have their systems situated in shared rooms where sessions must be booked in advance, often precluding the use of VERT to exploit learning opportunities as and when they arise.

A number of other problems relating to the practical use of VERT in both universities and departments have arisen and these will be outlined and discussed later in this paper.

### Integration into curricula

Feedback to date illustrates that VERT is being used in radiotherapy curricula in a variety of ways in order to meet the project outcomes, as follows:

#### *Preparing first year students for clinical practice*

VERT is being used to enable students to develop basic skills and confidence prior to their initial clinical placements. Employing virtual reality early in the learning curve and allowing aspects to be broken down into component parts, thereby negating the difficulties associated with mentor 'automaticity' in the clinical environment, has been recognised as important<sup>14</sup>. It is not surprising, therefore, to see the VERT technology being used in this way.

.....  
Conventional  
teaching can  
lead to over-  
simplification  
of complex  
concepts  
.....



Figure 3: Enhancing plan evaluation in VERT



Students are gaining familiarity with the equipment on which they will be gaining real life experience so that when they commence their placements they are, in theory, more confident and better placed to focus their learning on the development of clinical and patient oriented skills rather than basic psychomotor skills. These practical skills are being developed in structured, interactive sessions that also promote the development of other knowledge and skills that underpin clinical practice. These include the basic principles of radiation treatments, the concept of the isocentre, the concept of 'reference movements from tattoos', and relating treatment set-ups to anatomy. The extent to which VERT enhances skills and confidence prior to first placements is being evaluated currently and early feedback appears to show some success in this respect.

### ***Demonstrating and exploring radiotherapy techniques***

The ability to import plans and associated DICOM data into VERT is presenting useful opportunities to demonstrate and explain radiotherapeutic approaches in lecture and seminar settings (universities), and in planned or ad-hoc tutorial settings (departments). Users in some universities with their own treatment planning systems are generating a range of typical plans around a particular site and importing them into VERT. Using the prostate as an example, three plans may be generated – a simple isocentric technique, a 3D conformal technique and an inverse planned intensity modulated radiotherapy (IMRT) technique. Where time allows, students are generating these plans themselves. Visualisation of these forms the basis for a seminar session focusing on a discussion of the merits and limitations of the various approaches. The rationale for using VERT for this purpose lies mainly in the value of 3D visualisation enhancing students' understanding of complex 3D phenomena, although the advantages of the format in terms of its engaging and interactive nature should not be underestimated. The ability to manipulate the graphics, introduce set-up errors, overlay computed tomography (CT) data, dose colourwashes and dose surface displays, can promote a problem based learning approach.

### ***Integration with in house treatment planning systems for enhancing plan evaluation***

A subsidiary use of VERT in relation to that highlighted above lies in its potential

for enhancing students' skills in the evaluation of plans produced and the planning process itself. For example, 3D visualisation of the contoured structure sets can show clearly inadequacies in contouring technique that may not be immediately obvious in the treatment planning system. This can provide the stimulus for a discussion of the reasons behind inadequacies such as partial voluming effects. Surface colourwash and dose surface displays in VERT can add new insights for students that they cannot gain easily from interpretation of a dose volume histogram alone. Early feedback from students indicates that this is a feature of VERT that is of particular value and should be further exploited. Figure 3 illustrates dose colourwashes for two different plans and clearly indicates the advantages of one over the other.

### ***Allowing students to practice set-ups***

Beavis, Phillips and Ward<sup>3</sup> recognised that limited opportunities for practice in high pressure radiotherapy departments were a key driver for the development and implementation of a hybrid virtual environment. Some techniques are either relatively uncommon or inherently more demanding. For example, skin apposition techniques (electron set-ups) demand good spatial awareness, psychomotor skills and, ultimately, a large amount of experience. The opportunity to be able to practise these in a safe environment is intuitively valuable and the VERT technology facilitates this via the provision of a range of skin apposition technique scenarios along with a feature allowing objective assessment of performance. Figure 4 illustrates an electron set-up in VERT.

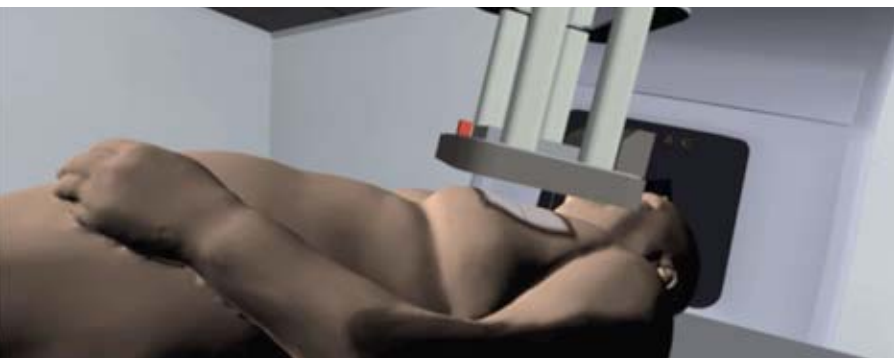
User tracking (Immersive VERT) can further enhance the degree of realism experienced during practicing treatment set-ups. It also minimises the requirement for an independent person to manipulate the view for the user, something which can increase the incidence of reported 'simulator sickness'<sup>15</sup>. However, the significance of user tracking in terms of performance/outcome has yet to be assessed and it must be remembered that its use dictates that sessions are individual; this may be problematic if student numbers are anything more than minimal.

### ***Enhancing learning and teaching of anatomy***

The ability to visualise imported CT data; for example, the visible human female

dataset<sup>16</sup>, and relate this to surface anatomy and beam portals is useful. But it should be remembered that CT data is not itself 3-dimensional. In theory, therefore, stereoscopic visualisation is only useful when this data is related to other 3D projected information (although it is acknowledged that the large screen, high resolution projection of a CT slice may be more easily interpreted).

A more valuable use of the technology lies in its potential for enhancing students' understanding of spatial anatomical relationships. Future software developments such as that described by Appleyard<sup>13</sup> may be of significant value although a more immediate solution is possible whereby anatomical structures on large CT datasets are carefully and systematically contoured in a treatment planning system. They are then imported into VERT where 3D visualisation and graphical manipulation enhances spatial cognition of the anatomy. One university has begun to contour large series of anatomical structures in this way. Some issues do arise with this approach, not least in accessing suitable datasets and the time consuming nature of contouring the structures. The visible human dataset packaged with the VERT software may be used although it is of poor quality and not representative of anatomy in a normal living subject. Additionally, an imposed resolution limit in the VERT software means that contoured structures under a threshold size are not rendered but this is a surmountable problem.



## Effective management of VERT at a local level is vital

### Recruitment

Centres appear to be making use of VERT to enhance recruitment. VERT demonstrations and interactive sessions are being integrated into prospective student visits, interview days, recruitment fairs and events.

### Development of other staff groups such as return to practice staff and dosimetrists

Although the VERT initiative is directed at pre-registration therapeutic radiography students, and first year students in particular, many centres are starting to realise the potential of the technology for postgraduate students, those re-entering the profession and other staff groups. Indeed, in some radiotherapy departments early reports indicate that VERT is being used more for staff development than for student education and training. In one centre, dosimetrists have recognised the value of using VERT to augment plan evaluation and are making substantial use of the Seminar VERT facility for this purpose.

### Discussion

The VERT technology has been implemented rapidly into radiotherapy curricula despite limited evidence addressing the practicalities of its use or educational worth. The VERT initiative therefore includes a comprehensive evaluation strategy linked to the desired project outcomes (see figure 1). This aims to build a rigorous evidence base surrounding the use of the technology and establish how it might be used optimally. The evaluation strategy will assess the impact of VERT on:

- recruitment and retention,
- the student learning experience,
- the development of skills and confidence,
- students' understanding of concepts, and, ultimately,
- radiotherapy curricula.

It will also begin to explore how students learn in virtual environments and what impact particular characteristics, such as students' spatial ability or learning group size, have on students' learning. A detailed overview of the national investigations being undertaken along with their methodologies is beyond the scope of this paper and will be presented elsewhere. What will be considered here are the early experiences of users reported to date.

### Adverse effects of virtual environments

A particular concern relating to the use of virtual environments is side effects such as vection induced simulator sickness, visual disturbances and headaches. The prevalence and severity of these symptoms can be affected by a number of factors including the degree of immersion (or presence), susceptibility to travel sickness, image flicker, misaligned projected images and concomitant illness<sup>17</sup>. Recent research undertaken in two universities<sup>18</sup> based on 75 (predominantly first time)

Figure 4: Using VERT to practice complex techniques



users of Immersive VERT indicated that 71 per cent reported at least one symptom. The symptoms reported most commonly were related to visual issues. These were minor and did not affect individuals' use of the system. The results are consistent with some of the early findings of studies integral to the VERT project evaluation strategy where users commonly report eye strain and/or headaches. Nausea and disorientation are less commonly reported although are more prevalent in those users with a pre-existing illness (including hangovers), and those who are viewing a 3D image that is being inexpertly manipulated by an independent person. Many users of Immersive VERT also report that the LCD shutter glasses are heavy, uncomfortable, or do not fit well over prescription spectacles.

Whilst these symptoms do not appear to limit the use of the system, the severity of them is reduced when the stereo 3D feature is turned off and users can view 2D images without having to wear the 3D glasses. Although this might notionally reduce the extent to which users feel immersed in the virtual environment, educators might consider this a worthwhile trade-off where appreciation of depth cues is not vital to students understanding or skills development. Similarly, user tracking might be worthwhile for those individuals who are susceptible to motion sickness or experience disorientation when the view is manipulated by another person. Both the impact of 3D stereo and user tracking on student performance and experience are being evaluated in one of the national VERT projects.

In any event, educators would be well advised to inform all users of the likelihood of symptoms prior to use, to use the 3D stereo feature with caution, to minimise manipulation of the scene when a user is interacting with it and to keep sessions where 3D stereo is used relatively short.

### Staffing and time

The implementation of VERT and the associated expectation that it will be widely integrated into the curriculum is undoubtedly placing substantial pressure on already highly stretched staff in departments and universities. Academic staff are having to reconsider curriculum design and prepare VERT sessions and, whilst this is predominantly only a short term problem, the rapid introduction of the technology has added to pre-agreed workloads and complicated timetabling. Clinical staffing levels in many departments preclude opportunities for radiographers using VERT to teach students. Use of VERT in the clinical environment is further restricted in those centres where it is necessary to pre-book a shared room.

Some centres are trialling the use of final year students to facilitate Seminar VERT tutorials. These students are trained to operate the VERT technology and may benefit themselves in this way through the development of mentorship and supervision skills. This may provide a cost-effective and symbiotic solution that alleviates the problem of limited clinical staff time although caution needs to be

exercised in overexploiting final year students in this way, particularly where they need to focus on developing their own clinical skills and experience.

### Access to DICOM data and integration with treatment planning systems

One of the major problems faced by many centres has been a lack of data that they can import into VERT and use subsequently in learning and teaching scenarios. Ensuring that the necessary patient consent exists for CT and treatment planning data to be used for teaching purposes, was an early stumbling block for many clinical departments and universities, although this now appears to have been largely resolved at local levels. There have been calls for a repository of shared DICOM plan files by some users. This has yet to be realised for a number of reasons, including consent issues similar to those identified above; it is unlikely to become available in the immediate future and may not be achievable given current data protection and confidentiality policies. Efforts to produce example plans based on the visible human female CT dataset have been explored although there are obvious limitations to this approach.

Those universities that have in-house treatment planning systems (TPS) and associated CT data appear to be at a significant advantage particularly in relation to being able to use VERT to demonstrate techniques and enhance plan evaluation (as previously discussed). The VERT technology seems to add considerable value for these purposes although it is necessary to take full advantage of the features of the VERT software to best exploit the learning opportunities.

Where centres have networked their TPS to the VERT facility they have had to address certain issues. Data has to be exported from the TPS in DICOM format before importing into VERT. Some users have reported this is excessively time consuming with export times of up to five minutes. Where students are exporting and importing data themselves, the risk of accessing and inadvertently corrupting other vital data (on the TPS server) must be considered. These problems are surmountable but a quick and simple solution is to export and import the data via a portable USB drive. This also reduces export time to a matter of seconds.

### Management of VERT resources

The VERT technology has been funded and implemented with the education and training of therapeutic radiographers in mind but the wider potential of the technology has not gone unnoticed by those institutions where it has been installed. Dosimetrists have been attracted by its capability to enhance plan evaluation. Academics in other disciplines are excited by possibilities for employing stereoscopic visualisation to enhance learning, teaching and research. Universities are particularly averse to any of their estate being underused. It is important, therefore, that academic and clinical leads for VERT take steps to protect against encroachment on the resource through maximising its use for radiotherapy education and

training whilst not stifling further development and links within their own centres. Within universities this may take the form of 'block-bookings' used for individually negotiated drop in sessions in addition to other timetabled sessions linked to specific aspects of the curriculum. Such an approach will also allow educators to tailor the use of VERT to individual needs and make more effective use of user tracking. With regard to dosimetrists using VERT for enhancing clinical work then it is perhaps obvious to encourage them to do this with students. The necessity for universities and their associated placement centres to work together in making effective use of VERT and maximising the use of the resource cannot be overemphasised.

Those managing VERT resources at a local level need to be cognisant of the ongoing maintenance costs. Significant amongst these is the cost of projector bulbs for the Immersive VERT system. These have a life span of approximately 1500 hours and the cost of replacing both bulbs together approaches £3000. So, although it is important to maximise the use of the resource, it would be unwise to use the VERT facility for simple projection of, say, PowerPoint presentations.

## Conclusion

VERT is a novel adjunct to radiotherapy education and training and, although there is a clear rationale for its use, it is still too early to draw any significant conclusions regarding its effectiveness. It is clear that students find the technology engaging and enjoyable although minor side effects such as headaches and eye strain are reported. As VERT is being integrated into curricula, evidence is beginning to emerge to support the notion that the student learning experience is being enhanced. Those 'light bulb' learning moments are difficult to predict but continue to be noted and recorded. Evidence is also beginning to surface regarding enhanced skills and confidence in first year students as they enter their initial clinical placement. However, it is necessary to establish more fully the efficacy of VERT in terms of its educational value and how best to optimise its use. The VERT project evaluation strategy is playing a significant part in achieving this.

It is becoming clear that universities without their own TPS are in a less advantageous position in relation to making the most of their VERT facility and efforts to seek funding for such systems to supplement the VERT technology need to be made.

Finally, effective management of VERT at a local level is vital. Maximising use of the resource within the radiotherapy curricula is yet to be fully achieved but local user groups are establishing themselves and considerable effort is being made to enhance integration of this very promising technology.

**Rob Appleyard is a senior lecturer at Sheffield Hallam University, Louise Coleman is a senior lecturer at University College Suffolk; jointly, they are the VERT project co-ordinators.**

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# Involving patients in service improvement: essential requirement or peripheral token?

Chris Wiltsher



## Introduction

Involving patients in service improvement in radiology is a challenge and one which hard-pressed services readily duck. Yet, without patient involvement, service improvement initiatives might well deliver improved performance statistics but be much less likely to deliver improved quality of care. Improved performance without improved quality of care is a recipe for a lean and uncertain financial future in the post-Darzi world.

Lord Darzi's final report of the National Health Service (NHS) Next Stage Review emphasised quality of patient care and linked payment<sup>1</sup> specifically to improved quality of care: *"we will make payments to hospitals conditional on the quality of care given to patients as well as the volume."*

In another paragraph, the report spells out its understanding of quality of care: *"Quality of care includes quality of caring. This means how personal care is – the compassion, dignity and respect with which patients are treated. It can only be improved by analysing and understanding patient satisfaction with their own experiences."*

The emphasis on personal care, measured by patient satisfaction with experience, is now familiar in healthcare. Less familiar is the introduction of the quality of caring, and it is this extension which points to the necessity of patient involvement in service improvement. For only patients can say what needs to be done to make service delivery more caring. Performance statistics and outcome measures, even patient-reported outcome measures, are significant indicators of some aspects of service delivery: they show how efficiently and effectively packages labelled 'a patient' have been passed through the system. They do not show how the service treats the people covered by the label, nor whether those people feel cared for.

The gap in understanding the 'feel' of service delivery cannot be filled by traditional patient satisfaction surveys. These are like consumer surveys, measuring consumer reactions to the delivery of a 'patient experience'. Words matter here, as Ian Kennedy has suggested<sup>2</sup>. Kennedy draws a distinction between the phrases 'patient experience' and 'the experience of patients'. The first is abstract and impersonal; the second grounded in the real world, personal and full of feeling. Analysis of traditional patient surveys provides data about an abstract 'patient experience', but not about how the experience felt to the person at the centre of it. Traditional surveys may generate ideas for handling the abstract patient more efficiently, but they are unlikely to generate ideas for relating more effectively to the person. To bring the abstraction to life, it is necessary to involve those who live the experience.

The importance of seeing patient experience as personal experience is discussed

at length in a recent Kings Fund publication<sup>3</sup> 'Seeing the Person in the Patient: the point of care review paper'. This paper looks at the experiences of patients in hospitals but much of its discussion is relevant to all patient care. An interesting part of the discussion is an analysis of factors which shape patients' experiences in hospital. The authors distinguish and discuss four levels at which healthcare affects the patient:

- individual interaction between patient and staff member;
- the clinical micro-system (eg department, ward or clinical pathway);
- the institution;
- the wider healthcare system.

The report claims that patients are the meeting point, and the only meeting point, of all four levels. These four levels can be paralleled in any radiology or oncology department. As with the hospital setting, patients are at the intersection of these levels, and only the patient can say whether or not they work together. To discover how the factors which affect patient experience interact, and to improve the interaction, it is necessary to involve the patient.

A third reason for involving patients in service improvement is that only patients know if their interaction with the service has produced any benefit for them. Clinicians can tell an imaging department if reports were helpful in reaching a clinical diagnosis; statistics can tell oncologists if their interventions have produced positive clinical outcomes, but only patients can say whether or not the care they received helped them to feel better. There is a growing body of evidence suggesting that giving patients a good feeling about their care can be clinically beneficial. The Kings Fund report<sup>3</sup> mentioned earlier lists several studies to support claims that for hospital patients 'anxiety and fear delay healing' and 'good communication with patients contributes positively to well-being and hastens recovery'. It seems reasonable to suggest that a good experience of caring will help towards positive outcomes for radiology and oncology patients, too. Only patients can provide the evidence to support this idea, and only patients can provide evidence that service improvement has resulted in improvements in their clinical conditions.

## Challenges of patient involvement

It seems then that there is a strong case for involving patients in service improvement, a case supported by both clinical and commercial considerations. Moreover, patients are, apparently, a cheap and readily available resource for service improvement. However, making use of this resource poses challenges.

The first challenge is to recruit 'useful' patients. In diagnostic imaging services, many patients will only pay one visit to the service, and that visit will not last

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long. The patient does not develop a long-term relationship with the service, and so has little incentive to improve the service. In oncology, patients may make several visits, but they are, understandably, so wrapped up in the process of their treatment that they have neither time nor energy to become involved in service improvement activities. Patients may come from a wide geographical area and may be unwilling to make the effort to become further involved with a service.

The next challenge is to get those patients willing to become involved to contribute constructively. Not all patients are useful: some have their own agenda, and some are unable to relate particular experience to wider concerns. Some patients are so grateful for their treatment that they have nothing but praise to offer – flattering, but not especially helpful for service improvement. Other patients have nothing to offer but minor whinges born of their own idiosyncracies. Yet others are unwilling to be critical because they fear that their remarks will affect adversely individual members of staff or, indeed, care they may need in the future.

One way of addressing this challenge is to rely on random anonymous surveys and questionnaires. But, as was suggested above, this is insufficient for service improvement purposes. If that suggestion is correct, then patients must be brought together in some way for constructive engagement with the relevant service improvement teams. This poses further challenges. Timing is difficult. Patients have many other things to do and are not always available at times which suit the schedules of busy professionals. Even if meetings can be arranged, many lay people clam up when faced with a body of professionals, however pleasant and welcoming.

A third challenge is that patients generally are not aware of and do not understand the structures and processes of the NHS or other healthcare providers. Nor do they understand the constraints under which services must work. Management hierarchies, budget processes and policy directives are of no interest to the patient. This is not because patients are unfamiliar with management, budgets and policy directives; on the contrary, patients also grapple with such things on a daily basis. However, patients have been told by politicians that healthcare services must be responsive to them as patients, and as taxpayers they believe, rightly, that they fund healthcare services. Consequently, they view service improvement as something that should happen in spite of any apparent constraints.

In the face of these and other challenges, it is easy to retreat into unintentional tokenism; to go through the motions of consulting patients but being very selective about what is done as a result of the consultation. Patient surveys and questionnaires can be produced and offered, and the results analysed. Poor return rates can be shrugged off with plausible reasons, such as ‘patients aren’t interested’, ‘patients don’t have time’, ‘we did our best’, or, even, ‘no complaints

## ••••• Giving patients a good feeling about their care can be clinically beneficial •••••

means we provide a good service’.

If a sufficiently large return is received, the wide range of needs and requirements can lead to further excuses: ‘we can’t do everything so, to avoid upsetting any respondent, we’ll do nothing’.

Patients can be invited to say what is wrong with a service but may then be expected to leave it to service professionals to decide what to do about the issues. Work on patient consultation can be given to busy staff who do not have the time to do anything worthwhile, or to staff of such a grade that they are left out when decision-making meetings are held and are unable to influence the nature of the decisions made.

Patients who actually respond to invitations and attend meetings can be listened to and then sidelined in post-meeting discussion amongst the professionals because ‘that’s a one-off incident’, ‘they’re not representative’, ‘they don’t understand the issues’ or ‘it’s just not possible to do that’. The worst piece of tokenism is to invite patients to contribute to discussion but then fail to give them any feedback on what happened next or any reasons for not doing what they suggested. In the face of this kind of tokenism, it is no wonder that patients become disillusioned and decline to participate further.

### **Overcoming tokenism in patient involvement**

To overcome the challenges and avoid tokenism, it is necessary to recognise that involving patients in service improvement is demanding. Like all useful service improvement activity, meaningful patient involvement requires the investment of significant resources. A service improvement team which is committed to involving patients will have a member whose primary function is patient involvement. That person will seek actively to involve patients in various ways, and will respond actively to them.

The person who takes on this role will need particular skills and aptitudes. One vital asset is empathy, the ability to see and feel the service from the perspective of the patient. Communication skills are another obvious requirement. On the one hand, listening skills are needed but this listening involves relating what the patient is saying about how it felt to pass through the service, to what the service looks like from the inside and what the service is trying to achieve; on the other hand, there will be a need to take what the patient says back into the service and feed it into relevant discussions, and afterwards to tell the patient what is happening, and why.

Flexibility in time management will also be important. It might be necessary to go to patients rather than have patients come to the service, and that might

.....  
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.....

involve working significant unsocial hours. Where patients do visit the service for meetings, the times of meetings will have to be adjusted to suit volunteers with busy lives, again requiring unsocial hours working. Diplomacy will be important; adjusting meeting times to suit patients will pose problems in terms of involving the senior service leaders in meetings with patients but, without the presence of senior staff with the decision-making power, the exercise will seem, if not be, tokenistic.

Together with particular skills and attributes, the person fulfilling the patient involvement role will need to have considerable experience, and be senior enough to have ready access to and engagement with management. Adding the time commitment required produces a role with significant resource implications. Factor in the time of service leaders for meetings and travel expenses for patient volunteers, and the resources required for useful patient involvement in service improvement mount rapidly. Is the result worth the expenditure?

### Is patient involvement worth the cost?

Perhaps the question should be asked in a different way; is a failure to involve patients worth the cost? The clinical justification for improving the quality of caring has been noted<sup>3</sup> and, in the face of a growing battery of performance indicators, no service can afford to neglect any means of improving clinical outcomes. The financial imperatives to improve the quality of caring are powerful and growing. As noted earlier, payment will become conditional on quality improvement<sup>1</sup>, not just volumes. The commercial pressures to improve the quality of caring are also growing and patient choice is affecting more and more healthcare provision. Patients are being encouraged to comment on their experience of care, and those comments will increasingly include comments on the quality of caring. The cost of failing to improve the quality of caring looks high and is likely to grow; without the involvement of patients, improvement in quality of caring is much less likely. No service which wishes to engage in successful service improvement can afford to neglect the quality of caring and so cannot afford to neglect involving patients actively in its service improvement work.

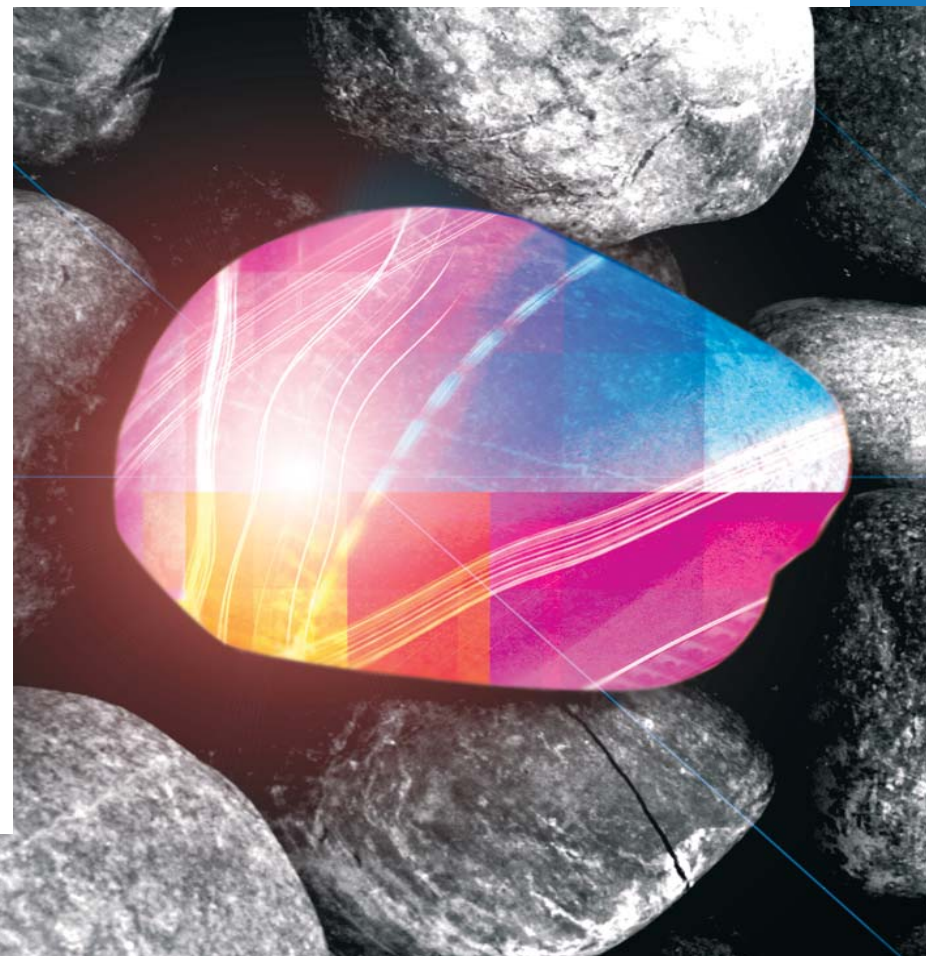
### Finally

The NHS Modernisation Agency<sup>4</sup> proclaimed in 2003 that one of the goals of service improvement in radiology was 'to ensure that the patient is central to the service improvement process'. That objective can only be achieved fully by involving the patient in the service improvement process.

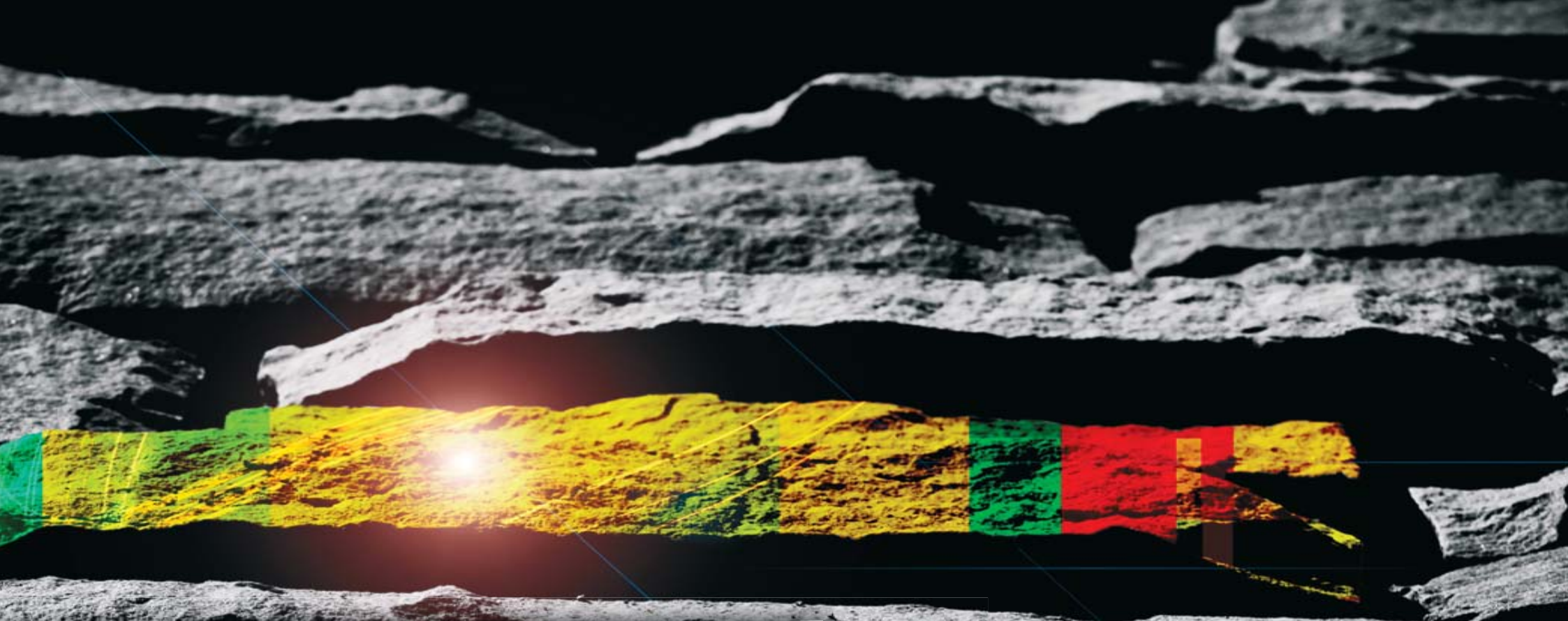
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# The HPA and clinical departments – a modern partnership

Sally MacLachlan,  
Una O'Doherty and  
Kathlyn Slack

## Introduction

The Health Protection Agency (HPA) is an organisation with a commitment to improving public health. It is an independent agency whose role is to provide an integrated approach to protecting UK public health through the provision of support and advice. Its radiation protection division's remit includes the provision of independent advice on radiological practice and radiation safety in the UK. Part of the work of the Medical Exposure Department of the HPA is to assist and support a range of organisations, including clinical departments, in addressing issues which may affect radiological practice and patient safety. It is an impartial resource equipped with the knowledge and skills to work in partnership with health care professionals within the clinical setting. The intention of this article is to heighten awareness of this resource at the HPA and to demonstrate how it is working to improve radiation protection and patient safety at local, national and international levels.

## Challenges to clinical practice

Although the principle areas where medical exposures are employed in the clinical environment – diagnostic imaging, interventional radiology, nuclear medicine and radiotherapy – have diverse working practices, common themes in the challenges that face professionals working in these modalities are apparent.

The assurance of patient safety combined with optimal service efficiency, whilst maintaining compliance with legislation are the cornerstones of everyday clinical practice. The ongoing demands facing healthcare professionals in the safeguarding of these cornerstones are well known.

Many initiatives and publications from national and international organisations and bodies have attempted to assist departments in achieving a safe and timely service, and new ones will continue to be published in the future. However, individual departments often have to interpret the advice and apply it locally without assistance. The Medical Exposure Department is a small and flexible group who can offer some support to clinical departments in translating national recommendations into local practice with the aim of improving patient safety in the context of compliance with legislation.

## About the Medical Exposure Department

The National Radiological Protection Board (NRPB) was originally established in 1970 and in its 35 years developed an international reputation for science, providing advice to government and working with a range of organisations with interests in radiation protection. In 2005, the NRPB was incorporated into the HPA and later that year the Medical Exposure Department was formed.

This department builds on the valuable work in radiation protection carried out by the NRPB. Whilst the NRPB's main focus was on diagnostic imaging and

# Many clinical departments rely on the 'green book'

interventional radiology, the department's scope has grown to include nuclear medicine and radiotherapy. It has been able to develop in this way through its expanded remit, by recruiting clinical personnel, and by working with a greater range of professional bodies involved in medical exposures. As technology develops, it is important that practice continues to optimise that technology and the Medical Exposure Department will continue to evolve to match these new demands in healthcare.

The staff of this department come from a range of backgrounds which includes radiographers, physicists and radiobiologists. Their collective experience includes all types of medical exposures, dosimetry and government policy. An awareness of current practical issues is maintained through radiographers employed by the department undertaking regular clinical placements and remaining registered with the HPC.

This understanding of current practices and clinical issues supports the department with the ongoing provision of advice to the public and professionals. This may be in the form of a telephone call or e-mail from an individual regarding a specific matter, or through working with a clinical department, more of which is described later in this article. Whilst advice is mainly provided to healthcare professionals, professional bodies, government departments and agencies, the public also often contacts the HPA for advice in relation to medical exposures that either they, or a family member, have or is about to undergo.

## Working with government, agencies and professional bodies

Formal advice via publications on clinical dose is still provided to the government and healthcare professionals, but this has now been expanded to include closer working with the professional bodies and, where appropriate, the provision of informal advice to individual professionals and clinical departments.

Work on reference doses continues in radiography, fluoroscopy and CT. This directly influences the national diagnostic reference levels<sup>1</sup> (DRLs) set by the Department of Health, which informs justification and optimisation decisions. Dose surveys<sup>2</sup>, compiled in five year cycles, are undertaken to provide the basis for these reference doses. The next survey on medical and dental imaging is currently underway and will reflect changes in technology and associated practice by focusing on CR/DR as well as paediatrics. It is also intended to start the next CT scanning survey this year which will consider changes brought about by the increasing use of multi-slice CT scanners. These surveys are dependent on the imaging community being able to provide as much data as possible and, to ensure that these published documents are a true reflection of the UK's working practice, it is essential that dose data is provided for inclusion in the patient dose database. For advice concerning the management of a pregnant female referred for a



By giving individuals the confidence to challenge their practices, more efficient ones can be implemented

diagnostic imaging examination, many clinical departments rely on the 'green book' published in 1998 by the NRPB<sup>3</sup>. This publication 'Advice on Exposure to Ionising Radiation during Pregnancy' has been updated and was published in February 2009<sup>4</sup>. The reappraisal of the likely health effects to the embryo or foetus following exposure to ionising radiation during pregnancy was undertaken in collaboration with the Royal College of Radiologists and Society and College of Radiographers. This document takes into account the increase in the national baseline of childhood cancers from 1:650 in 1998 to 1:500 today and reiterates that the likely radiation dose to the foetus resulting from any diagnostic procedure in current use should present no risk of causing foetal death, malformation, growth retardation or impairment of mental development. However, exposure of pregnant women to the higher dose procedures may lead to foetal doses in excess of a few mGy and at the highest doses may result in a doubling of the childhood cancer risk compared to the natural rate, and therefore should be avoided where possible.

To formalise the relationships which produce this type of work, the department holds Memoranda of Understanding with both the Society and College of Radiographers and the Royal College of Radiologists to allow and promote communication on matters relating to radiation protection in clinical practice and regulatory requirements as well as policy development.

Some of the department's staff provide advice on regulatory matters, specifically the Ionising Radiation (Medical Exposure) Regulations 2000/2006 [IR(ME)R]. Part of this work involves working with the inspectorates and accompanying inspectors during their visits in Scotland and Wales, however it must be emphasised that none of the staff in the department holds a warrant nor takes part in any enforcement decision or action under IR(ME)R. This approach helps to ensure some consistency across the UK and, in addition, that inspectors are familiar with the challenges of providing a clinical service within a regulatory context. Advice has also been provided to the Healthcare Commission and liaison will continue with the Care Quality Commission from April 2009.

In Scotland, some staff have been involved in a programme of study days arranged by the IR(ME)R inspector. These have been attended by senior Health Board management as well as healthcare professionals of all disciplines to discuss the regulatory requirements concerning the use of ionising radiation in healthcare. The department has also been involved in the training of inspectors at Healthcare Inspectorate Wales (HIW), who are responsible for IR(ME)R in Wales. This training covers the use of ionising radiation in healthcare as well as the regulatory requirements to assist the inspectors in appreciating the different environments in which medical exposures are carried out.

The department also contributes to the drafting of national guidelines. Examples

of this may be seen in the publication of Towards Safer Radiotherapy (2008)<sup>5</sup> and A Guide to Understanding the Implementation of the Ionising Radiation (Medical Exposure) Regulations (2008)<sup>6</sup>.

The National Patient Safety Agency (NPSA) has an established system of voluntary reporting of radiotherapy incidents and near misses called the National Reporting and Learning Service (NRLS). Last year the NPSA engaged expertise from the department to undertake analysis of these radiotherapy incidents. The first analysis was reported on the NPSA website in its quarterly report in May 2008<sup>7</sup>. The HPA now have a data sharing agreement with the NPSA to provide the expertise to undertake the analysis of data collected on radiation incidents on a regular basis. It is envisaged that these reports will be routinely published on the NPSA website as part of their quarterly reports. This will enable the national sharing of any lessons learnt from incidents and near misses.

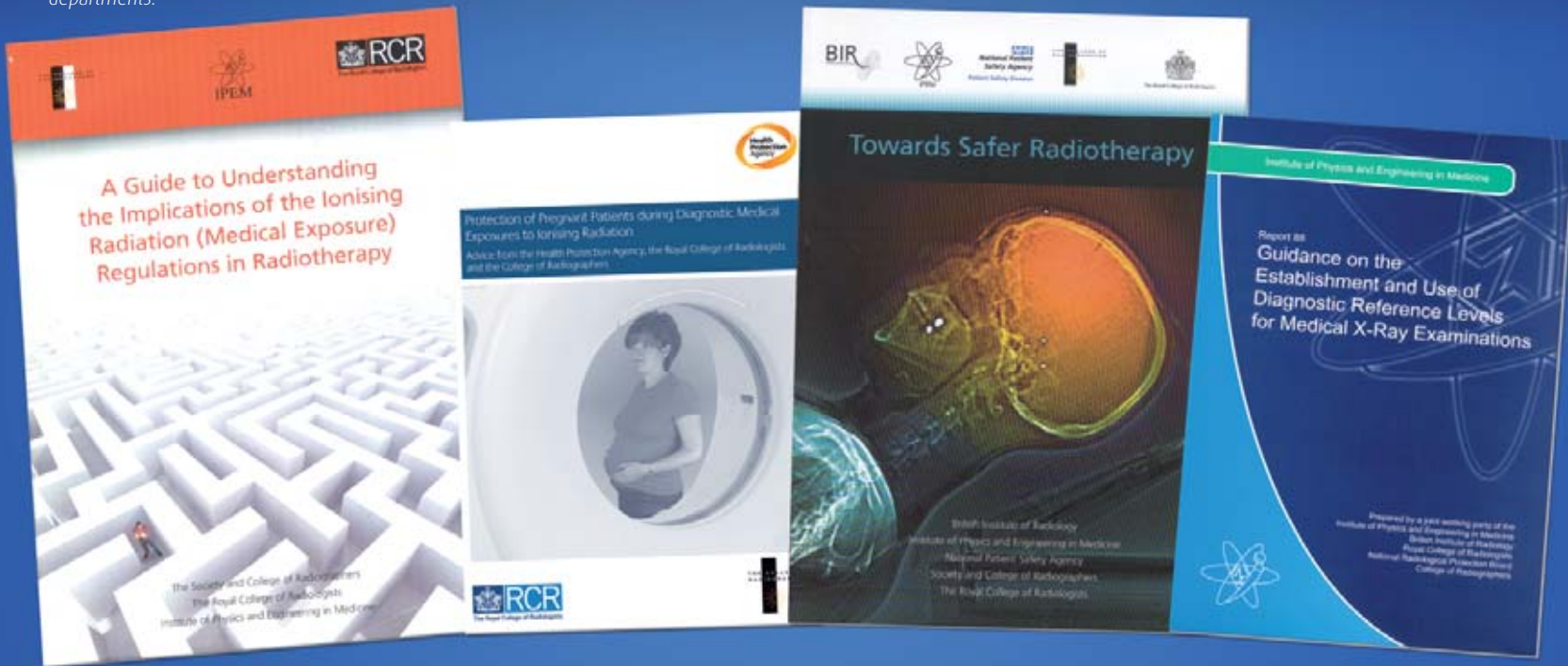
Further work with the NPSA Steering Group on Patient Safety in Radiotherapy is being undertaken on how to implement the 'Towards Safer Radiotherapy' coding and classification locally. A guidance document<sup>8</sup> is currently being piloted in six radiotherapy departments and this document will be launched at a national workshop in Birmingham on 4 June 2009, hosted by the NPSA steering group.

The department is also responsible for supporting two major government advisory committees, Administration of Radioactive Substances Advisory Committee (ARSAC) and Committee on Medical Aspects of Radiation in the Environment (COMARE). ARSAC advises ministers on the administration of radiopharmaceuticals in the clinical environment and the department provides this committee with secretariat support. On the advice of the committee, the ARSAC Support Unit is responsible for issuing certificates, without which these administrations cannot be made.

COMARE is an independent expert advisory committee which offers advice to all Government Departments and Devolved Authorities, not just the Health Departments, and is responsible for assessing and advising them on the health effects of natural and man-made radiation. It is also asked to assess the adequacy of the available data and advise on the need for further research. COMARE has recently expanded its work programme to cover medical exposures as demonstrated in its recent twelfth report regarding CT scanning of asymptomatic individuals<sup>9</sup>.

Many department members also carry out work at an international level either through European projects on radiation dose or with bodies such as the International Atomic Energy Agency (IAEA). This allows UK input into international work as well as enabling an early knowledge of matters which may ultimately impact on clinical practice in the UK.

MED staff work impartially with government in England and the devolved administrations, IR(ME)R inspectorates, professional bodies, and clinical departments.



### Working with clinical departments in Great Britain

Interaction with clinical departments depends on the type and location of that department. As indicated earlier, the provision of advice may be simply in response to a telephone enquiry from a healthcare professional or may involve a visit to a clinical department. For example, several radiotherapy departments in England have participated in a programme of visits by a member of the department. These visits, which may take place over several days, are at the department's invitation and intended to provide independent on site support and reassurance on issues surrounding patient safety and process efficiency in the context of IR(ME)R.

A site visit usually begins with a meeting with a representative from each discipline (radiographer, physics and medical teams) and management, where possible and appropriate, to ensure that there is involvement from all parties and to allow the opportunity for all to express their expectations. To date, visits have consisted of a series of observations of key areas of the clinical department,

informal interview of individual members of staff and a review of department procedures. At the end of the visit, feedback of findings and agreement of an action plan is reached usually in consultation with representatives from the clinical department. Future development of these visits will be informed through working with key stakeholders.

By working in partnership, real improvements can be made and any advice given is done in consultation with local sites and with local practice in mind. The department's staff are in the unique position of being able to provide an independent overview of a clinical department's practices (whether diagnostic imaging or radiotherapy) without any preconceived ideas and draw on good practice from elsewhere, as well as their own experiences. Flexibility of approach when undertaking a site visit is a key factor in tailoring advice as each site or situation can be unique. By giving individuals the confidence to challenge their existing practices and identify redundant work processes, more efficient ones can be implemented.



## So what can the HPA offer you?

The Medical Exposure Department is part of an outward looking agency and should be viewed as an independent resource but not as a solitary solution. Whilst advice and tools to enable compliance with IR(ME)R can be provided by the department's staff, their recommendations are not mandatory and service responsibility remains with each department. It is up to individual clinical departments to decide for themselves if they should act on the advice given. This being said, by working in partnership it is hoped that any advice given would be acted upon, especially if the recommendations would aid compliance with legislation and lead to improved radiation and patient safety. By providing reassurance and support to departments now, it is hoped that clinical staff will continue to grow in a cyclic culture of review, plan and change and have confidence in their own abilities to detect, highlight and resolve concerns in the future.

The work of the HPA is relevant to all professionals involved in the use of ionising radiation in healthcare irrespective of discipline. This permanent, evolving resource gives individuals and clinical departments the unique opportunity to obtain ongoing assistance and support in improving their practices.

### Contacts

More information on the work of the HPA can be found on the website. Please see details below if you would like to contact the HPA for advice on patient safety, compliance with legislation, process efficiency, or if you have any questions about this article.

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Table 1 – Useful websites

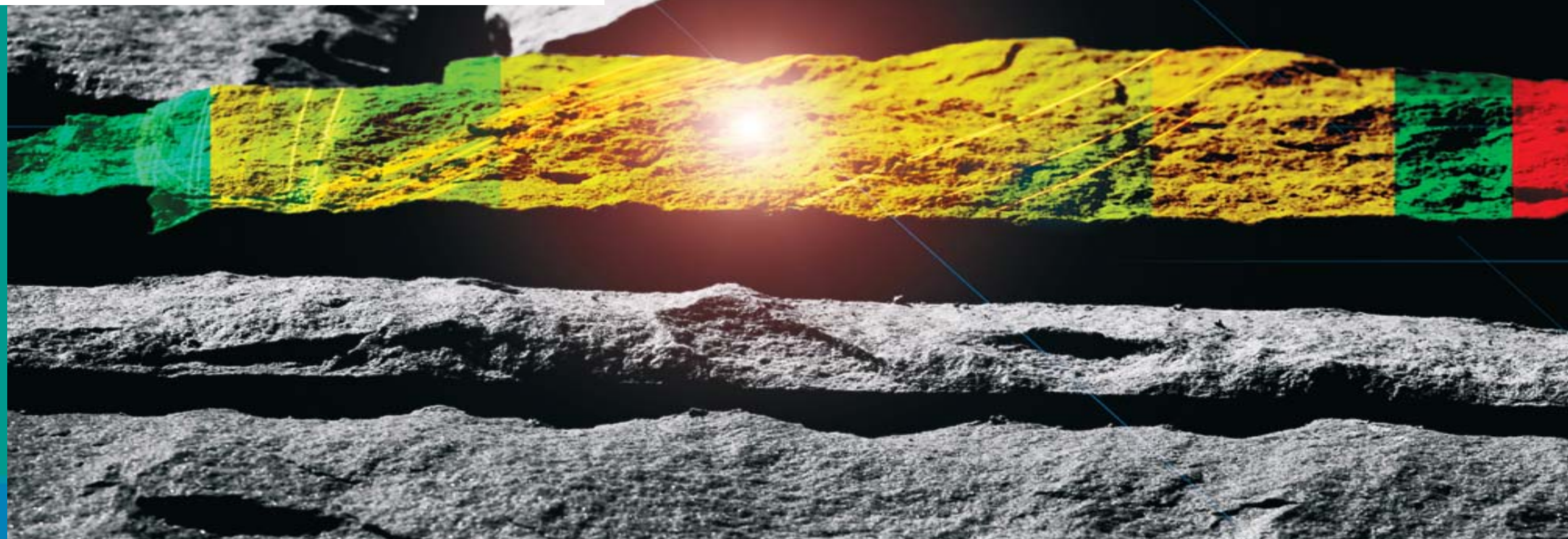
Useful Websites		
<b>ARSAC</b>	The Administration of Radioactive Substances Advisory Committee	www.arsac.org.uk
<b>BIR</b>	British Institute of Radiology	www.bir.org.uk
<b>COMARE</b>	Committee on Medical Aspects of Radiation in the Environment	www.comare.org.uk
<b>CQC</b>	Care Quality Commission	http://www.cqc.org.uk/
<b>HCC</b>	Healthcare Commission	www.healthcarecommission.org.uk
<b>HIW</b>	Healthcare Inspectorate Wales	www.hiw.org.uk
<b>ICRP</b>	International Commission on Radiological Protection	http://www.icrp.org
<b>IPEM</b>	Institute of Physics and Engineering in Medicine	www.ipem.ac.uk
<b>NPSA</b>	National Patient Safety Agency	www.npsa.nhs.uk
<b>RCR</b>	Royal College of Radiologists	www.rcr.ac.uk
<b>SCoR</b>	Society and College of Radiographers	www.sor.org
<b>SE</b>	Scottish Executive for Health	www.scotland.gov.uk/Topics/Health
<b>WA</b>	Welsh Assembly – Chief Scientific Adviser	http://new.wales.gov.uk/topics/health/professionals/scientific/?lang=en
<b>HPA</b>	Health Protection Agency	www.hpa.org.uk

TABLE 2 – Key aims.

Our key aims are:
Improving and promoting patient safety
Optimisation of all equipment/processes to improve efficacy and efficiency
Translation of theory into practice
Standardisation of practice within sites
Compliance with legislation

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# Objective assessment of spinal motion: the future?

Fiona Mellor and  
Alan Breen



## A chronic pain in the back

Low back pain (LBP) afflicts most people at some point in their lives but trying to measure the prevalence of LBP is not straightforward. Prevalence and LBP have various interpretations and issues arise from varying methodologies between studies<sup>1</sup>. Consequently, the prevalence of LBP is quoted as a range. For instance, a systematic review<sup>2</sup> between 1966 and 1998 determined the lifetime prevalence of low back pain in English speaking countries to be between 11-81 per cent, whilst Waddell<sup>3</sup> reported it to be between 59-84 per cent. However, of more interest, is that these ranges have not increased over time<sup>4</sup>, although the increase in disability and the burden placed on social and health care systems rose so much in the decades from 1985<sup>5</sup> that one eminent spinal surgeon<sup>3</sup> labelled LBP 'a 20th century medical disaster'.

For the majority of sufferers, LBP will ease with time and without any intervention other than simple pain killers. Nachemson et al<sup>6</sup> noted that only 10 per cent suffer disabling back pain after six weeks, later supported by results from Coste et al<sup>7</sup>. However, more recent studies calculated the recovery rate to be only 76 per cent at three months<sup>8</sup> with one-third of people still not recovered a year later<sup>9</sup>. Of those who go on to develop chronic low back pain (CLBP), only 15 per cent will have any kind of specific or serious pathology and few will have nerve root problems. For the remainder, no cause will be found<sup>3</sup>. CLBP is defined as pain lasting for more than 12 weeks<sup>10</sup> although this fails to take into account recurring, or episodic, LBP which can also be chronic. Von Korff suggested the term 'chronic' should also apply if pain has been present on more than half of the days of the previous year<sup>11</sup>. Hence there is also ambiguity over the definition of 'chronic' in relation to low back pain<sup>12</sup>.

In the absence of a specific cause, chronic non specific low back pain (CNSLBP) is often assumed to be mechanical in nature<sup>10</sup>, ie affected by movement and originating from the holding structures of the spine such as the ligaments, muscles and inter-vertebral discs. However, as is the case with 'prevalence' and 'chronic' there is still no universal definition for mechanical low back pain<sup>13,14</sup>, so the benefits of 'mechanical' treatments aimed at this group, such as spinal manipulation, mobilisation and surgical fusion, are difficult to predict.

The problem seems to be the heterogeneity of patients with CNSLBP. The varying definitions and meanings of relevant terms mean that comparison across studies and pooling of data is complicated and subject to high errors. Additionally, CNSLBP is a symptom, but selecting the appropriate treatment is difficult when the cause is not known. Consequently, there is a need to further sub-categorise patients with CNSLBP to enable more focused clinical trials into causes and treatment, and to reduce the pressure on social and health care.

Previous attempts to subgroup patients with CNSLBP utilised diagnostic imaging but numerous studies and reviews have shown that abnormalities once thought to cause pain, including spondylolisthesis, disc degeneration and osteophytes, are not exclusive to symptomatic populations<sup>15-18</sup>. Even provocation discography is contentious as high false positive rates in asymptomatic participants have been reported<sup>19</sup>, though a recent systematic review concluded these were not as high as previously thought<sup>20</sup>.

In response to such findings, The Royal College of Radiologists recommends that radiographs are not performed for CNSLBP<sup>21</sup>. Additionally, in May 2009, the National Institute for Health and Clinical Excellence (NICE) will publish guidelines for the management of CNSLBP recommending that MRI is not undertaken within the first 12 months<sup>22</sup>. There is evidence that the use of diagnostic imaging increases patient satisfaction with treatment<sup>23</sup> but this does not necessarily relate to improved outcomes and, in fact, is more likely to lead to more invasive (and expensive) interventions<sup>24</sup>, putting further pressure on health and social care.

Common sense suggests that if mechanical back pain is influenced by movement, then measuring movement may help determine the nature of the problem. In vitro studies of spinal motion in healthy, degenerate, and diseased spines are well established<sup>25-28</sup> and from such studies it is known that the healthy intact spine is a relatively stable structure in the neutral position. It can withstand substantial forces and moves in a uniform and predictable way when force is increased. Conversely, a spine with damaged or diseased inter-vertebral discs does not have resistance to force and will move quickly and rapidly to its maximum range of motion. The explanation for such laxity is known as the neutral zone (NZ) theory<sup>29</sup>.

Neutral zone theory is of particular interest as an alternate method for describing, and so diagnosing, 'instability' of the spine, although confusion exists because the term 'instability' has different meanings for different specialists (clinicians, radiologists, bio-engineers)<sup>30,31</sup>. Previous attempts to provide a biomechanical definition of instability include hyper-mobility of rotation and increased sagittal plane translation with values of 10 degrees and 4mm being used respectively<sup>32,33</sup>. However, these values fail to describe adequately the mechanical properties of the spine due to difficulties in determining the cut off between normal and abnormal<sup>31</sup>. There is substantial overlap between symptomatic and asymptomatic range of motion<sup>32</sup> and sagittal rotation may be as high as 25 degrees in healthy young volunteers<sup>34</sup>. Measuring the NZ and the quality of motion may be a better way forward in determining which patients with CNSLBP need further or more invasive mechanical interventions. But, because the NZ has been difficult to identify in vivo, the link between motion features and CNSLBP is yet to be proven.

In vivo measurements of spinal motion include goniometry which uses data

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**Diagnostic  
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obtained from skin markers placed over the posterior spinous processes. Unfortunately, the reliability remains too low for accurate inter-vertebral measurement because the movement of the skin is separate to the movement of the spinous processes<sup>35</sup>. Nevertheless, many clinicians and researchers use goniometry to measure gross trunk motion because it is accessible and non-invasive, and its reliability in measuring gross overall trunk motion is considered acceptable<sup>36</sup>.

Flexion-extension radiography has been used traditionally to measure finer inter-vertebral motion in vivo, starting as early as 1904<sup>37</sup>. This is essentially static imaging because the patient remains in a fixed position whilst the exposure is made. Consequently, information depicting the quality of motion throughout the bend is missed, precluding the application of the neutral zone theory<sup>38</sup>. Data obtained with this method are the source of previously published normative ranges for lumbar inter-vertebral levels<sup>39-42</sup> and treatment decisions may be based on clinical signs, symptoms and 'abnormal' motion on radiographs. However, measuring inter-vertebral movement from plain radiographs is subject to large measurement errors<sup>32,43-45</sup> and little effort is made to account for natural variations in trunk range.

More recently, focus has turned to dynamic magnetic resonance imaging (MRI) using open coil scanners to allow full trunk motion. This has the obvious advantages of not using ionising radiation and visualisation of soft tissue structures but, despite its name, the images are acquired whilst the patient remains static at differing points throughout the bend. Hence, quality of movement cannot be measured. This method also has an increased scan time which can be uncomfortable for symptomatic patients. Nevertheless, useful information has come from these studies, including behaviour of the inter-vertebral disc during rotation<sup>46,47</sup>. Open coils, easier accessibility and faster acquisition times without loss of image quality, may mean that, in time, MRI becomes the method of choice for measuring continuous inter-vertebral motion.

The lack of information obtained from static imaging has led researchers to examine the utility of fluoroscopy. The advent of the image intensifier in the 1950s helped realise the advantages of the dynamic approach to studying spinal motion, with one of the first fluoroscopic studies of the cervical spine conducted in 1957 by Fielding<sup>48</sup>. However, these initial studies were subject to high radiation dose and poor image quality. Furthermore, the assessment of motion in the spine was subjective and prone to the same high observer errors as flexion and extension projections. Consequently, cinerentgenography (as it was called) did not establish itself as an accessible clinical or research tool for some time.

Poor evidence of a relationship between anatomical pathology, or abnormality

## Video-fluoroscopy of the spine is again attracting the attention of researchers and clinicians

with pain and disability, led to a change in the back pain paradigm in 1987 when the bio-psychosocial model was introduced<sup>49</sup>. This model approaches the treatment of CNSLBP from a different angle to the disease model which does not allow for the complex human response to pain and disability<sup>3</sup>. As a result, the focus turned towards the measurement of social and psychological factors and these have since been used to develop subgroups of CNSLBP sufferers<sup>50</sup>. However, this model fails to acknowledge that there may still be a biomechanical cause for some CNSLBP that has, so far, remained undetectable with goniometry or flexion-extension radiographs.

Recent advances in medical imaging and computer processing speeds have meant video-fluoroscopy (as it is now called) of the spine is once again attracting the attention of researchers and clinicians. In 1989, Breen et al<sup>51</sup> described a technique for quantifying inter-vertebral motion using computer algorithms and digitised images from a fluoroscopy unit. This technique evolved into an examination known as OSMIA (Objective Spinal Motion Imaging Assessment), for which reliability has been established<sup>52</sup>. Other groups have also studied spinal motion in both symptomatic and asymptomatic participants using video-fluoroscopy<sup>38,53-59</sup>, although methods used by these groups are not standardised, precluding the pooling of data.

### About OSMIA

OSMIA can be undertaken for the lumbar and the cervical spine. Its main features are that it controls the speed and overall range of trunk/neck motion whilst fluoroscopy is undertaken at a rate of 15 frames per second. This standard for acquisition allows comparisons across patient and asymptomatic groups, and controls for the natural variation in trunk range. It also allows radiography to be undertaken in a controlled manner and reduces the issues of flare, rotation or movement out of the field of view.

OSMIA of the lumbar spine may be undertaken in the weight-bearing (figure 1) or recumbent positions (figure 2), in the sagittal and coronal planes.

In the weight-bearing examination, patients stand on a specially designed motion bucky (Atlas Clinical Ltd) with their hips stabilised. Their trunk motion is guided by an upper disc rotating through a pre-determined range of motion which patients follow. The standard trunk range is 60 degrees flexion and 20 degrees extension, accounting for the natural lordosis of the lumbar spine when standing erect. In the coronal plane it is 40 degrees left and 40 degrees right (80 degrees total). Weight-bearing motion of the lumbar spine is influenced by muscle activity which some may argue is more representative of functional motion.

However, it is possible that the influence of muscles may inhibit or somehow

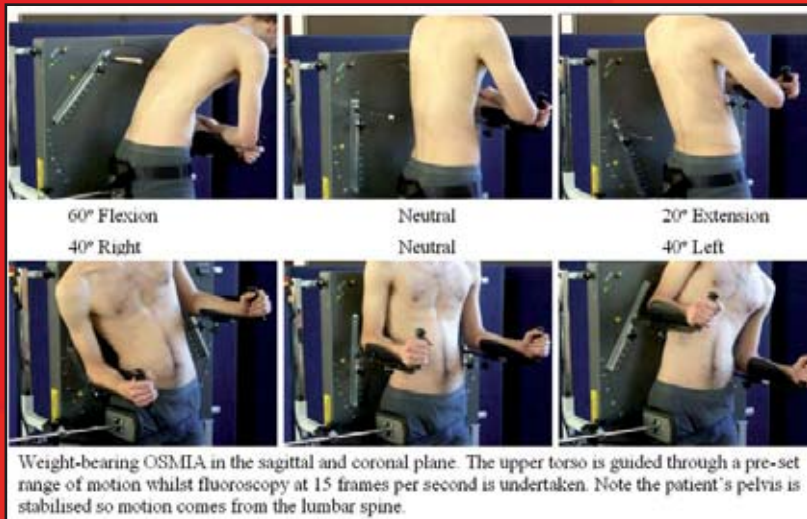


Figure 1. Weight-bearing OSMIA

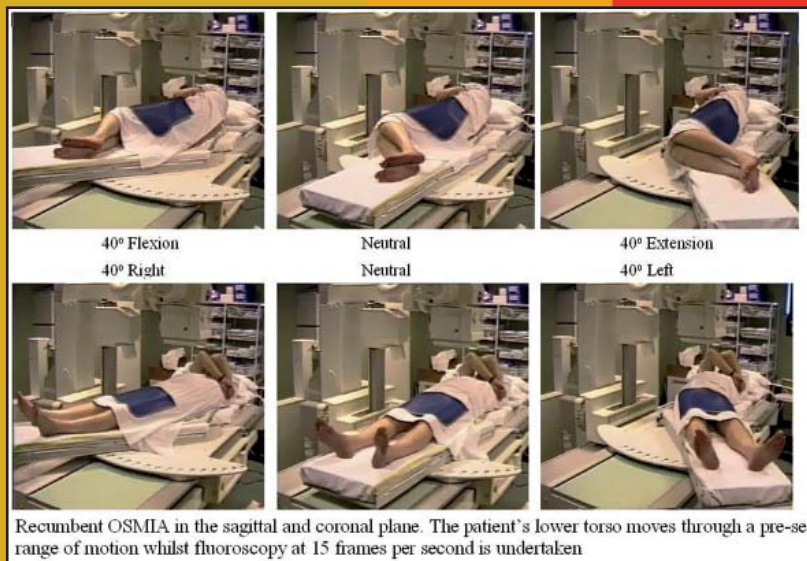


Figure 2. Recumbent OSMIA

alter spinal motion, particularly voluntary or involuntary contractions ('guarding' or muscle spasm), leading potentially to false conclusions about the quality of intervertebral motion. Recumbent OSMIA overcomes this by measuring passive motion only (ie motion not influenced by muscles). For recumbent OSMIA, a specially designed passive motion table (Atlas Clinical Ltd) fits onto existing fluoroscopy tables; the lower half swings through an arc of up to 80 degrees (40 degrees

each side from neutral). Patients lay on the table in either the supine or lateral decubitus position with their hips and pelvis on the lower part of the table whilst their torso remains stationary. As for the weight-bearing procedure, the standard range of trunk motion in the coronal plane is 40 degrees left and right but, in the sagittal plane, the range is 40 degrees extension and 40 degrees flexion. This accounts for the flattening of the lumbar lordosis that occurs as the patient is recumbent.

The cervical OSMIA (see figure 3) uses the same bucky as the weight-bearing lumbar spine OSMIA but with a different attachment guiding the patient's neck through flexion and extension. For both recumbent and weight-bearing lumbar spine OSMIAs, the x-ray beam is centred to the mid-lumbar region (lumbar vertebrae 3/4) and the fulcrum of the table or disc. For the cervical spine, the beam is centred to cervical vertebrae 3/4 and collimated accordingly.

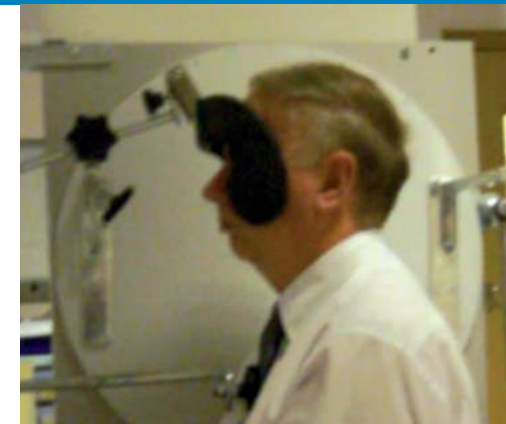


Figure 3. Cervical spine OSMIA

The other main feature of OSMIA is automatic vertebral tracking, undertaken following acquisition of the fluoroscopic loop of spinal motion. The images are individually extracted and the first image is obtained. Pixel recognition templates are manually placed around each vertebra in the field of view (see figure 4) before the templates automatically scan every subsequent image to obtain the best fit (ie they follow the vertebrae through the motion sequence). An output of absolute vertebral angles is produced which are adjacently subtracted (eg L5 - L4) to produce continuous intervertebral rotation (see figure 5) and translation data. Combining rotation and translation allows the calculation of the instantaneous centre of rotation (ICR), a biomechanical term used to describe a precise point of rotation of a vertebra with respect to its neighbour over a given interval of time. Of course, if the vertebra is translating as well as rotating, then the ICR will be located at different points throughout the movement, as demonstrated in cadaveric spines<sup>60</sup>. The location of the ICRs throughout the bend may be another indicator of spinal instability, or abnormal motion but, until recently, it has been impossible to measure these in vivo without taking multiple radiographs<sup>61</sup>.

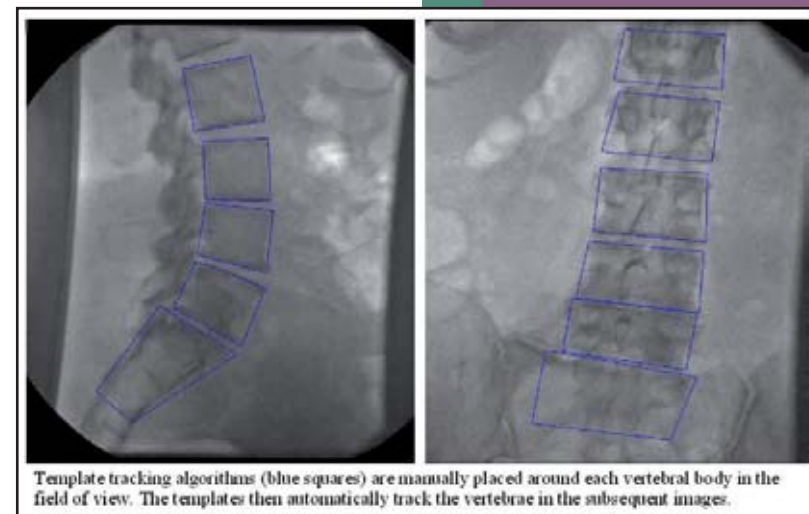


Figure 4. Automatic vertebral tracking. Pixel recognition templates automatically follow the vertebrae throughout the fluoroscopic sequence.

The inter-observer error for OSMIA is 1.86 degrees for rotation<sup>52</sup> and 0.72mm for translation (previously unreported). Earlier OSMIA studies of the lumbar spine



# OSMIA is now a fully operational clinical and research tool

imparted an average radiation dose of 2.6Gycm<sup>2</sup> for 30 seconds of screening at five frames per second<sup>62</sup>. However, this protocol resulted in poor image quality and failure of the automated tracking algorithms. As a result, the protocol was changed to 15 frames per second with an associated increase in radiation dose to 14.9Gycm<sup>2</sup>. This computes to 2.05mSv which is less than the quoted average for a year's natural background radiation in the UK<sup>62</sup>. By comparison, a 5 series lumbar spine radiographic examination (AP/PA, Lateral, L5-S1 junction, Flexion and Extension) would impart an average dose of 1.17mSv (data from Hart 2005<sup>63</sup> converted with NRPB conversion factors<sup>64</sup>). The extra information obtained from video-fluoroscopy justifies the increase in radiation exposure.

## Applications of OSMIA

To date, the majority of OSMIA examinations have been in the recumbent lumbar position for both clinical and research purposes. An initial research study undertaken in 1996 compared inter-vertebral motion in asymptomatic males pre and post chiropractic manipulation. Although there was no overall difference in the rotational range of motion after manipulation, this study produced a set of normative data in the coronal plane which has since been used for comparisons of motion signatures with symptomatic patients.

OSMIA has also been used to detect the presence of pseudarthrosis (failed fusion), defined as movement greater than 5 degrees<sup>65</sup>. OSMIA is less invasive than the current gold standard of re-operation and it is more accurate than plain flexion extension radiographs which only detect 68 per cent of pseudarthrosis<sup>66</sup>. It is known that radiographic and clinical signs of pseudarthrosis are poorly correlated with symptoms, however<sup>67</sup>; hence, further research is needed to establish the relationship between the quality of motion and symptomatic pseudarthrosis.

Between 2004 and 2006, a feasibility trial sponsored by Zimmer Ltd, used OSMIA to compare one method of dynamic stabilisation (DYNESIS) with a standard posterolateral fusion. Baseline pre-surgical data was collected from 10 patients; this allowed interesting comparisons with the asymptomatic data referred to previously. The symptomatic patients appeared to have a higher incidence of unusual motion patterns which were classified as: stiffness (less than 3 degrees ROM), irregular motion (low correlation to trunk motion), paradoxical motion, (inter-vertebral motion in the opposite direction to the trunk bend), and laxity (intervertebral segment reaches its maximum end of range before the trunk motion). With the exception of paradoxical motion, first reported on flex-extension radiographs by Kirkaldy-Willis<sup>68</sup>, these motion patterns are undetectable with static imaging methods. Figure 5 demonstrates an intervertebral motion pattern from an asymptomatic participant and shows a regular sine wave for inter-vertebral rotation throughout the trunk bend. However, figure 6 demonstrates other inter-vertebral motion patterns including irregularity, paradoxical motion, and laxity.

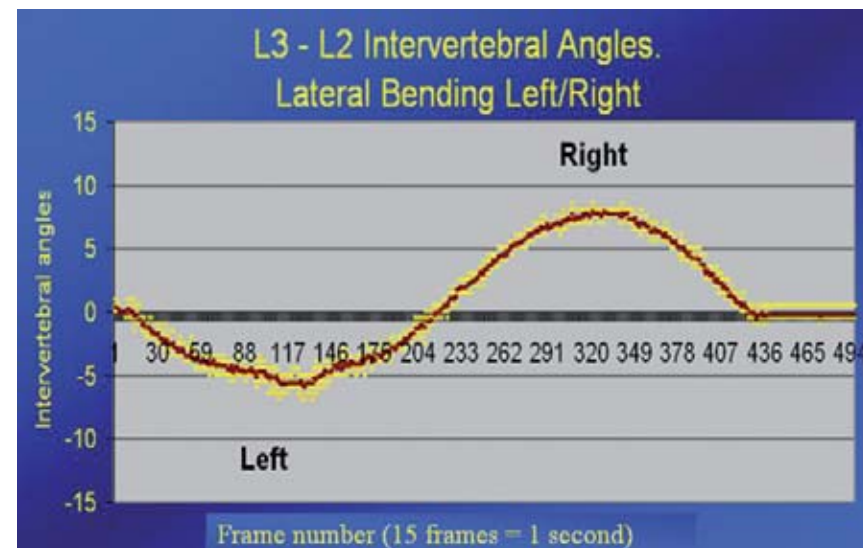


Figure 5. Continuous inter-vertebral rotation from an asymptomatic participant at L2/L3

The appearance of, and explanations for, laxity and irregular motion in vivo may be linked back to the NZ theory, whereas stiffness may be linked to the end stage of the degenerative process in the spine<sup>69</sup>. Consequently, focus has turned once more to the biomechanical model in an attempt to identify sub groups of sufferers with CNSLBP.

## The future of video-fluoroscopy of the spine

Before conclusions can be drawn from the quality of inter-vertebral motion and CNSLBP, more normative data from weight-bearing, recumbent, sagittal and coronal planes are needed. Previous researchers have demonstrated a lower range of motion in the weight-bearing position<sup>34,70-73</sup> which may be due to the stabilising activity of surrounding musculature, whereas d'Andrea<sup>74</sup> demonstrated greater translatory movement in the recumbent plane.

OSMIA comprises a practical investigation to determine the physiology of new and existing treatments for back pain, including the ability of total disc replacements (TDRs) to mimic physiological movement, as well as the presence or absence of adjacent segment disease following spinal fusion. Finally, OSMIA could be used to determine whether the presence of certain motion patterns is linked to pain, so providing data for a new biomechanical approach to CNSLBP.

## Conclusion

There is a high rate of failure for current treatments for CNSLBP and a major reason for this is the heterogeneity of sufferers. Better diagnosis of the cause of their pain would better help selection of appropriate treatments for the various sub-groups

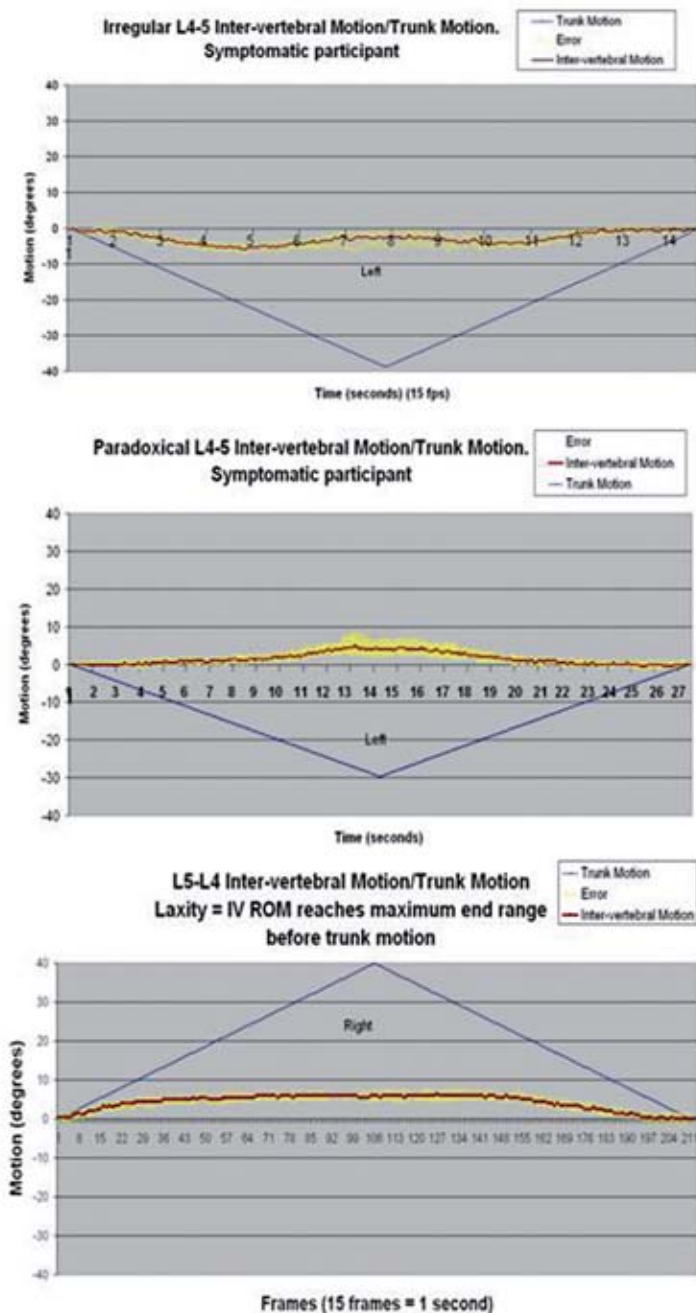


Figure 6. 'Abnormal' continuous motion patterns seen in symptomatic pre-surgical patients.

of patients, so improving outcomes. Video-fluoroscopy of the lumbar spine may help distinguish these subgroups by detecting the quality as well as the quantity of inter-vertebral motion. OSMIA is now a fully operational clinical and research tool.

**Fiona Mellor is a research radiographer and Alan Breen is a chiropractor at the Institute for Musculoskeletal Research and Clinical Implementation, Anglo-European College of Chiropractic.**

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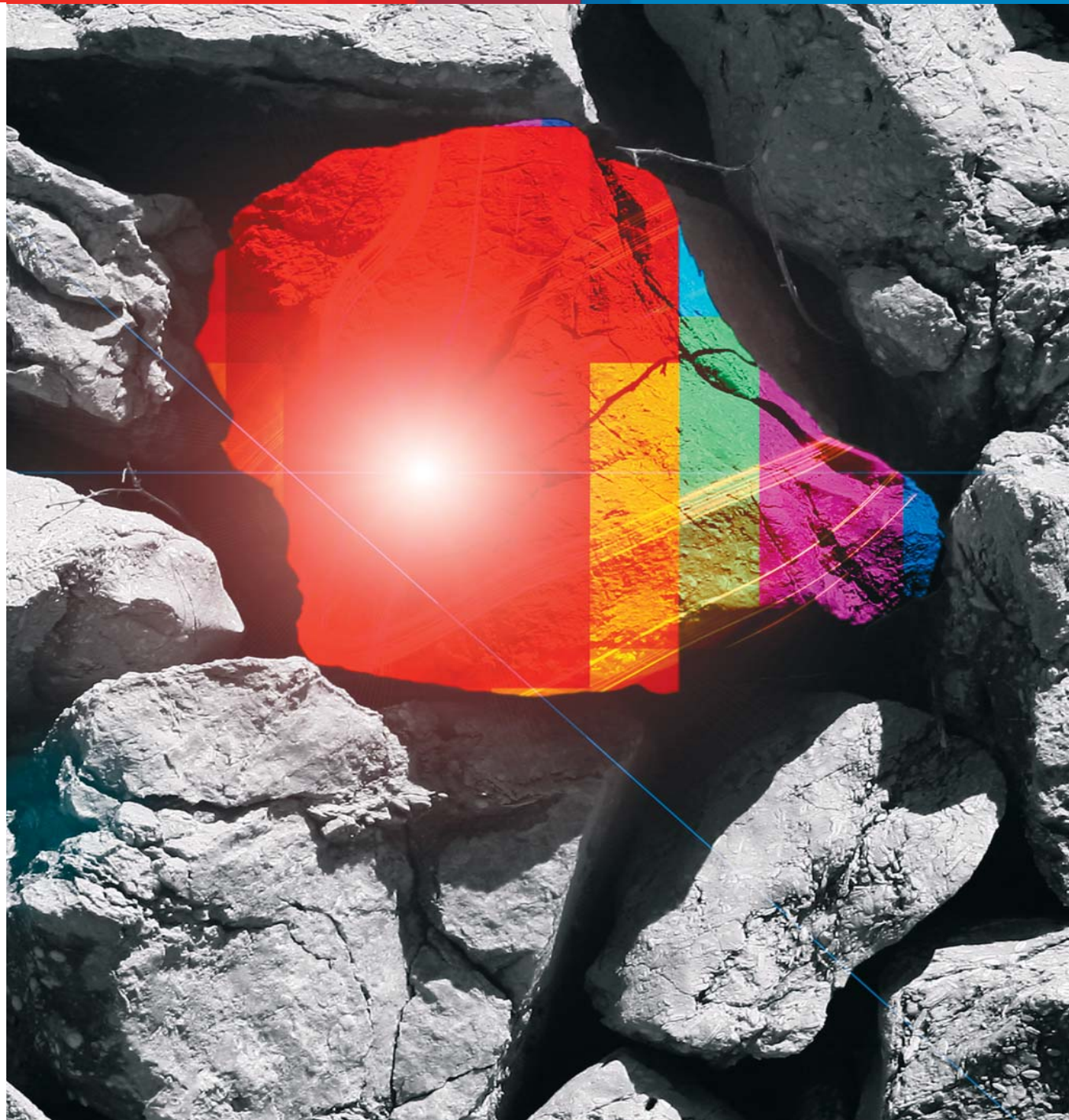
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# SPECT-CT and its role in imaging and oncology

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## Introduction

Nuclear medicine has been engaged in considerable transformational change; this is particularly true in the current decade. In part, this is due to developing technology, software algorithms, disease management pathways and models, and evidence based medicine. The merging of functional and anatomical technologies ('hybrid imaging', for example, SPECT-CT) is beginning to provide a more focused approach to disease management.

Within current clinical practice, various types of computed tomography (CT) configurations are available for purchase with a SPECT system, and the workload of a department as well as its financial constraints will have an influencing factor on the final specifications of such a purchase<sup>1</sup>. Historically, low resolution/dose, single slice CT units (eg GE Hawkeye) provided an initial platform to undertake routine clinical hybrid SPECT-CT imaging; more recently the advent of multi slice high resolution (diagnostic quality) CT has resulted in nuclear medicine centres utilising this technology in routine SPECT-CT clinical practice.

This article focuses on several aspects of SPECT-CT that appear to have particular importance within clinical practice. First, through case illustrations, an indication of where SPECT-CT has value is given; a debate is then raised about the added radiation dose that is incurred through CT. Building on this, the scope of practice of radiographers is considered in light of practitioner and referrer status<sup>2</sup> for the CT component of SPECT-CT and, finally, education and training and business planning matters are considered.

## Areas in which SPECT-CT has value

### Attenuation Correction

An obese 43 year-old female who had experienced left sided chest pain underwent an exercise tolerance test (with ECG); no ST depression was noted. The origin of her cardiac related pain was required and, consequently, the patient underwent stress and rest myocardial perfusion imaging (MPI; see figure 1). The images shown are rest only; row A is not attenuation corrected (AC); row B is with CT AC applied. On comparing rows A and B, the attenuation induced photon deficient artefact (on the non AC images) is corrected on the CT AC images, so ruling out potential myocardium infarction (the stress study demonstrated similar photon deficient areas on the non AC images). This is an interesting case as the resting CT AC images rule out any problem in the inferior wall but pinpoint the problem in the anterior wall. This case illustrates that the use of attenuation correction in MPI should only be used as a tool to support decision making in relation to establishing the presence of attenuation artefacts<sup>3</sup>.

For certain SPECT studies non-homogeneous photon attenuation within the chest

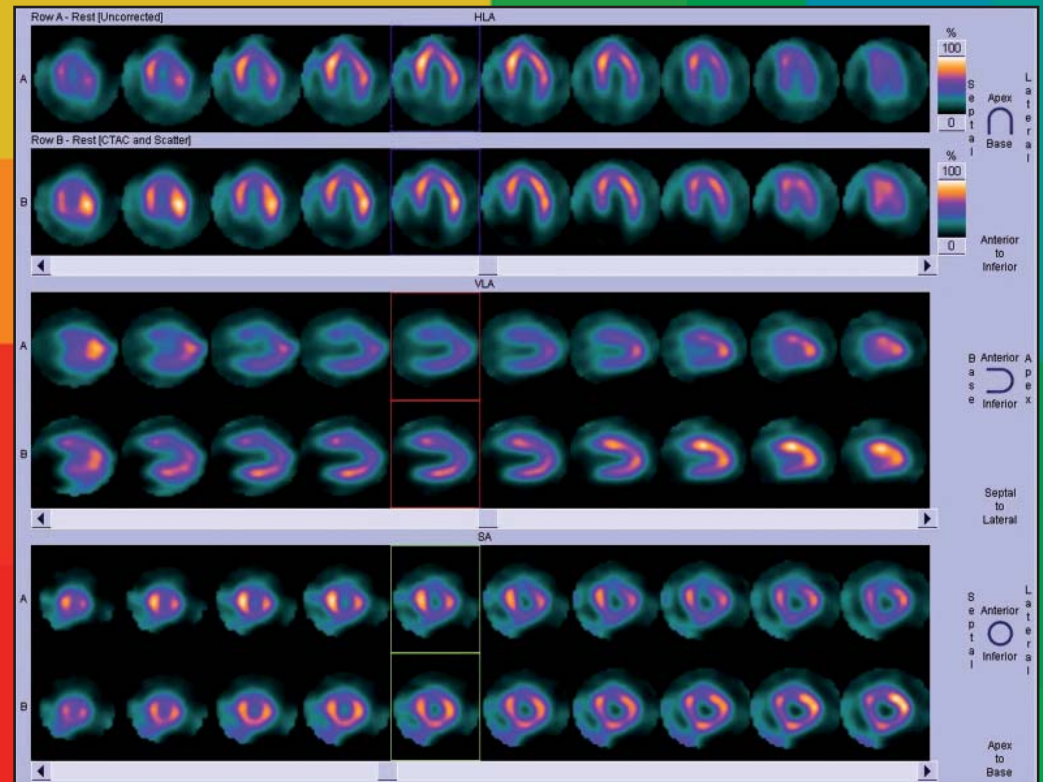


Figure 1. Myocardial perfusion scan, rest images only. Row A = no AC; row B = CT AC applied.

and abdomen has made diagnosis difficult. Non-homogenous attenuation can affect sensitivity and specificity. To counteract this, AC can be used to counteract attenuation artefacts. Attenuation is an exponential process (linear attenuation coefficient); when measured, the value depends upon the proportion of scatter included in the measurement<sup>4</sup>. In SPECT imaging, the spatial distribution of the linear attenuation coefficient data and impact upon the raw projection data is unknown, and additional information (such as the information provided from CT) is required to correct for the effects of attenuation and/or scatter<sup>3</sup>.

Evidence suggests a necessity to interpret attenuation corrected studies as part of an overall quality control process<sup>3</sup>. This may include various steps but the added value of attenuation corrected images should be considered as part of the complete imaging process, and to aid the overall clinical decision making process. In terms of clinical studies which have utilised AC for cardiac imaging, the majority include small to medium sample sizes. Although Ficaro et al's study in 1995<sup>5</sup> included a limited number of patients (n=10), lateral-to-posterior and basal-to-apical wall ratios of near unity value were demonstrated using AC. The use of AC is further supported in more recent research, also undertaken by Ficaro et al in 2002<sup>6</sup>.



## CT can be used with SPECT to localise cold or hot areas

Additional studies by Prvulovich et al in 1997 and Hendel et al in 1999 demonstrated improvements in diagnostic specificity in patients with follow-up angiography, in comparison with non-attenuation corrected images<sup>7,8</sup>. It should, however, be noted that these studies were all conducted using radioisotope and transmission based attenuation correction units, not CT. In terms of the impact of attenuation correction on diagnostic sensitivity of MPI, Duvernoy et al's study on 28 patients with left main coronary artery disease in 2000<sup>9</sup> showed this to be present on 64 per cent of AC images versus seven per cent of uncorrected images.

In the 1980s, the use of external transmission sources such as Ba-133 and Gd-153 were utilised to provide attenuation correction data. However, issues related to poor statistical quality has resulted in a limited use of such sources within modern clinical practice. Nevertheless, in clinical instances whereby only AC is being performed, as in nuclear cardiology for example, the use of a transmission-based system may be justified. Acquiring the required AC data using a transmission based system such as Gd-153 takes longer than a CT based method due to the large difference in available photon flux and the fact that transmission based systems have a limited field of view coverage<sup>3</sup>.

CT data may be used to create linear attenuation coefficients based upon anatomical detail specific to each patient. This data (attenuation map) may be used to correct for the effects of photon attenuation within the subject and, if only AC is being undertaken (eg myocardial perfusion imaging), the CT may be acquired with a lower statistical quality. Although this reduces the spatial resolution, this technique reduces the radiation dose to the patient.

With reference to oncology-based applications, CT AC has particular values. SPECT imaging is increasingly used to quantify the uptake of a particular radiopharmaceutical within tumours/organs. Such targets are quantified in SPECT as volumes of interest (VOI); these are defined around the region to integrate the number of counts, which is directly proportional to the activity (expressed as MBq or mCi) in the volume defined<sup>10</sup>.

Accurate quantitative measurement of radioactivity from a SPECT study can be compromised by the effects of attenuation (and scatter). Such factors may be corrected by the use of CT AC data. The use of SPECT-CT is beginning to create a new role for nuclear medicine in terms of accurately quantifying radionuclide uptake within targets, compared to measurements undertaken with SPECT alone. Results from clinical studies<sup>11,12</sup> have demonstrated the value of SPECT-CT in terms of measuring response to radiotherapy treatment for patients with non-Hodgkin's lymphoma and radioimmunotherapy. The use of SPECT-CT within oncology is beginning to replicate clinical experience with PET-CT, in terms of improving localisation and extent of disease, and differentiation of physiological and pathological uptake.

### Localisation

CT (low resolution or diagnostic quality) can be used in conjunction with SPECT to help localise cold or hot areas seen on SPECT imaging. This has particular value in cases where there are limited or no anatomical landmarks present on SPECT imaging and/or when such landmarks are present but greater anatomical spatial resolution is required. Examples with the registration of SPECT with CT for localisation purposes could include: to aid definitive diagnosis and to give more precise lesion localisation as part of surgical work up, such as sentinel lymph nodes<sup>13</sup>, radiotherapy treatment planning<sup>14</sup> or initial patient treatment work up<sup>15</sup> (eg neuroendocrine tumours (NET)).

Advancements in computing power and software algorithms have also impacted upon the ability to compensate for the errors in SPECT imaging. In particular the inclusion of an iterative reconstruction model (eg OSEM) for the correction of attenuation with SPECT data and providing quantitative information is becoming more common within clinical practice<sup>10</sup>. Numerous studies have identified the improved diagnostic accuracy of SPECT/CT over conventional SPECT imaging and the empirical evidence points toward the following areas of clinical practice which have benefited from the emerging hybrid imaging technology, for example:

- Lymphoma<sup>16</sup>
- Lung Cancer<sup>16</sup>
- Primary and secondary malignant bone disease<sup>17</sup>
- Infection and inflammation<sup>18</sup>
- Abdominal disease<sup>19</sup>
- Endocrinology<sup>15,20</sup>

A comprehensive list of potential clinical applications for SPECT-CT has previously been published<sup>10</sup> and the majority of applications relate to the anatomical localisation of tumours using various radiopharmaceuticals. Published research by Koral et al identified the added value of SPECT-CT in terms of providing valuable tumour organ uptake and dosimetry data, enabling accurate patient workup prior to treatment for lymphoma<sup>11,12</sup>. This research involved a range of professional fields and provides evidence of multiprofessional working.

### Case study

An eight-year-old male presented with a painful right tibia; the clinical question surrounded whether this patient had an osteoid osteoma or leukaemia. A whole body bone scan was conducted (anterior and posterior) and a focal area of uptake was noted within the right femur. Subsequently, localised SPECT images of pelvis and femora were acquired; the poor resolution could not differentiate the high uptake between cortex and medulla and CT imaging was undertaken (see figure 2). Correlation with plain films and a SPECT-CT acquisition of the area show a localised area of thickening and sclerosis of the medial cortex of the upper right

femoral shaft, and a small central lucent nidus with a surrounding sclerotic rim. The features are consistent with an osteoid osteoma.

Surgical resection of certain pathologies often requires quite precise localisation of lesions prior to surgery. This helps the surgeon locate the area to be removed more quickly; it also helps the surgeon plan more accurately which areas need

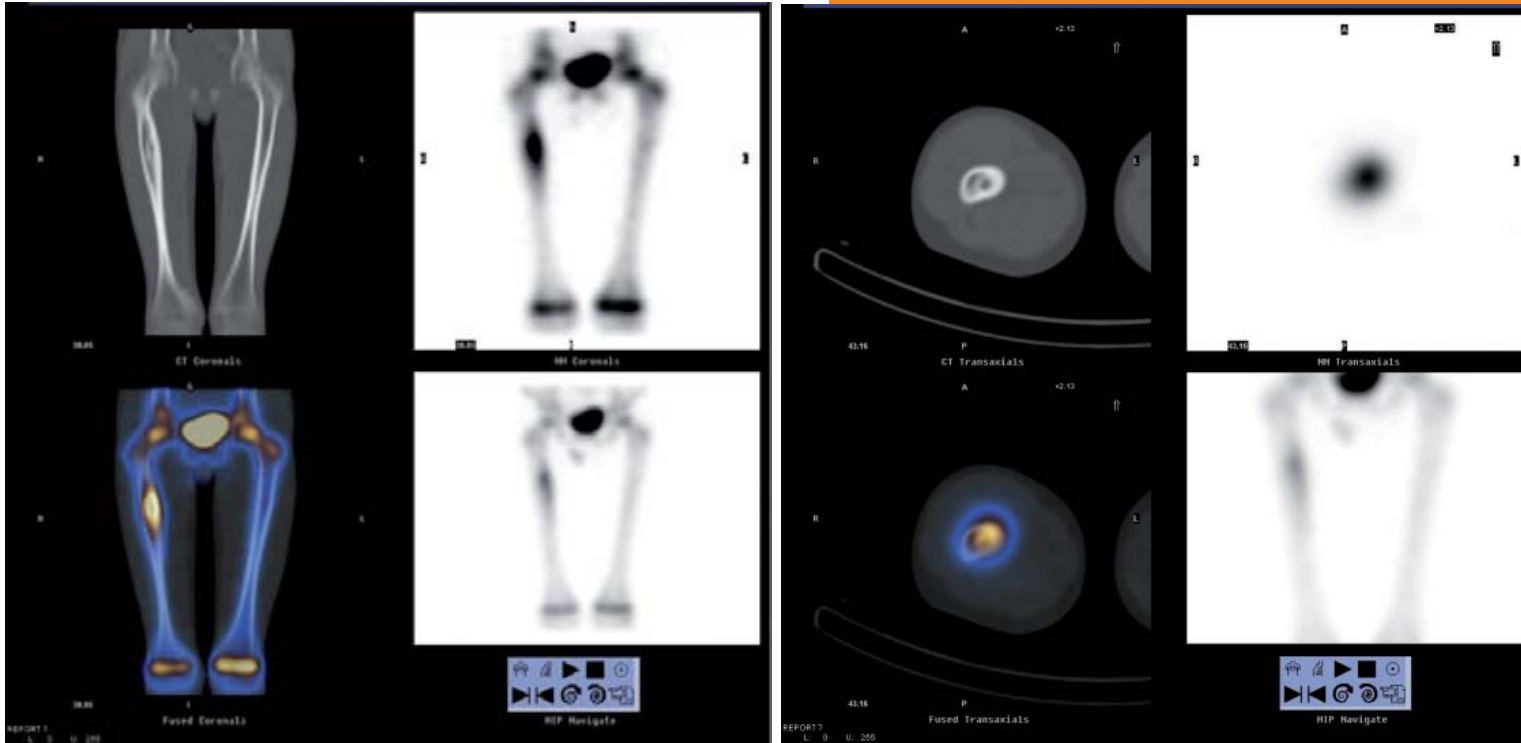


Figure 2.

to be removed. Better intelligence prior to and during surgery results in increased probability of removing the affected tissue and reduced operating time. Both can have an impact on post-operative recovery and, ultimately, patient outcome.

Low dose/resolution and high dose/resolution can both play a part in localising lesions seen on SPECT studies, and the precise overlay of regional anatomy, together with co-registered SPECT-CT (structural and functional aspects) of the lesion make for better surgical localisation, possible radiotherapy treatment or, even, extraction of tumour tissue. For example, SPECT-CT of brain tumours using a range of Tc99m based radiopharmaceutical agents, such as Sestamibi and Tetrofosmin and In-111 Pentetreotide, may be utilised to provide accurate functional and anatomical diagnosis, and monitor patients' responses to

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An educational  
strategy is  
required for  
the use of  
CT in nuclear  
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radiotherapy/chemotherapy treatment. CT used in isolation cannot always distinguish tumour progression from radiotherapy damage/necrosis, even up to several months after the patient has received treatment<sup>14</sup>.

Various empirical studies and critical reviews have demonstrated the additional value of SPECT-CT over stand alone SPECT systems, particularly in cases such as lymphoma<sup>21,22</sup>, infection and bone disease<sup>17</sup>. However, there appears to be a debate relating to the appropriate use of low dose CT for attenuation correction and/or basic localisation purposes (which were the parameters of a low performance x-ray scanning device) and higher quality CT data for improved anatomical image quality. Roach et al's study in 2006<sup>23</sup> was conducted using a multislice SPECT-CT unit which permitted greater spatial resolution for the anatomical data. Although the overall final diagnosis and reporter confidence was improved using a multislice SPECT-CT unit, the increase over first generation low-performance SPECT-CT units was minimal.

### Diagnosis using diagnostic quality CT

SPECT-CT has a role in diagnosis, particularly when 'targeted' SPECT imaging reveals lesions with no surrounding discernable anatomical landmarks (for localisation) and also when the internal structure of the SPECT lesion needs additional radiological (high resolution CT) scrutiny to determine its nature. An example could be differentiated thyroid cancer, using whole body imaging with iodine 123 or 131. Here, the precise localisation of lesions is often not possible because of the absence of anatomical landmarks in nuclear medicine data. Co-registered SPECT-CT allows for differentiation between artefactual and normal uptake, and pathological uptake.

Research conducted by Roach et al highlighted the value of SPECT-CT in terms of diagnostic accuracy and reporter confidence within clinical practice<sup>23</sup>. This evaluation of the impact of SPECT/CT on common areas of clinical practice, such as bone scintigraphy, infection imaging (Gallium-67), Indium-111 octreotide scans, I-123/1-131 MIBG scans/treatment monitoring, and Tc-99m Sestamibi parathyroid scans, reflected a typical nuclear medicine department workload. Overall, the utilisation of SPECT-CT added extra confidence to the final diagnosis, and reporter confidence was also increased in particular cases where anatomical landmarking would have been an issue without the CT data. The following case study demonstrates the clinical value of diagnostic accuracy using SPECT-CT.

### Case Study

A 78 year old female had known multiple liver metastases from a carcinoid tumour and Yttrium-90 therapy was being considered. An In-111 octreotide SPECT-CT scan was conducted (see figure 3). As can be seen, the images demonstrate liver metastases, incidental adrenal gland findings and hydronephrosis. The

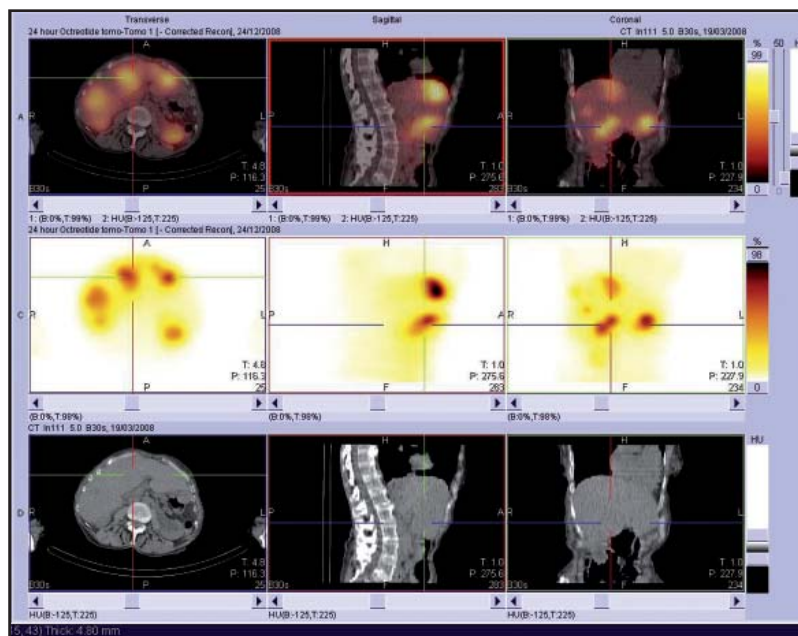


Figure 3. Radiation dose from CT

morphological appearance of the metastases can be clearly located on the diagnostic quality CT image series, giving heightened confidence for areas of radiopharmaceutical uptake.

One of the biggest considerations of using low resolution or high dose CT scans in addition to SPECT is the additional radiation dose to the patient and whether or not the extra dose from using high-resolution CT is justified, bearing in mind the extra clinical information that may be obtained. Table 1 illustrates radiation doses that a patient will typically receive from SPECT, low-resolution and high-resolution CT, and plain radiography for reference. As can be seen, the CT component adds a significant amount to the total dose the patient receives; this is particularly true for high resolution CT. It is interesting to compare plain film and high resolution CT and the dose differential. This brings into sharp focus the need to consider carefully whether CT or plain film imaging would give the same radiological information and, if so, whether the lower dose alternative (plain film) would be better justified.

### Professional responsibilities and legislative considerations

Depending upon local circumstances in clinical imaging departments, radiographers can be referrers, practitioners and operators within the context of the Ionising Radiation (Medical Exposure) Regulations<sup>2</sup> (IR(ME)R). Within nuclear medicine and with regard to radiopharmaceuticals, this is not the case. Radiopharmaceuticals are regulated

Radiographers have adopted the roles of referrer, practitioner and operator

	Imaging and Dose (mSv)							
	SPECT [i]		Low-Res CT <sup>[ii]</sup>		High-Res CT <sup>[iii]</sup>		Plain Film <sup>[iv]</sup>	
<b>Pulmonary Nodes</b>	Tc-99m Depreotide	6	Chest	1	Chest	5.8	Chest	0.02
<b>Lumber Spine Metastases</b>	Tc-99m phosphonate	5	Abdo + pelvis	1.5	Abdo + pelvis	7.1	Lumber Spine	1.3
<b>Myocardial Imaging</b>	Tc-99m sestamibi	4	Chest	1	Chest	5.8	Chest	0.02

Table 1.

[i] Notes for Guidance on the Clinical Administration of Radiopharmaceuticals and Use of Sealed Radioactive Sources Health Protection Agency, Administration of Radioactive Substances Advisory Committee, March 2006 (Revised 20 April 2006).

[ii] Effective doses to patients from CT acquisitions on the GE Infinia Hawkeye: a comparison of calculation methods. Sawyer, L et al. Nuclear Medicine Communications. 29(2):144-149, February 2008.

[iii] Doses from computed tomography (CT) examinations in the UK – 2003 review Shrimpton PC et al. NRPB-W67 March 2005.

[iv] RADIATION PROTECTION 118 Referral guidelines for imaging, European Commission 1999.

under both medicines and ionising radiation legislation and the former mandates that only a registered dental or medical practitioner may direct the clinical service and, as such, provide the clinical justification required under IR(ME)R. For nuclear medicine examinations, with regard to IR(ME)R, only the ARSAC licence holder may justify clinical examinations. Radiographers working within nuclear medicine and with specific reference to radiopharmaceuticals may only act as operators.

Within nuclear medicine departments, legislative arrangements permit radiographers to act as practitioners and referrers for x-ray examinations and acting as referrer for plain x-ray examinations, in association with nuclear medicine procedures, has become common practice. Using the same legislative arrangements, radiographers can, indeed should, act as referrer and practitioner for the CT component of SPECT-CT. There is logic for both as SPECT-CT has limited routine applications. For many patients, the decision to make a CT exposure (low or high resolution) will depend on factors such as the clinical background, physical make up and the nuclear medicine images themselves. Hence, the decision to refer for CT may only be made at the point of care within the nuclear medicine department. Therefore, the radiographer is ideally placed to fulfil the role of referrer. In full knowledge of the evidence base and the clinical background, a radiographer can act as practitioner, thereby protecting the patient from unnecessary x-radiation exposure. On discussion with several nuclear medicine departments, it was found that radiographers have already adopted formally the roles of referrer, practitioner and operator for the CT component of the SPECT-CT studies.

### Business, practical and educational considerations when purchasing a SPECT-CT system

A department should consider the physical footprint required for a hybrid SPECT-CT system. This is especially true if the existing gamma camera has a small footprint. Some clinical departments within the United Kingdom are

replacing first generation SPECT systems with SPECT-CT units, which generally require a larger physical space. The space required for a SPECT-CT system will depend on the type of unit being installed and the nature of the examinations conducted. The quoted minimum room size for a GE Hawkeye/Hawkeye-4 is 14 feet x 16 feet and the amount of lead shielding required for this environment may be less than a dedicated CT unit. Some departments utilise mobile lead shielding devices for the GE Hawkeye devices which permits some flexibility with the organisation of the imaging environment. The exposure rate from low performance CT units is approximately 20 times less than that from a multislice CT unit<sup>24</sup> and the use of mobile shields are common in departments with these units.

A larger physical room environment (minimum 15 feet x 24 feet) is required for SPECT-CT systems employing a dedicated multislice CT unit, and thicker protective shielding is required for the use of multislice SPECT/CT units. The weight bearing parameters of the floor should also be considered<sup>24</sup>, especially if the unit is not being installed on the ground level within a hospital. Separate operator console environments are also becoming common within SPECT-CT rooms, although this does remove an element of patient interaction normally associated with nuclear medicine.

Currently the cost of the high end CT components (eg 64 slice) may exceed the cost of the SPECT device and the justification for such units will depend upon the clinical workload of a nuclear medicine department. With current shifts in imaging tools for certain conditions (eg pulmonary embolism), a SPECT-CT unit with multislice capabilities may be positioned to undertake contrast enhanced CT scans, such as pulmonary angiography and the assessment of coronary calcification<sup>10,25</sup> and, potentially, providing a 'one stop' approach for patients undergoing their diagnostic CT and physiological scans, if required.



Nuclear medicine departments may wish to evaluate the feasibility of undertaking CT examinations during periods where access to radiopharmaceuticals is limited (eg early morning/late afternoon), or utilising the CT component of the hybrid unit for out-of-hours work to alleviate some of the demands on the radiology department's main CT unit. This may require some degree of cross pollination of training requirements<sup>26</sup> and the development of appropriate educational curriculum within the workplace and at academic institutions. Educational programmes for nuclear medicine technologists in North America and Australia provide focused academic and clinical training specifically related to the utilisation of CT within the nuclear medicine environment.

In the USA, working relationships between the Society of Nuclear Medicine Technologists and the American Society for Radiologic Technologists are considered to be a good example of a synergistic approach to the training requirements between professions. The University of Sydney in Australia also offers a dedicated distance based CT module aimed at nuclear medicine technologists who are involved in using CT within a nuclear medicine environment. In the UK, there is limited scope for the provision of a dedicated hybrid imaging programme. However, short courses for technologists related to the safe use of CT, and hybrid imaging modules of study have emerged from two academic institutes over the last couple of years. Currently, it is unclear what CT training requirements are needed officially by a technologist working within the hybrid nuclear medicine field, especially if the CT unit has a multislice configuration and the imaging parameters are interchangeable. A clear educational strategy is required for the safe and optimal use of CT within a hybrid nuclear medicine environment, to minimise patient dose and optimise disease detection, aiding patient management.

### Conclusion

Following the inception of SPECT-CT hybrid technology, there appears to be an evolution in the useful applications associated with this modality. Initial 'low-end' systems introduced over a decade ago provided a platform for improved anatomical localisation and high photon-flux attenuation co-efficient data, potentially improving the sensitivity and specificity of existing imaging techniques. Beyond the existing techniques, SPECT-CT has the potential for mirroring the success of PET-CT in terms of radiotherapy planning, dosimetry calculations and multi-imaging approaches, which include coronary artery calcium scoring and myocardial perfusion imaging.

As detector technology also continues to evolve, the overall design and utilisation of future SPECT/CT units may further develop. The use of solid state materials such as cadmium-zinc-telluride will provide a single detector interface and, potentially, improve the functional count rate and spatial resolution further. The training and

education of the hybrid imaging workforce is crucial to the future utilisation of this important area of clinical practice.

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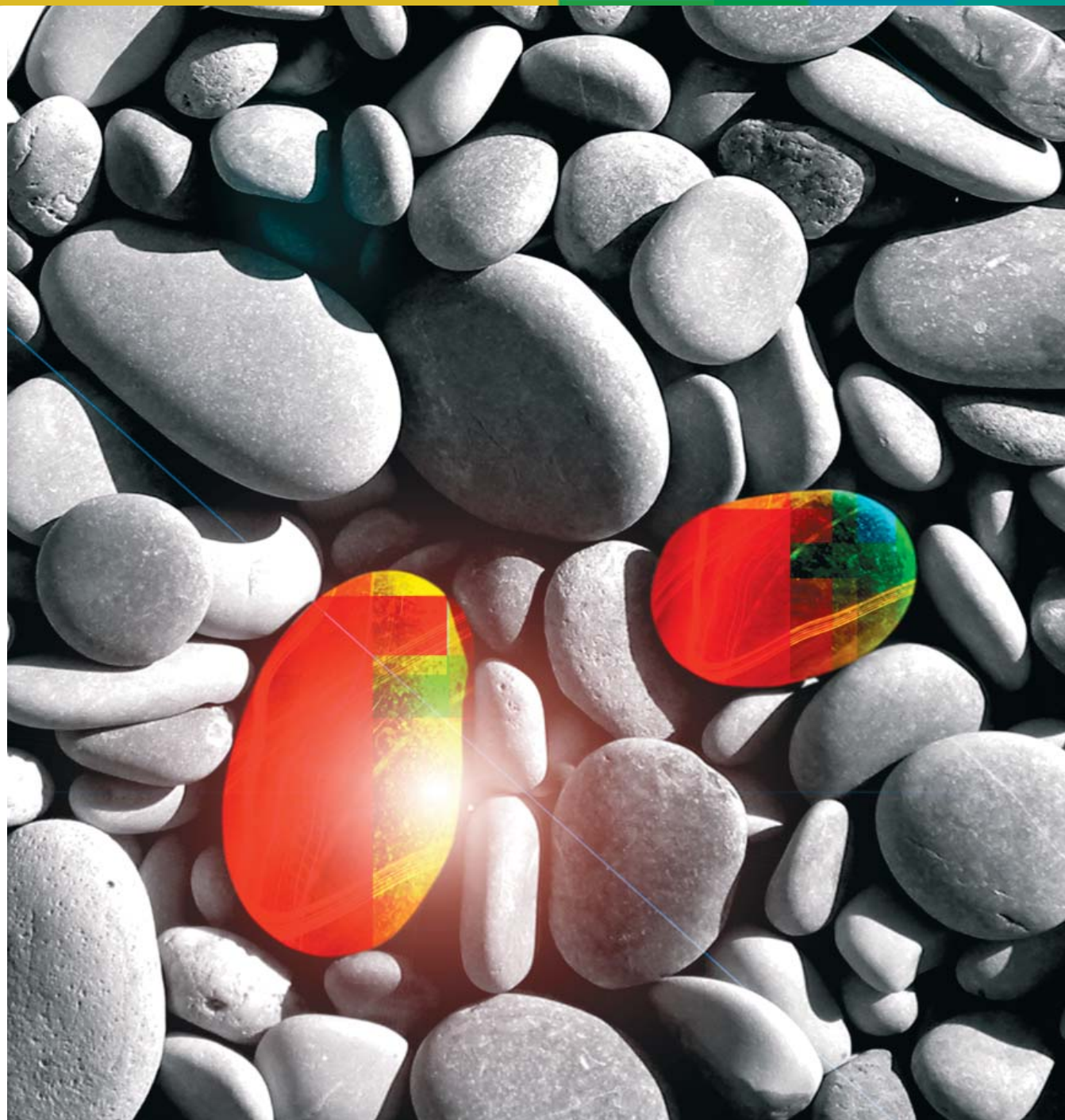
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# Living with the targets in radiology

Amanda Martin and  
Anthony Maxwell





# Radiology is process- intensive

## Introduction

For many radiology departments the pain of trying to get waiting times down to meet the December 2008, 18-week general practitioner (GP) referral to treatment target, is beginning to ease. However, the problems of sustaining acceptable waiting times in the face of a continuing escalation in demand are becoming apparent. In many cases, waiting times have been reduced to meet the target by additional out of hours work, often in an expensive ad hoc manner. Clearly, a more systematic approach is needed, and this article will explore some of the possibilities. These are based largely on the principles of Lean.

## What is Lean?

Lean thinking, or simply Lean, is based on a set of ideas which was developed by the Japanese car manufacturer Toyota in the 1950s and was known as the Toyota Production System (TPS). As a result of the use of TPS, Toyota began to increase its profits and market share while the North American car companies, which had previously enjoyed domination of the market, began to see a downturn. The Japanese demonstrated that they could produce more cars in less time, with less stock, in a smaller space, and with fewer defects than their competitors, whilst having minimal absenteeism. This was achieved by focusing closely on the manufacturing processes, concentrating on improving quality and eliminating waste.

Over the last half-century, Lean thinking has been applied successfully by many other manufacturers, and more recently has been embraced by suppliers of services such as postal carriers, insurance companies and healthcare organisations, and also retailers such as Tesco. It can be applied in any organisation that utilises complex processes. In essence, it consists of the following:

- Identify the 'value stream' – the parts of the process that really add value to the final product or service (the 'value-added' steps).
- Eliminate waste (the 'non-value-added' steps) from the process. Waste is everywhere – overstocking, waiting, transport, duplication, overproduction, etc.
- Pursue perfection by constantly improving the process and quality of the product or service.

Benefits that can be gained in healthcare include:

- A truly patient-centred service, designed around patients' needs.
- Decreased waiting times,
- Increased throughput,
- Improved environment,
- Decrease in resources required,
- Increased quality.

## Lean in radiology

Radiology is process-intensive. Traditionally, it has been associated with long waiting times, particularly for outpatient services. Waiting is a form of waste, and this therefore suggests that the use of Lean could be beneficial. The Royal Bolton Hospital Radiology Department has been using Lean for almost four years as part of a trust-wide application of Lean, known locally as the Bolton Improving Care System (BICS). A group of trained facilitators enable individuals to come together, work through a problem in a systematic way and implement a solution using Lean tools. Three case studies from the radiology department are given later in this article but, before those, some more general ideas about improving radiology services are discussed.

## Be ambitious

To provide the timeliest service for patients and to allow for occasional slippage in turnaround times when things aren't going quite to plan, services should aim to perform and report examinations within two weeks of receipt of the request. There are plenty of opportunities to provide a same day imaging service. The prime example of this is in breast clinics. In many trusts mammography, ultrasound and needle biopsy at the first outpatient visit is well established. This 'one stop' model can be extended to other imaging-intensive specialties such as urology (renal ultrasound, intravenous urography and computed tomography [CT]) and ear, nose and throat (sinus CT, and neck lump ultrasound and biopsy). Not only does this provide an excellent service for the patient, it also eliminates the work associated with booking appointments. Short Lean '2P' (Process Planning) events are useful to plan these changes.

## Change the culture

Major changes to the way imaging departments provide their services cannot be achieved without a major change in staff attitude. Instead of paying lip-service to the notion of a patient-centred service, staff should consider how they would wish the service to be provided were they patients themselves. The large amount of public money that has been sunk into the National Health Service (NHS) really does give patients the right to expect a good service, something which is sometimes forgotten. Involvement of front-line staff in Lean service improvement events is essential so they develop a sense of ownership of and pride in their service. It is important to involve medical staff where appropriate, as they are often the most resistant to change. Making full use of the skills of existing staff with the appropriate use of skillmix not only makes sense financially, but also increases staff ownership of the service.

## Leadership

Major changes cannot be wrought without strong clinical and managerial leadership. An effective departmental management structure is needed, and there



should be representation of the radiology department at senior management level. The innate suspicion that clinicians and managers sometimes have of each other can be diffused by recognising that, in most cases, they share the same ambitions and goals for the radiology service. Lean service improvement events are an excellent way of bringing clinicians and managers together, and are a very effective method of demonstrating the need for investment where service redesign alone is not enough. On occasions, managers may need reminding of the pivotal role of radiology in the management of many patients and that support for improvement in radiology can result in speedier assessment of emergency admissions and reduction in hospital length of stay.

### Information technology

Picture Archiving and Communication System (PACS) has given radiology departments a fantastic opportunity to change the way they work. No longer are departments tied to hard copy films. This, together with digital dictation and voice recognition, give the capability to report images as soon as they have been acquired at any available workstation on the system. Same-session reporting of ultrasound and inpatient CT is the norm in many hospitals, and departments should work towards 'hot' reporting of emergency department (ED), inpatient and GP plain 'film' work. Electronic requesting and results reporting should be implemented to cut the current dead time when requests and reports are in transit.

### The right equipment

Radiology departments need to be adequately equipped. It is a false economy to delay the replacement of obsolete equipment as it becomes increasingly difficult to maintain, and there are significant workflow advantages with direct digital radiography (DR) over computed radiography (CR). There are often further advantages to be gained by placing equipment in the patient flow outside the main radiology department – two examples from Bolton are given below. Lean service improvement events are useful to optimise the use of existing equipment and to provide a persuasive case for equipment replacement where such need exists.

Capital funding for equipment replacement is often difficult to obtain, and trusts should consider the option of a 'managed facility service' – essentially purchasing a service from a supplier who will provide regular equipment replacement, usually over a 10 to 20 year period, to an agreed timescale for a fixed monthly payment. This also takes advantage of the VAT-free status of the purchase of a service as opposed to equipment.

### Case studies from the Royal Bolton Hospital

The application of Lean is shown below, with three examples from the radiology

## Waiting time for an outpatient appointment reduced by two weeks

department at Bolton: the complex development of a dedicated orthopaedic radiology service; the simple rescheduling of patients within the CT department; and the development of a new acute ultrasound service.

### Orthopaedic radiology

In 2006, complaints about the orthopaedic radiology pathway were on the increase. Patients complained that they were waiting excessively in radiology, radiographers complained that there were too many patients attending in a short period of time and clinicians complained about clinics over-running due to the late return of patients from radiology.

A team was identified, consisting of staff directly involved in the orthopaedic radiology pathway, leaders, patient representatives and staff who were not familiar with the pathway. Engaging a diverse team including staff who know the service, and encouraging them to redesign the process as they see fit, is fundamental to Lean and enables sustainability to be achieved. The team took a week out from their normal roles for a Lean rapid improvement event (LRIE). The aim was to improve access to radiology, with shorter waiting times, a better patient flow and increased staff morale.

A value stream analysis was performed, documenting the value-added and non-value added steps in the process. A 'current state map' of the journey from arrival at the main hospital entrance to being discharged from clinic was created. An 'ideal state' was identified, the pathway that could be provided if money, resources and space were no object. From this a proposed 'future state' was created, a pathway that is achievable in the near future.

The data demonstrated that a patient could spend five hours on one visit to the orthopaedic clinic with up to two hours being spent in the radiology department. Patients were frustrated with being sent across a main corridor from one department to another, having to queue and give their personal details to multiple receptionists and having to wait continually in often overcrowded waiting rooms. These problems were exacerbated by prioritisation within radiology of patients from the ED as a result of the four-hour target for such patients, leading to outpatients having to wait even longer for their imaging. Staff were stressed and overworked. Radiology staff were unable to cope with the large numbers of patients arriving in a short period of time and delays in their imaging resulted in outpatient staff having to cover over-running clinics. Sickness absence rates were above the Trust target.

Investigation of the clinic booking template identified that the majority of patients were being booked in the first 90 minutes of a session, with up to five patients being booked every five minutes. This was because of the misconception that, if all





same day CT scans. Ad hoc evening lists were being scheduled to scan patients that could not be accommodated during the normal working day.

A two-day 2P event was arranged. This required data collection and the development of a current state value stream map (VSM) prior to the event. The team involved in the event consisted of a range of professionals associated with the CT scanning service and each team member had ideas as to the root cause of the problems. These ideas were captured on a 'fishbone' (cause and effect) diagram.

From the VSM, it was identified that there were up to 22 steps in the process of appointing and scanning a patient. Only two of these steps added value for the patient, and the process took as long as 32 days. One of the problems creating this delay was that of carve-out for the one-stop clinics and ward patients. These patients seldom arrived at the correct time for their slots, leading to delays in scanning the outpatients and wastage of slots.

It was decided to conduct a rapid experiment of fully booking one of the two scanners with outpatients only, and partially booking the morning session on the second scanner with outpatients. The rest of the appointment slots were then available for ward patients, one-stop clinics and emergencies. This proved successful, with improved capacity for outpatient appointments and a better flow through the fully booked scanner, whilst allowing the second scanner to deal with urgent cases only. Standards were written for referral management, appointment and scanning processes. Staggered radiographer lunch breaks are taken, allowing inpatient scanning to continue uninterrupted. The waiting time for an outpatient appointment reduced by two weeks and the majority of in-patient requests are now accommodated on the day of referral.

### **Acute abdominal ultrasound**

In March 2007 a rapid improvement event was held to implement changes to the abdominal pain pathway identified as necessary during a previous scoping event. Whilst introducing these changes, it was recognised that difficulties in accessing diagnostics, in particular ultrasound scanning, was causing blockages in the pathway, resulting in delays in diagnosis, unnecessary admissions, and extended length of stay for a significant number of patients. A 2P event allowed the feasibility of offering a dedicated abdominal pain ultrasound service to the ED to be assessed and a rapid experiment was organised to allow abdominal pain patients quick access to ultrasound with prompt review by senior staff.

Siemens Medical Systems loaned a midrange piece of ultrasound equipment and a suitable room for scanning was identified within the ED. The examinations were performed by an advanced practitioner in ultrasound. The service was offered

between 9am and 5pm for a period of one week. ED patients requiring ultrasound were scanned in the scan room or, if clinically indicated, at the bedside. A senior member of the surgical team reviewed the patient and treatment commenced with or without admission. Any patient who attended after 5pm was admitted, if required, and scanned the following morning. To identify potential benefits, the medical team documented the expected and actual benefits for each patient who accessed this service.

It was found that, on average, there was a decrease in presentation to scan of approximately 10 hours per patient, with an increase in the ED waiting time of only 15 minutes. It was estimated that an average of three bed nights per patient scanned had been saved as, once a patient was admitted, the process for requesting and conducting the scan could take up to 48 hours. The patient could then be an inpatient for a further 24 - 48 hours whilst a clinician reviewed the results, prescribed treatment and discharged the patient.

An increase in sonography posts was approved as a result of the experiment, and the service has now been established. It is anticipated that it will be extended to include trauma examinations, vascular examinations and obstetric and gynaecology examinations.

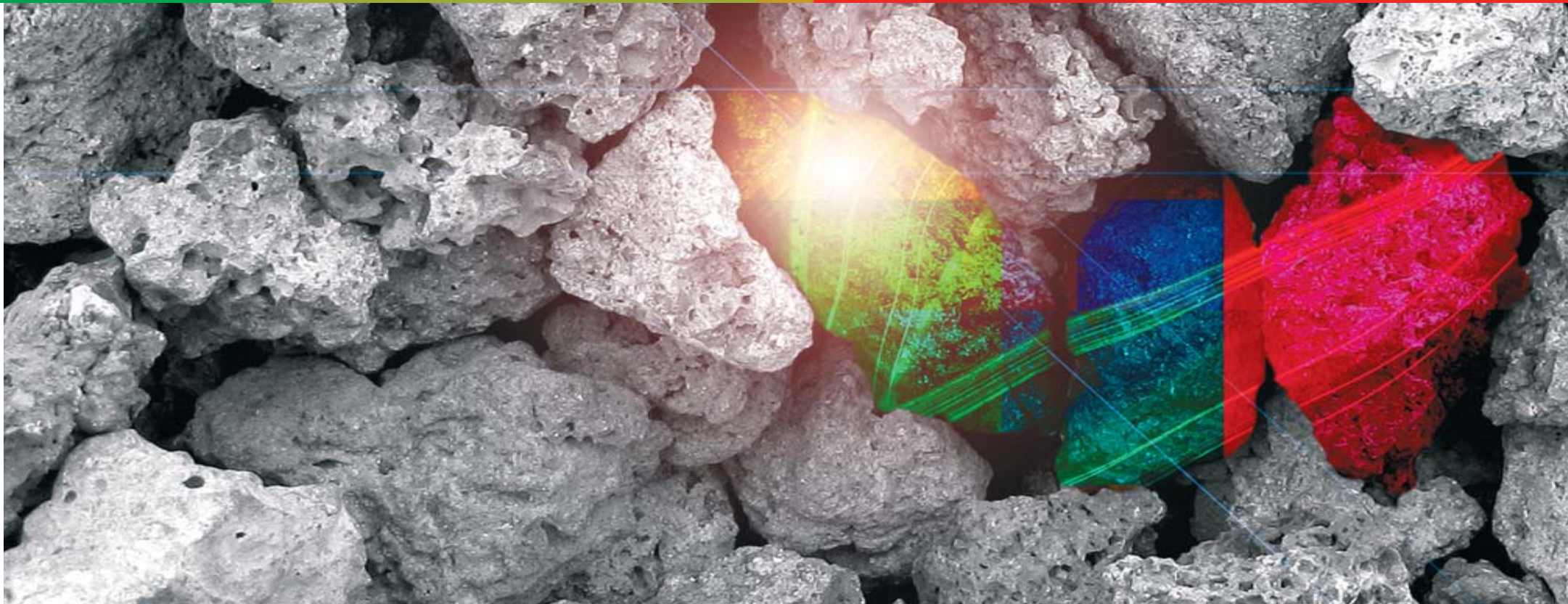
### **Conclusion**

This article has attempted to provide some ideas for service improvement which others may wish to consider for their own departments. In particular, it is hoped that the benefits of the adoption of Lean thinking have been illustrated and, in particular, how Lean can be used to bring staff together in the pursuit of service excellence.

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The team documented the  
expected and actual benefits for  
each patient  
.....





# Teleradiology – how much flatter is the world now?

Paul Dubbins



## Introduction

Teleradiology is the electronic transmission of radiographic images from one geographical location to another for the purposes of interpretation and consultation.

Sounds simple, doesn't it when defined in that way? Why then has the introduction of teleradiology caused so much debate and, indeed, so much unhappiness amongst the professions? Individuals and professional bodies cite issues of quality, of lack of consent, of loss of continuity of care, of legal jurisdiction, amongst others to oppose the growth of teleradiology as a method of delivering imaging services. It is important, however, to separate the technology from potential applications.

## Why is teleradiology so important?

The world of medicine has been irrevocably changed by the advances in medical imaging. Patients presenting to primary or secondary care are now much more likely to undergo imaging as part of the diagnostic work up. In Japan, for example, the number of imaging investigations approaches three per head of population, per year. In the United Kingdom (UK) the number remains less than one but the growth of imaging procedures continues at a rate of three per cent per year. For some specialist investigations such as computed tomography (CT) the growth rate far exceeds this, with some departments reporting an annual growth of more than 25 per cent.

The ability to receive and view images acquired at a geographically different location has the potential to improve markedly the provision of imaging services. Remote communities where the volume of work would not support the services of a whole time radiologist, now have the potential to benefit from the same level of service as a major centre, at least for simple imaging investigations. Weekly or fortnightly visits by a reporting radiologist with the inherent delays that this involves, can now be replaced by immediate transmission of images and rapid turnaround of the report.

Where the investigation or the condition is complex, images from any institution can be transferred immediately to a specialist centre, or to a recognised specialist for a primary report or for a second opinion. Case conferences between specialist radiologists, specialist clinicians and local doctors are possible on line. Decisions can be taken about whether the patient is treated locally, or transported to the centre for expert care.

Thirty years ago, a patient presenting with right iliac fossa pain would be seen by a surgeon and, usually, an operation would be performed. The surgery would function as both a diagnostic and a therapeutic tool. At that time, too, a patient with pleuritic chest pain and shortness of breath would have a chest x-ray and

# Why has teleradiology caused so much unhappiness?

would start on heparin prior to a lung scan performed the next day.

This approach has been largely replaced by immediate multi-slice CT (MSCT) or CT pulmonary angiography (CTPA), regardless of the time of day that the patient presents. The requirement for 24/7 radiology, or at least something very similar, is becoming compelling; not easy even for training departments let alone smaller district general hospitals to deliver. How much easier then if the images could be read by a radiologist who was already awake, a night service either locally provided, or located in a part of the world where it was 10am rather than midnight?

If volume of work is a problem, why not use teleradiology to transmit images to where there are teams of radiologists waiting to provide a reporting or reading service?

## What's in it for the patient?

The potential benefits to the patient are significant:

- Access to local provision of image acquisition and, where necessary, immediate access to expert opinion even if this is at many miles distant;
- Speed and turnaround time of reports are said to be enhanced by the judicious use of teleradiology service providers;
- Immediate availability of appropriate emergency investigations even if the local hospital does not have an on-call radiologist; and,
- The radiologist reporting the images is not the same one who was awake at 3am the previous morning reporting someone else's emergency CT.

## What's in it for the hospital and the National Health Service?

Teleradiology has the potential to address lack of local expertise, shortfalls of radiology provision, peaks and troughs of demand, backlogs of work, out-of-hours workload and availability of expert opinion. It opens up the world as a skills resource for the NHS to exploit.

## What's in it for the radiologist?

Teleradiology offers the radiologist the opportunity to review images from home rather than attending the hospital out of hours. Workload could be managed more effectively, and the potential for shared provision across the world could allow defined working patterns and achieve improvements in work life balance, if it were possible to co-ordinate radiology services across different time zones.

## What's in it for the radiographer?

Teleradiology makes new demands on radiographers and places new responsibilities on them. Working in departments without the presence of a



# It has the potential to address lack of local expertise

radiologist necessitates greater responsibility for justification, for triage and for the prioritisation of patients. Preliminary interpretation of images is likely to be a greater part of the work of a radiographer as decisions relating to emergency image transfer and the urgency of formal review become crucial to proper patient management. More demanding certainly, but also potentially much more rewarding.

## Too good to be true?

There is much that can be learned from the use of teleradiology to deliver outsourced services. A far higher proportion of images are double reported than is the case within most of UK practice; audit of the service is structured and regular and undertaken by independent radiologists, and turnaround time for the report is at a level that in most UK hospitals is only dreamt about.

Does this sound all too good to be true? Sadly, the answer is 'yes'. What is it that challenges this vision of Nirvana for medical imaging? The drivers for change within radiology are not simply those that will improve patient care. Medical imaging relies on expensive technology and uses expensive experts (radiological and radiographic) to deliver the service. The professional groups are governed (properly) by very strict criteria of education and training accreditation and, in the case of radiologists, revalidation.

So, cost is also a driving force. The demand is for a service which is cheaper, as well as convenient; even, perhaps, located in the local supermarket where the patient can drop in for an x-ray, in between the frozen peas and the pickled onions.

Value for money is an essential part of commissioning of health care and it is right and proper that commissioners seek high quality care at a competitive price. However, quality in clinical radiology is hard to measure. Speed of service is identified as an important measure of quality and this is certainly a major contributor to the patient experience. But what of quality of report, of effect on outcome, of communication with the patient, between radiologists and clinicians, radiologists and radiographers? How are these to be managed in the virtual environment?

## Outsourcing is the issue

Much of the concern that has been expressed about teleradiology is rather more about outsourcing of services, a model that is facilitated by teleradiology rather than the technological change itself. Are the concerns valid?

Well, after the somewhat ill-fated venture to off-shore the reporting of magnetic resonance imaging (MRI) examinations to Europe, much of the outsourcing now

is to companies and to radiologists and radiology partnerships based in the UK. This has addressed the considerable difficulties that were initially encountered with structure and phraseology of reports. Nonetheless, several off-shore reporting services remain, apparently providing a service that is of high quality and valued by those who commission and use them.

If it is so good, then why are not all services outsourced and delivered through teleradiology? At present, at least, this is an issue of capacity. Those UK radiologists who are contributing to the delivery of reporting services and out-of-hours review will mostly have a day job and are unlikely to be able to extend their working days much further without compromising their performance, at least potentially. In addition, the impact of the European Working Time Directive has yet to be felt.

Teleradiology has the potential to exploit team working within the radiological and radiographic workforce. Already, highly skilled radiographers are contributing to the reporting of images in plain film radiography, in ultrasound and in some MRI and CT applications. The use of mixed teams could address some of the shortfall of capacity for image review and reporting. However, the teleradiology environment has the potential to be very isolated and isolating. The isolated reporting radiographer without immediate access to medical opinion is extremely vulnerable and such an arrangement is not effective team working, so carrying inherent risks for patients.

Surely, it must be possible to exploit the environment of other English speaking countries to expand the amount of work that can be outsourced and reviewed remotely. India has been proposed as a potential partner in such service delivery. Indeed, already in Bangalore there are services particularly for out-of-hours reporting that can address image reporting in the UK, the United States (US) and Canada. Radiologists in these institutions are registered as specialists in the host countries and therefore the issue of qualifications does not arise.

EU member states are, however, restricted currently from sending images for review outside the European zone because of issues with patient consent. The US health insurers will not reimburse providers outside of the US but it is a simple matter to furnish a preliminary report that is 'confirmed' by the reading radiologist on the morning after images were read during the previous night in India. The Indian service charges a fee that is less than that received by the US imaging department, so everyone is happy.

And, of course, India is awash with suitably qualified radiologists, isn't it? Well, actually, no. Radiologists in India are trained according to a model abandoned in the UK more than 25 years ago. The uniformity of training and accreditation seen in the UK is not replicated. The training of radiologists to Diplomate of National

Board (DNB) standard is widely considered to be equivalent to international training, but these were estimated to number approximately 3300 in 2005 by the Indian Radiology and Imaging Association. The remainder hold the DMRD, a qualification that is not considered internationally equivalent. This to serve a population of 1.08 billion; there are more radiologists in the UK serving its population of some 64 million, and the UK has fewer radiologists relative to its population than most countries in the European Union.

The European working time directive is unlikely to receive much support in this environment, particularly if high reporting rates are required to maintain financial viability of the service.

India is not the only country that is touted as having spare radiology capacity, but it is representative of the issues that are faced. Most have insufficient capacity to address the delivery of universal access to modern imaging for their own population, let alone shoring-up services within the western world. It is possible that the use of overseas contracts could contribute to the underwriting of local services in those countries, so maintaining and stimulating the retention of experienced staff rather than losing large numbers to emigration. At present, there is insufficient data to determine whether this is a realistic expectation and considerable uncertainty that it will contribute much to the worldwide delivery of imaging services, given the appetite in the west for more, and more complex, investigations.

### More outsourcing problems

There remain, however, other issues that compromise the free flow of images around the world and the delivery of reporting services from outside the UK's shores.

In the UK, the General Medical Council requires that doctors demonstrate their continued fitness to practice by the process of revalidation and it would seem essential that the same requirement is made of radiologists delivering services to UK patients, wherever the geographical location of the radiologist. Such revalidation will depend on all the components including demonstration of team working, continuing professional development, appraisal and demonstration of audit of individual practice.

Consent for images to leave the country in which they are generated remains a complex legal issue in respect of liability, although the commissioners will retain responsibility if they have commissioned services abroad.

Consent for high dose examinations may be compromised by the difficulties engendered by communication at a distance. High dose examinations may be

undertaken more frequently because of lack of availability of previous images and to ensure that the investigation has maximum yield irrespective of clinical indication.

Teaching and supervision would clearly be compromised if off-shore reporting services were to replace major components of, or the entire, local reporting services. While telecommunication, e-learning and remote supervision may offer solutions to some of the lost learning opportunities, there is, as yet, insufficient evidence to suggest that the learning experience would be equivalent. This is particularly important if low tariff examinations are sent off-shore for reporting – what then will be the training opportunities for learning first on simpler cases?

### Finally, the patient

What of the patient? Increasingly, radiologists have moved to the front line of health care delivery, discussing diagnostic and treatment options with the patient, informing the patient about the outcome of their investigation, and contributing to a service in which the patient is better informed and would like to be kept informed. Would the loss to the service by moving the radiologist back into the back room be more than compensated for by greater efficiency and would this change in practice compromise radiology recruitment? Up to this point, no radiological or radiographic post has been lost as a consequence of teleradiology. The worldwide shortage of radiologists suggests that such losses are unlikely for the foreseeable future.

The eventual role of teleradiology may, in fact, be that of improving patient care, as well as access to expert opinion, extending the role of the radiographer to provide more in the way of hands on imaging, and affording 24 hour collaboration across the world with a quid pro quo sharing of responsibility of image review across the time zones. As for communication, perhaps a new generation of young radiologists will function better than the old hands in the virtual environment of the professional chat room and 'XR Txt'.

**Paul Dubbins is a consultant radiologist at Plymouth Hospitals NHS Trust.**

Drivers for change are not simply those that will improve patient care

The isolated reporting radiographer is extremely vulnerable







# Sharing data across healthcare organisations

Stephen Gatley





Radiology ended the 20th century with PACS (picture archive and communication system) taking centre stage in the workings of almost every busy radiology department. True, United Kingdom (UK) imaging departments had been somewhat slow to move with the digital times but, by the beginning of the 21st century, all National Health Service (NHS) radiology departments had been (or were in the process of being) equipped with a film-free system for creating, storing and reviewing medical images. PACS investments by private companies have since seen an increase following the NHS lead.

Looking back only 15 years to the early days of the introduction of digital imaging in radiology, it is easy to forget the feverous debates that raged then between those that welcomed the use of the new computer screens and those that said they would never be good enough to replace traditional light box viewing.

How times have changed. As films have given way to fluorescent screens, so paper worklists have been replaced by computer programmes that plot the daily workflow of the radiographer and radiologist alike. And, in what feels like a final act of digital domination, even the radiology secretaries are now being replaced by voice recognition engines which tirelessly and (mostly) faultlessly transcribe words into digital reports.

### Digitisation gives way to virtualisation

With medicine finally beginning to move with the digital times, industrial corporations had already entered the 21st century digital age with gusto. Having seen their individual organisations benefit from the digital world, companies had started to link them together using copper and fibre optics to build super-organisations, allowing digital information to flow easily across the borders of this new 'virtual workplace'.

From car manufacturing to banking, information flows, made safe by industrial strength encryption, had broken down the borders between collaborating companies, allowing even small businesses to achieve efficiencies and profitability hitherto only possible in major multinational corporations. New forms of business also emerged alongside their more traditional cousins; Google and Yahoo to name but two, with Google laying plans to extend the reaches of its technology into every aspect of people's lives. In 2007 this saw the introduction of Google's virtual patient record Google Health<sup>1</sup>, proof, if needed, that virtualisation in medicine is fast becoming a reality.

Progress towards virtual data sharing within the healthcare economy is, however, much slower than it has been in the corporate world. Despite the fact that 'networking' is at the heart of the medical community, it seems that the fear of

the possible negative consequences of sharing data often outweighs the perceived benefits of doing so. As a result, hospital information technology (IT) departments can find themselves more focussed on maintaining patient confidentiality than they are on allowing those outside the organisation to access the data that they need. Evidence for this can be seen, for example, in tertiary referrals for cancer care, where weekly multi-disciplinary team meetings are often unable to progress patients along their urgent care pathways as a result of data that has not yet been sent from one organisation to another.

The reason for this is simple: individuals are currently more likely to get fired for compromising patient confidentiality than they are for holding up a treatment programme. Healthcare organisations are not like banks; money lost if account security is compromised can be given back but a patient's confidentiality cannot be returned in the same way. So, the need for an organisation to avoid the risk of prosecution leads to a consequential investment in systems and procedures that support this goal. And because, thus far, it is much less likely that a patient will sue because their data did not arrive on time, the need to put in place systems for security management has tended to get more management attention than the need to build systems to facilitate data exchange.

Progress towards virtual data sharing is nonetheless being made. Teleradiology, though still regarded with concern, especially when this involves overseas organisations, has become the leading edge in a wave of virtualisation initiatives that is now beginning to change the world of radiology.

The DICOM standard<sup>2</sup>, supplemented by its more recent cousin IHE<sup>3</sup>, has enabled those organisations that wish to create virtual radiology links to do so irrespective of PACS system vendor. Some radiology departments have simply viewed this as a way to access services during periods when their in-house team are not able to meet demand. Others have been looking at virtualisation as a means of putting all or part of their work out to regular sub-contract, with the expectation that this will help them to better manage the costs of delivery of radiology services.

This newly emerging potential for virtualisation to introduce price competition between local and distant radiologists is viewed with alarm by many leading figures in the field, who point out that this will be detrimental to both professional development and to patient care. At the very least, they say, UK reporting should be restricted to UK radiologists, ensuring both quality and continued professional development within national boundaries.

And yet the forces of virtualisation may be unstoppable. The relatively small amount of remote reporting that currently takes place is already leading to the emergence of a 'market rate' for a given reporting episode. This separation of the

.....  
**Bidding has  
alarmed many  
who see it  
as the end of  
radiology as it is  
known today**  
.....



# The re-invention of entire healthcare pathways

healthcare pathway into discrete components that may be carried out and paid for according to need, creates the potential for the commoditisation of medical activities. And to the extent that these may be safely and properly conducted by individuals or organisations that may be remote from the patient, virtual outsourcing is likely to form an increasing part of purchasing resources in the 21st century healthcare economy.

## Trading in radiology commodities

As the baby boom generation ages, and as controlling costs features more and more highly on government and corporate healthcare agendas, the development of increasingly sophisticated 'market' or 'trading' systems to facilitate access to healthcare commodities will be seen – and at the lowest price possible.

Evidence for this is already available in the area of radiology outsourcing. Over the past 10 years, teleradiology companies have grown up around the world, providing services such as night-time reporting for increasingly overstretched radiology departments. Until recently, the business model for these ventures was relatively simple. A PACS system is set up and a group of radiologists to do the reporting is hired – then their services are sold to whoever wants to buy them. Among the largest of these in the UK is Medica<sup>4</sup> and in the US, Nighthawk<sup>5</sup>, each carrying out radiology reporting for multiple clients connected via virtual private network links to their corporate PACS.

In many regards, this is no different from one hospital offering reporting services to another and, from the point of view of a radiologist, the companies concerned offer simply another form of employment with payments and contracts accordingly.

However, the recent emergence of websites that are designed to facilitate links between individuals wishing to offer radiology services and those that wish to buy them, suggests that these traditional models of teleradiology service delivery are about to be challenged by something that has more than a passing resemblance to a commodities trading floor.

Two examples of this are R-Bay<sup>6</sup> and TeleRays<sup>7</sup>, both launched during 2008. These offer the means by which buyers and sellers of diagnostic services can interact within the context of a 'virtual auction'. R-Bay is a European Union (EU) funded project which was initially designed to ensure free access to radiology expertise throughout the European Community, notably in those countries with limited radiology resources. TeleRays is a United States (US) venture designed to provide a marketplace to facilitate interaction between US radiologists and hospitals that wish to access their expertise. Both sites allow bidding, a development, though probably inevitable, that has alarmed many in the field who view the buying of reporting services from the lowest bidder as the beginning of the end of radiology as it is known today.

## Virtual radiology networking

As e-Bay has given rise to R-Bay, so the huge success of sites that support social networking has led to exploration of the benefits of social networking technology (Web 2.0) in the field of medicine. One such system, called PACSMail<sup>®</sup> (commercial interest declared: the author is CEO of the company that runs this service) allows radiologists to set up their own reporting practices and to develop their own network of clients without the need to invest in a PACS. The service combines Web 2.0 technology (used by Facebook and MySpace) with DICOM/PACS technology, creating a secure diagnostic imaging platform that can be accessed via standard internet broadband.

Since its launch in 2005, PACSMail has been widely adopted in the UK and is used by radiologists, orthopaedic surgeons, sports club doctors and physiotherapists, allowing them to collaborate in the delivery of a variety of virtual diagnostic and treatment support services. These range from simple remote reporting of radiological images to more complex services that can be provided through using the system; for example, to share information with more than one clinician, such as may be required in the event of a sports injury where the advice of a remote radiologist and an expert in knee surgery may be critical in making decisions about injury and rehabilitation management.

PACSMail challenges the conventional view of a healthcare information network. It not only allows those providing reporting services to link together across organisational boundaries, but also enables the referring clinician's desktop to become an integral part of the flow of information between those that need to work together to provide multi-disciplinary, cross-organisational healthcare. The service overcomes the need, for example, to send copies of scans by post, eliminating the difficulties experienced by receiving clinicians who no longer need to work out how to access files from yet another (possibly encrypted) CD, and all within the precious few minutes that they have with the patient. PACSMail also avoids the need to learn how to use multiple web-PACS browsing interfaces; there is a limit to the number of different log-in and user interfaces that any one clinician can happily, let alone safely, handle.

The benefits of Sybermedica's PACSMail platform are perhaps best described by Chelsea Football Club's Doctor, Bryan English who says:

*"What Chelsea needed was a way for experts to report scans for us quickly and for us to be able to receive images and reports on-line at club level. Teleradiology was obviously the way forward but the technology at that time was very much focused on the needs of hospitals and not the needs of referring doctors, especially where they are working within large sporting organisations such as Chelsea. PACSMail has taken teleradiology to a whole new level, allowing the rapid sharing of key diagnostic information between reporting radiologists, club doctors, surgeons and physiotherapists.*

*Keeping accurate long-term records of scans and reports is an increasingly important part of medical record keeping at any club, especially within the Premier League. We are now able to use PACSMail as a central repository for information, with on-screen viewing from several workstations on the network. We can also view files from the Academy images store and we can move information to and from the archive as needed. This approach means that Chelsea's digital access to diagnostic images is now on a par with some of the best hospital information systems in the country".<sup>9</sup>*

## Virtual wound care

Virtualisation technology has also proved highly successful when applied to the care of leg ulcers by one of the UK's leading vascular surgeons, Simon Dodds. He has developed a virtual process mapping tool – the Care Pathway Simulator<sup>10</sup> that allows him to predict the most efficient way of managing the resources available to him in his outpatient clinic. Using this to carry out process mapping of his leg ulcer clinic, Dodds has found that he can radically improve the throughput of patients through his clinic, allowing him to reduce his waiting times to zero.

Dodds has also designed software that creates virtual networking links between himself and his specialist wound care nurses. Working with them to understand how to share the right information with him (wound charts, photographs, etc), and at the right time, he and his team have been able to build a virtual networking system that supports the nurse in the community, improving patient care without the need for patients to visit him in his clinics. This has the added benefit of freeing up his own time so that, when his intervention is needed, this happens quickly, ensuring better long-term outcomes for his patients.

Dodds tells the story of his virtual medical innovations<sup>11</sup> in his book, *Three Wins* – a win for his patients, his nurses and his employer (actually its four wins because Dodds is also very happy with the outcome).

## Summary

It is truly amazing that it has taken only 15 years to move from a time when clinicians had serious doubts about the use of computer screens to replace light boxes, to the situation today where members of the same profession are beginning to bid on-line for the right to provide healthcare services via the internet.

There are, of course, very valid reasons why there should be concern about the potential negative impact that this may have on both patient safety and professional development in a clinical context. But to focus only on the downside of the new virtual world of medicine is to ignore the potential gains that arise when clinicians are given the means to collaborate in ways that break down the monopoly that major healthcare providers have traditionally held over the delivery of healthcare services.

The combination of virtualisation and commoditisation in healthcare provides a new opportunity for clinicians to create and own their own virtual practices with little or no investment in capital equipment. An innovative vanguard of radiologists have already begun to do so and these early adopters are being followed by a larger cohort of mainstream providers, some of whom are joining group practices set up by early adopters, while some are setting up practices of their own.

These emerging healthcare entrepreneurs add both breadth and depth to the virtual skill-set which is now on offer to healthcare organisations both large and small. It is probable that this will, in time, lead to the emergence of a substantial and active market in healthcare services trading. Clearly, these commodities are not yet featuring on the screens of stock market traders but, if there is already room for two on-line auction houses for radiology service commodity trading, then it will not be long before others emerge. These will then be followed by ever more innovative trading 'instruments', which may include trading in futures, designed to help healthcare organisations avoid price fluctuations in diagnostic services procurement, just as they already do for other commodities such as energy.

The decisions made about how to provide access to healthcare data across organisations will therefore have an impact that goes far beyond the current focus on protecting patient confidentiality; these decisions have the power to allow the re-invention of entire healthcare pathways, and to redistribute workload across new forms of cross-organisational, multi-disciplinary, virtual clinical partnerships.

In the end, the success of any patient episode relies in part on clinicians being able to add value to information as it is gathered along the care pathway. Virtualisation will increasingly help them to do this effectively, and at the lowest possible cost.

**Stephen Gatley is chief executive officer of Sybermedica Ltd.**

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